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INFLUENCE OF BOVINE SOMATOTROPIN ADMINISTRATION TO HOLSTEIN STEERS ON GROWTH, LIPID METABOLISM, AND CARCASS CHARACTERISTICS

presented by

Michael L. Schlegel

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# INFLUENCE OF BOVINE SOMATOTROPIN ADMINISTRATION TO HOLSTEIN STEERS ON GROWTH, LIPID METABOLISM AND CARCASS CHARACTERISTICS

By

Michael Lynn Schlegel

A DISSERTATION

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ABSTRACT

INFLUENCE OF BOVINE SOMATOTROPIN ADMINISTRATION TO HOLSTEIN STEERS ON GROWTH, LIPID METABOLISM AND CARCASS CHARACTERISTICS

By

Michael Lynn Schlegel

Two experiments were conducted to study the effectiveness of bovine somatotropin (bST) to alter the growth, carcass characteristics and lipid metabolism of Holstein steers. The first evaluated the effectiveness of long-term (354 d) bST administration to growing-finishing Holstein steers at the beginning, end or during the entire feeding period on lean, skeletal, and carcass measurements. One hundred and sixty-eight Holstein steer calves (185 kg) were blocked into four body weight (BW) groups and randomly allocated to initial harvest (8 steers) or four treatments (10 steers/treatment) within a block. Treatments were control, no bST; bST d 0 to 182; bST d 183 to harvest; and bST d 0 to harvest. Doses were 320 mg bST/14-d injection from d 0 to 112 and 640 mg bST1/14-d injection from d 113 to harvest. Two steers from each block were harvested on d 199 with the remaining steers harvested when block BW averaged 615 kg. The last treatment was administered 31 d before harvest. Administering bST to young, light-weight Holstein steers increased skeletal growth and reduced carcass fat content producing a leaner product. Somatotropin increased noncarcass components without increasing carcass weight. Steers receiving bST during the entire study showed the greatest effects with the majority of lipid reduction occurring during the latter part of the study. Somatotropin increased protein accretion and therefore red

meat yield.

The second study evaluated the effect of bST administration to Holstein steers on measures of lipogenesis and lipolysis during the latter half of the feeding period when fat deposition was the greatest. Twenty-eight Holstein steers (460 kg) were blocked by weight and randomly assigned to an initial harvest group (8 steers), or to 116 daily treatments of control (no bST, 10 steers) or bST (100 μg bST/kg BW, 10 steers). Three perirectal adipose tissue (AT) biopsies were collected from each steer (5 to 16 d before treatment and 40 to 49, and 103 to 112 d after treatment). Lipogenesis was measured in triplicate in vitro as tritium incorporation into fatty acids, fatty acid synthase activity, and NADP-isocitrate dehydrogenase activity. Lipolysis was measured in triplicate in vitro by glycerol release from AT and in vivo by a seven-dose epinephrine challenge administered intravenously beginning on d -24, 32 and 95. It was clear that somatotropin improved the efficiency of carcass protein accretion and content, while drastically reducing carcass lipid accretion and content. The decrease in lipid accretion was a result of depressed lipogenesis through inhibiting lipogenic enzymes and enhancing lipolysis in the adipocyte.

Bovine somatotropin was effective in reducing carcass fat and increasing edible lean in both experiments. Administering bST to young, light-weight steers increased skeletal growth and noncarcass weight, but did not increase the total carcass weight and reduced the quality grade of the carcass. Somatotropin decreased lipogenesis and increased lipolysis in AT of finishing-Holstein steers in positive energy balance.

**Dedicated to my parents,**
**Kay and G. Sidni Schlegel**

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| | |
|---|---|
| ACC | acetyl CoA carboxylase |
| ACS | acetyl CoA synthase |
| ADG | average daily gain |
| AT | adipose tissue |
| AUF | Animal Use Form |
| BW | body weight |
| βAR | beta-adrenergic receptor |
| bST | bovine somatotropin |
| BRSV | Bovine Respiratory Syncytial Virus |
| BVD | Bovine Viral Diarrhea |
| C | control |
| °C | degree Celsius |
| cc | cubic centimeters |
| cDNA | chromosomal deoxyribonucleic acid |
| cm | centimeter |
| $cm^2$ | square centimeters |
| CoA | Coenzyme A |
| CP | crude protein |
| CPM | counts per minute |
| d | day(s) |
| DES | diethyl stilbestrol |
| DM | dry matter |
| DMI | daily dry matter intake |
| DP | dressing percent |
| DPM | disintegrations per minute |
| E | efficiency of detection |
| $ED_{50}$ | one half of maximum response |
| EDTA | ethylenediaminetetraacetic acid |
| EEL | ether-extractable lipid |
| FA | fatty acids |
| FAS | fatty acid synthase |
| g | gram |
| $G_i$ | inhibitory G protein |
| $G_s$ | stimulatory G protein |
| GDP | guanosine diphosphate |
| GLM | general linear models |
| GHRF | growth hormone releasing factor |
| GDP | guanosine diphosphate |
| GTP | guanosine triphosphate |
| h | hour |
| $^3H$ | tritium |
| HCW | hot carcass weight |

| | |
|---|---|
| HSL | hormone-sensitive lipase |
| IBR | Infectious Bovine Rhinotracheitis |
| ICD | NADP - isocitrate dehydrogenase |
| IGF-I | insulin-like growth factor- I |
| i.m. | intramuscular(ly) |
| INAD | Investigational New Animal Drug |
| IU | International Units |
| kg | kilogram |
| km | kilometer |
| KPH | kidney-pelvic-heart fat |
| KRBB | Krebs-Ringer-bicarbonate buffer |
| L | liter |
| lb | pound(s) |
| m | meter |
| $m^2$ | square meters |
| M | molar |
| MCA | marrow cavity area of metacarpal bone |
| μCi | microcurie |
| ME | metabolizable energy |
| mEq | milliequivalent |
| μg | microgram |
| mg | milligram |
| min | minute |
| MJ | millijoules |
| μl | microliter |
| ml | milliliter |
| μM | micromolar |
| mm | millimeter |
| mM | millimolar |
| mRNA | messenger ribonucleic acid |
| NADPH | nicotinamide dinucleotide-phosphate |
| NEFA | nonesterified fatty acid |
| NCW | non-carcass weight |
| ng | nanogram |
| nm | nanometer |
| oST | ovine somatotropin |
| *P* | probability |
| pg | picogram |
| pH | the negative logarithm of the hydrogen ion activity |
| $PI_3$ | Parainfluenza 3-Virus |
| PIA | $N^6$-phenylisoproyladenosine |
| PI-PLC | phosphotidylinositol phospholipase C |
| PM | Psoas major |
| pST | porcine somatotropin |
| rbST | recombinant bovine somatotropin |
| REA | ribeye area |

| | |
|---|---|
| RF | Rectus femoris |
| RIA | radioimmunoassay |
| $R_{max}$ | maximum response |
| RNA | ribonucleic acid |
| s | second |
| SA | specific activity |
| s.c. | subcutaneous(ly) |
| SE | standard error |
| SED | standard error of the difference |
| SEM | standard error of the means |
| SRIF | somatostatin (somatotropin releasing inhibitory factor) |
| SS | Supraspinatus |
| ST | somatotropin (a.k.a. growth hormone) |
| STMUS | Semitendinosus muscle |
| t | time |
| TB | Triceps brachii |
| TBA | trenbolone acetate |
| TCA | total cross-sectional area of metacarpal bone |
| wt | weight |

## INTRODUCTION

After nearly 25 years (1974 to 1995) of selecting for lean, growth-type cattle, carcass characteristics have changed (NCBA, 1995). Carcass weight (HCW) and ribeye area (REA) have increased 10 and 8.5%, respectively, with backfat and kidney-pelvic heart (KPH) fat decreasing 24 and 30%, respectively (NCBA, 1995). With these changes, yield grades have improved but marbling score and the number of carcasses grading USDA choice or higher have decreased. It has been estimated that it costs the beef industry $2.4 billion per year to put excess fat on cattle and another $2 billion per year for the retail food industry to trim the excess fat from beef (H.D. Ritchie, personal communication). Carcass backfat has decreased from 1.6 cm (.62 in) to 1.2 cm (.47 in; NCBA, 1995). To meet consumer preference most packers and retailers trim carcasses to a fat trim of .64 cm (.25 in) or less (H.D. Ritchie, personal communication). Therefore, there is a need for leaner carcasses.

Second generation growth promotants (e.g.. zeranol, and estradiol) have been shown to increase ($P < .05$) ADG (9.8%), HCW (7.5%), and REA (6.8%) over non-implanted Holstein steers (Apple et al., 1991). Trenbolone acetate (TBA), a synthetic androgen with 50 times the potency of testosterone (Preston, 1987), does not increase ADG to the same extent as the estrogenic-growth promotants. The benefit of TBA is in combination with the estrogenic implants and increases ($P < .05$) the ADG of Holstein steers up to 14.8%, HCW by 9.6% and REA by 16.5% over non-implanted steers (Apple et al., 1991).

Reducing the waste fat of beef carcasses is a major industry goal.

Estrogenic implants or the combination of estrogen and TBA have increased growth of Holstein steers, but the study by Apple et al. (1991) demonstrated no significant effect on carcass fat thickness, KPH fat, or marbling score (Apple et al., 1991). Although in crossbred beef steers which received an estradiol benzoate-progesterone implant, KPH fat, marbling score and the number of steers grading choice or higher decreased compared to non-implanted control steers (Preston et al., 1995).

Recently, interest in another growth promotant, somatotropin (ST), to alter growth and carcass composition has increased. The primary goal has been to increase circulating serum levels of ST to increase milk production, increase muscle mass or increase the protein:fat ratio of the final product (Etherton and Kensinger, 1984; Etherton and Smith, 1991). When exogenous ST was administered to pigs, ADG increased 10 to 20%, feed efficiency improved 15 to 30%, lipid accretion decreased 20 to 80% with a 20 to 50% increase in protein deposition (Etherton and Smith, 1991). Responses varied in cattle administered ST.

In cattle, ADG may increase 6 to 24% (McBride and Moseley, 1991). The most pronounced effect of ST treatment is the decrease in carcass fat (McBride and Moseley, 1991). Moseley et al. (1992) showed a linear decrease in carcass fat of steers given increasing levels of ST administration (0, 33, 100 300 μg/kg BW per day). The most dramatic decease in carcass fat (55% less than control steers) was from steers treated daily with 300 μg ST/kg BW. Early et al. (1990a) did not observe a decrease in backfat thickness but the lean to fat ratio was increased .

Even though bST increases growth and decreases carcass fat in cattle, Early et al. (1990a) found that bST had no effect on HCW, but observed an increase ($P < .05$) in non-carcass weight and lower ($P < .05$) dressing percent (DP) as compared to control steers. The bST steers had 19.9% greater ($P < .10$) digesta weight. Furthermore, 75% of the non-carcass weight was due to greater gut fill which accounted for 64% of the greater live weight. Early et al. (1990a) hypothesized that by giving younger cattle ST over a longer period might increase not only non-carcass tissue, but the more economically important, carcass tissue.

A review article by Etherton et al. (1993), proposed that the decrease in adipose tissue growth from pST-treated pigs was the result of a decrease in lipogenesis rather than an increase in lipolysis. The review further stated that "metabolic effects of ST in adipose tissue of cattle and pigs are a function of energy balance . . . (and when) . . . animals are in positive energy balance, ST decreases lipid synthesis whereas the effects of lipolysis are modest at best."

Both Mikel et al. (1993) and Dunshea et al. (1992a) demonstrated increased non-esterified fatty acid (NEFA) concentrations in plasma of growing pigs administered ST. Evidence exists that plasma NEFA concentrations are elevated in ST treated animals, thus indicating an increase in lipolytic capacity (Eisemann et al., 1986). In a 266 d study, beef heifers treated with ST had plasma NEFA concentrations 26 to 46% greater than control heifers (Schwarz et al., 1993). A greater increase in lipolytic capacity of adipose tissue of bST-treated steers was shown by Boisclair et al. (1989) and Peters (1986), who demonstrated a 43 and 86% increase in NEFA response to an epinephrine challenge following 15 and 28 d of ST treatment, respectively. Few studies have been completed investigating the effect of long-term bST administration on lipolysis in finishing steers.

With the increased use of biotechnology, researchers are able to elucidate and define the mechanisms of cell action. With an understanding of the basic mechanisms of cellular lipid metabolism, new methods of modulating this system can be evaluated. Somatotropin modulates lipid metabolism by decreasing carcass fat and lipid accretion. Evidence suggests that ST uncouples insulin from its secondary messengers (Roupas, et al., 1991), producing insulin resistance (Walton et al., 1987), therefore, reducing lipogenesis and enhancing lipolysis.

The first series of objectives were to test a hypothesis by Early et al. (1990a), that administering ST to younger animals for a longer period might increase growth of carcass as well as noncarcass tissue. The second set of objectives were to further elucidate the role of ST in modulating lipid metabolism of the growing-finishing Holstein steer.

Therefore, the objectives of this dissertation were:

1) To evaluate the effectiveness of long-term ST administration to growing-finishing Holstein steers at the beginning, end or during the entire feeding period on:

    a) feedlot performance

    b) skeletal growth

    c) lean and adipose tissue accretion and body composition

    d) carcass trait characteristics

    e) internal organ growth

    f) serum IGF-1 concentration

    g) and, liver IGF-1 mRNA abundance

2) To determine the effect of long-term ST administration to finishing Holstein steers on:

   a) lipogenesis as measured by in vitro tritium incorporation into fatty acids, fatty acid synthase activity and isocitrate dehydrogenase activity

   b) lipolysis as measured by in vitro basal and epinephrine stimulated glycerol release into the media, and by in vivo NEFA and glycerol dose response to epinephrine challenges

   c) and, changes in lipogenesis and lipolysis during the finishing period

Chapter one will review the current literature regarding the use of bovine somatotropin to improve growth, reduce carcass lipid content and modulate lipid metabolism. Chapter two will outline the methodology, results and discussion of the experiment which addresses objective one. Objective two will be discussed in chapter 3, and both experiments will be reviewed in the conclusion. Raw data, detailed methodology, and animal use approval letters are contained in the appendices.

# Chapter 1

# LITERATURE REVIEW

## Regulation of endogenous somatotropin secretion

Somatotropin (ST) is a single polypeptide chain of 191 amino acids (Kopchick and Cioffi, 1991) stored and secreted by acidophile cells of the anterior pituitary gland (Bennet and Whitehead, 1983). Regulation of ST is under both positive and negative control as well as feedback inhibition. The hypothalamus produces a ST releasing factor (growth hormone releasing factor, GHRF) and an inhibitor of ST release (somatostatin, SRIF). Growth hormone releasing factor and SRIF are neurally regulated by serotonin, dopamine and catecholamines. The hypothalamus is under negative feedback control by ST and other factors of this system. Plouzek and Trenkle (1991a) determined that overall plasma ST decreases with age (5 - 15 months) in beef cattle. This was due to a decrease in ST baseline, amplitude of secretory periods, the number of ST spikes, and the amplitude of ST spikes. They further determined that the reason ST decreases with age may be due to decreased responsiveness to GHRF. Additionally, Plouzek and Trenkle (1991a) found that bulls have greater overall plasma ST concentrations, greater baseline concentrations, greater amplitude of secretory periods, and greater amplitude of ST spikes than steers. The number of secretory periods and spikes in a 12-h period were similar between bulls and steers (Plouzek and Trenkle, 1991a). This may explain, in part, why bulls gain faster and are leaner than steers. Unlike humans, plasma ST concentrations do not increase during puberty in bulls, but decreases from birth to maturity (Plouzek and Trenkle, 1991a; McAndrews et al., 1993).

Somatotropin acts directly through binding receptors on precursor bone, muscle, and adipose cells causing their proliferation, or indirectly by binding hepatocytes causing production and release of insulin-like growth factor-I (IGF-I) which acts on peripheral tissue to stimulate growth (Kopchick and Cioffi, 1991)

Although ST plays a major role in partitioning nutrients for support of physiological and developmental processes (Bauman et al., 1982), many functions are indirect and are medicated by IGF-I (Campion and Novakofski, 1990). Even though Plouzek and Trenkle (1991a) demonstrated a decrease in plasma ST concentration with age in beef cattle, plasma IGF-I concentrations increased more than three-fold in bulls and steers from 5 to 12 mo of age (Plouzek and Trenkle, 1991b). Additionally, bulls had greater plasma IGF-I concentrations than steers after 5 mo of age. Plouzek and Trenkle (1991b) suggest that IGF-I in cattle appears to be controlled by many regulator hormones including ST along with the sex hormones, insulin and thyroid hormones.

**Effect of exogenous somatotropin on plasma hormones and metabolites.**

*Somatotropin.* Boisclair et al. (1994) demonstrated that within 1 h after exogenous bovine ST (bST) administration (29.2 IU bST/d), plasma bST increased to its peak above the control and then decreased in the remaining 12 h. Eisemann et al. (1986a) and Enright et al. (1990) saw plasma bST increase to its peak within 2 h after exogenous administration with 40 μg bST/kg BW and 120 μg bST/kg BW, respectively.

Although, mean and baseline plasma bST concentrations increased with bST administration, Enright et al. (1990) determined that the number and amplitude of endogenous bST pulses decreased. Roeder et al. (1994) observed over a two-fold increase in serum bST baseline with administering 160 mg bST/wk, and observed a decrease in peak amplitude and a trend towards a decrease in the frequency of bST spikes. The decrease in frequency of bST spikes and amplitudes observed by Roeder et al. (1994) were not evident in steers receiving bST in a study by Moseley et al. (1982). Moseley et al. (1982) did observe an increase in baseline serum bST concentration and an increase in the number of bST spikes, but amplitude of the spikes was not changed. One reason for the discrepancy maybe in the mode of administration. Moseley et al. (1982) evaluated three patterns of administration; infusion, pulse (six pulses per day), or a combination. When all bST patterns were compared to the control, the number of spikes were increased (7.5 vs. 11.2 for the control and bST treatment, respectively), but only the pulse method increased the number of spikes per day as compared with infusion (13.3 vs. 9.8 spikes per 24 h, respectively) and the combination was intermediate (10.4 spikes per 24 h).

Preston et al. (1995) demonstrated a quadratic response in serum bST concentration with exogenous bST administration of 0, 80, and 160 mg bST/wk. But bST concentrations were lower for steers receiving bST than control steers. This could be explained by differences in the procedures utilized. Blood samples were collected prior to the weekly bST implant, therefore, blood was collected when the implant was depleted and combined with the fact that exogenous bST reduces endogenous secretions, could explain why bST-treated animals had reduced serum bST concentrations.

*Insulin-like growth factor-I.* Previous research (Enright et al., 1990; Dalke et al., 1992; Moseley et al., 1992; Boisclair et al., 1994; Roeder et al., 1994; Preston et al., 1995) has demonstrated that bST administration increased blood IGF-I concentrations 13 to 150% in cattle. In growing lambs, plasma IGF-I concentration increased after one week of treatment and increased three-fold after ten weeks of ST administration (Pell et al., 1990). Both Dalke et al. (1992) and Moseley et al. (1992) observed linear increases in serum IGF-I concentration with increasing doses of bST (0 to 160 mg bST/wk and 0 to 300 µg bST/kg BW, respectively).

The increase in serum IGF-I concentrations occurs rapidly after bST administration. Roeder et al. (1994) observed a 7.8% increase in serum IGF-I concentration 8 h after a 160 mg/wk dose was administered to steers and the IGF-I concentration continued to increase to 35.8% over controls at 32 h post-administration, with the elevated concentrations maintained for 88 h after the initial implantation of bST.

The liver is the main source of IGF-I in the blood (Pell, 1997). Grant et al. (1991), Coleman et al. (1994) and Ramsay et al. (1995) demonstrated a 100 to 300% increase in liver IGF-I mRNA with ST administration to pigs. Mathews et al. (1986) demonstrated an increase in liver mRNA within 2.5 h after mice were injected intraperitoneally with human ST. The increase in IGF-I mRNA abundance is transient. In both the liver (Mathews et al., 1986) and gastrocnemius muscle (Isgaard et al., 1989), IGF-I mRNA abundance decreased after reaching its peak within 12 h after a single ST injection in mice. Ramsay et al. (1995) demonstrated in pST-treated pigs, that IGF-I mRNA quantity increased 4 h after a single injection of pST, remained elevated for 12 h and began to decrease by 20 h after treatment. Grant et al. (1991) showed a 270 to 300% increase in liver IGF-I mRNA in pigs 24 h following the last pST injection of a 24-d treatment period.

*Insulin.* Somatotropin induced increase in plasma insulin has been observed in cattle (60 and 114%; Eisemann et al., 1986a; Boisclair et al., 1994, respectively), sheep (81 and 150%; Johnsson et al., 1985; Pell et al., 1990; respectively), and pigs (502 and 514%; Dunshea et al., 1992a; Hansen et al., 1997b; respectively). Schwarz et al. (1993) demonstrated a ST-dose-dependent increase in plasma insulin concentration of 15 to 84% and 37 to 118% in heifers with doses of 62 and 126 μg ST/kg BW, respectively. The drastic increase observed in pigs, described above, occurred 7 (Dunshea et al., 1992a) and 28 d (Hansen et al., 1997b) following the start of pST treatment. There is evidence that ST decreased insulin sensitivity. Hart et al. (1984) observed a reduction in the insulin-induced decrease of plasma glucose during an insulin tolerance test and Roupas et al. (1991) suggested that insulin uncouples from its second messengers.

*Nonesterified fatty acids and glycerol.* Eisemann et al. (1986a) observed a chronic elevation in plasma nonesterified fatty acids (NEFA) in growing beef heifers with bST administration, but Enright et al. (1990) and Peters (1986) observed no increase in plasma NEFA of growing steers. Pell et al. (1986) demonstrated plasma NEFA levels were unaffected by ST administration to growing lambs. Dunshea et al. (1992a) demonstrated an increase in plasma NEFA of barrows within 7 h of the first pST injection and the response increased on the second and seventh day of treatment.

It has been suggested by Boisclair et al. (1997) that the increase in plasma NEFA concentration with bST treatment of animals in positive energy balance is a result of mild disturbances or stress during blood collection. This was suggested because bST causes an increase in β-adrenergic receptor (βAR) number in rat adipocyte membranes (Watt et al., 1990), therefore, these animals respond to catecholamines to a greater extent than non-treated animals. Houseknecht et al. (1995) determined that bST increased the maximum binding of a βAR agonist to the βAR without a change in the binding affinity. Boisclair et al. (1997) cautions that proper protocol is required to prevent inadvertent responses which may suggest lipolytic activity. Eisemann et al. (1986a) demonstrated both an increase in irreversible loss and oxidation of NEFA with bST treatment in heifers. Their data further suggested that NEFA are used as an energy source and perhaps this spares oxidation of other metabolites (e.g. amino acids) during bST treatment.

Plasma glycerol concentrations were increased 31% in sheep (Doris et al., 1996) and 79% in barrows (Dunshea et al., 1992a) after receiving ST. This may be the result of triacylglycerol breakdown as suggested by Pell et al. (1990). Sechen et al. (1990) stated that because adipose tissue has very low glycerol kinase activity, alteration in plasma glycerol concentration relates to lipolysis whereas changes in NEFA concentration reflects mobilization (i.e., the difference between lipolysis and NEFA re-esterification). A consistent increase in blood NEFA and glycerol concentrations has been shown to occur in animals that are in negative energy balance. Plasma NEFA and glycerol concentrations increased 743% and 46%, respectively, in steers under a prolonged fast (Rule et al., 1985). Sechen et al. (1990) saw a 372% increase in plasma NEFA and 119% increase in plasma glycerol concentration in bST-treated lactating dairy cattle. Additionally, Peters et al. (1986) observed a 63% increase in basal-plasma NEFA with feed restriction.

*Glucose*. Plasma glucose was increased 5 and 11%, respectively, in bST-treated growing cattle (Boisclair et al., 1994) and in ST-treated lambs (Pell et al., 1990). Dunshea et al. (1992a) observed an increase in plasma glucose within 2 h after an initial injection of porcine ST (pST) to barrows. Early et al. (1990a) and Enright et al. (1990) in steers and Sechen et al. (1990) in lactating dairy cattle, did not observe an increase in plasma glucose with ST administration. Pell et al. (1990) stated that the increase in plasma glucose could be due to an increase rate of gluconeogenesis, or a decrease in peripheral glucose utilization. Boisclair et al. (1994) demonstrated a decrease in hindlimb glucose uptake in growing steers administered bST. Additionally, Hart et al. (1984) demonstrated that bST had diabetogenic activity and reduced insulin's depression of plasma glucose during an insulin tolerance test and suggested that bST decreased glucose uptake by body tissues as seen by Dunshea et al. (1992c) in pST-treated pigs. Pell et al. (1990) suggests they have unpublished data which demonstrates an increase in gluconeogenic potential by hepatocytes isolated from ST-treated lambs and therefore, glucose production may be increased, but would require an adequate supply of gluconeogenic precursors, glycerol being one.

**Effect of somatotropin on feedlot performance**

*Growth.* Additional evidence since the study by Evans and Simpson (1931) has shown a growth response in rats due to chronic ST administration. Administering ST to farm animals is of interest because as animals grow older, the proportion of fat in weight gain increases and there is a need to produce meat with less fat (Etherton and Smith, 1991). When administered exogenously, ST increased ADG 10 to 20% in pigs (Etherton and Smith, 1991) and 19 to 24% in sheep (Wise et al., 1988; and Beermann et al., 1990a, respectively). Excellent tabular summaries of the effect of ST on beef cattle feedlot performance can be found in McBride and Moseley (1991) and Moseley et al. (1992) which summarize data from heifers, steers, and bulls from 1959 to 1990. The following review will primarily focus on the effects ST has on steers. A summary of recent research on the affects of ST on beef cattle feedlot performance is presented in Table 1-1. The range in growth (ADG, kg) response to ST as compared to controls varies from -6.3 to +26%. Three studies have looked at ST dose response on feedlot performance (Dalke et al., 1992; Moseley et al, 1992; and Preston et al., 1995). Moseley et al. (1992) demonstrated ST increased ADG in crossbred steers up to a daily dose of 33 μg ST/kg BW, and decreased ADG with doses of 66 to 300 μg ST/kg BW with the 300 μg dose having the greatest reduction in gain. Observations by Dalke et al. (1992) and Preston et al. (1995) showed similar results in bST-treated cattle. In sheep, ovine ST (oST) increase lamb weight gain 19 to 24% (Beermann et al., 1990b; Wise et al., 1988), although early work by Muir et al. (1983) did not show

Table 1-1. Summary of recent studies on the effect of somatotropin on beef cattle feedlot performance

| Reference (animals used) | Initial wt., kg | Daily ST dose, µg/kg BW | Duration of treatment, d | ADG, kg [a] | DMI, kg [a] | Feed efficiency, g/kg [a] |
|---|---|---|---|---|---|---|
| Dalke et al., 1992 [b] (steers) | 378 | 0 | 28 | 1.70 | 10.5 [c] | 161 [c] |
| | -.10 | 12 | 28 | -1.2 | -5.7 | +4.9 |
| | 0 | 24 | 28 | +1.1 | -4.0 | +6.0 |
| | 0 | 49 | 28 | +5.3 | -7.0 | +13.8 |
| Moseley et al., 1992, Exp. 1 (steers) | 392 | 0 | 131 | 1.14 | 6.9 [c] | 165 [d] |
| | 0 | 33 | 121 | +7.9 [¶] | -5.8 | +13.7 [¶] |
| | 0 | 100 | 131 | -7.0 [¶] | -13.0 [¶] | +7.3 |
| | +.01 [¶] | 300 | 151 [¶] | -37.7 [¶] | -17.4 [¶] | -26.2 [¶] |
| Moseley et al., 1992, Exp. 2 (steers) | 417 | 0 | 132 | 1.10 [d] | 8.7 [c] | 126 [d] |
| | -.01 | 8.25 | 133 | -.01 | -6.9 [†] | +5.9 |
| | 0 | 16.5 | 121 | +9.0 | -3.4 | +14.4 [†] |
| | 0 | 33 | 121 | +10.8 [†] | -5.7 [†] | +17.8 [†] |
| | 0 | 66 | 135 | -3.6 | -12.6 [†] | +10.7 [†] |
| Preston et al., 1995 [e] (steers) | 379 | 0 | 84/119 [f] | 1.44 [c] | 8.1 [c] | 177 [c] |
| | -.01 | 25 | 84/119 | +3.5 | -3.7 | +6.8 |
| | 0 | 51 | 84/119 | +4.9 | -4.9 | +10.2 |
| Rathmacher et al., 1996 [g] (steers) | 357 | 0 | 140 | 1.44 | 8.26 | 171 |
| | +1.4 | 49.6 | 140 | -.6 | +2.7 | -2.9 |
| Rumsey et al., 1996 (steers) | 182 | 0 | 56 | 1.37 | 5.40 | 249 |
| | +.01 | 100 | 56 | +24.4** | +2.3 [†] | +23.2** |
| Schwarz et al., 1993 (heifers) | 286 | 0 | 257 | .91 | 7.40 | 122.8 [h] |
| | 0 | 62 | 239 | +8.5 [†] | -3.9 | +12.9 |
| | +.73 | 124 | 232 | 10.6 [†] | +.5 | +10.0 |

Table 1-1. (cont'd)

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[a]Control values are given in actual units, bST doses are percent change from controls; a difference does not indicate a statistical significance.

[b]bST dose was given as 40, 80, and 160 mg/wk.

[c]Significant linear response ($P < .10$) with increasing bST dose.

[d]Significant quadratic response ($P < .10$) with increasing bST dose.

[e]A 2 x 3 factorial experiment was conducted; with or without an estradiol benzoate progesterone-trenbolone acetate and bST doses of 0, 80, 160 mg/wk.

[f]Duration of treatment was determined by initial body-weight block.

[g]A 2 x 2 factorial experiment was conducted; with or without 120 mg trenbolone acetate and 24 mg estradiol-17β and with or without 160 mg bST/wk.

[h]Energy consumption, MJ of ME/kg of gain was decreased ($P < .05$) 11.7% with treatment of 62 µg ST/kg BW .

¶Different from control ($P < .20$).

†Different from control ($P < .10$).

**Different from control ($P < .01$).

an improvement in ADG of oST-treated lambs.

*Dry matter intake.* In the reviews by McBride and Moseley (1991) and Moseley et al. (1992), the effect of ST on dry matter intake (DMI) varies greatly. Swine treated with ST show a marked depression in DMI (Bonneau, 1991). Based on the review by McBride and Moseley (1991) and Table 1-1, when ST is given to cattle with initial weights less than 260 kg, DMI is increased and when BW is over 260 kg, DMI is decreased. There are exceptions, for example, Fabry et al. (1987) and Rathmacher et al. (1996) demonstrated a 1.5% and 2.7% increase in DMI in 439 kg heifers and 357 kg steers, respectively. Schwarz et al, (1993) did not observe an effect on DMI of heifers administered ST with a beginning weight of 286 kg. Groenewegen et al. (1990) observed a 24% increase in DMI of ST-treated bull calves and also noted an increase in digestive tract volume. The reticulo-rumen, small intestine and large intestine weights were 24, 28 and 19% greater, respectively, in ST-treated bull calves (45 kg BW, Groenewegen et al., 1990). This is also supported by Early et al. (1990b) who observed a 2% increase in DMI with ST treatment in steers (231 kg BW) and an increase in gut fill.

In the three dose response studies summarized in Table 1-1, DMI decreased linearly with increasing daily doses of bST from 3.4 to 17.4%. Cattle in those studies weighed greater than 370 kg. One plausible reason for the discrepancy in ruminants is suggested by the quote from McBride and Moseley (1991).

> "A hypothesis to explain this depression in DMI, might be that the abundance of nutrients from mobilized fat stores cannot be utilized by growing tissues at a rate fast enough to reduce circulating nutrient concentrations, therefore that animal responds by reducing DMI and bringing body to homeorhesis. On the other hand, in young growing cattle and sheep treated with somatotropin, it would be expected that the protein and energy requirement

cannot be met by mobilization of energy reserves, therefore DMI may be increased to help support the stimulated metabolic response to somatotropin."

*Feed Efficiency (gain/feed).* In cattle and sheep, the most consistent ST response is improved feed efficiency (McBride and Moseley, 1991). Studies by Enright et al. (1990) demonstrated a 4% increase in feed efficiency over controls, although in the same study steers receiving an estradiol implant exhibited a 8% increase in feed efficiency. Moseley et al. (1992) reported an improvement in feed efficiency of 14 and 7.3% when daily treatments of 33 and 100 µg bST/kg BW were administered to steers, respectively. When the daily bST dosage was increased to 300 µg bST/kg BW, feed efficiency was reduced 26.2% as compared to control steers (Table 1-1). The other two dose response studies, Dalke et al. (1992) and Preston et al. (1996) demonstrated similar results. The effect of ST treatment on feed efficiency in sheep is consistent with that of cattle. Feed efficiency was shown to increase 8 to 24% in oST-treated lambs (Muir et al., 1983; Wise et al., 1988; Beermann et al., 1990b).

The above findings are supported by studies by Early et al. (1990a) in which ST-treated steers exhibited a 12.2% increase in the efficiency of metabolizable energy (ME) intake used for gain as compared to control steers. Early et al. (1990a) showed that 75% of the noncarcass weight (NCW) of bST-treated steers was due to greater gut fill, while rumen and intestine weights were numerically 4.8% greater, than control steers. From this data, one can infer that bST-treated animals may have a greater capacity to digest and absorb nutrients. This concept is supported by a study by Moseley et al. (1982) which showed a 5% increase in dry matter digestibility and a 7% increase in nitrogen digestibility in bST-treated steers. These findings are corroborated by Lapierre et al. (1992) which demonstrated a 2% increase in dry matter (DM), energy , nitrogen, and organic matter digestibility with GHRF administration. Wray-Cohen et al. (1991) found a 3 to 4% increase in apparent nitrogen digestibility in pST-treated pigs. These researchers (Wray-Cohen et al., 1991) hypothesized that the increase was due to decreased feed intake. In other studies DM digestibility of bST-treated steers (Eisemann et al., 1986b) and N digestibility of ST-treated lambs (Pell et al., 1990) were similar to control animals.

**Effect of somatotropin on skeletal growth**

Somatotropin is considered to be the main regulator of long-bone growth (Scheven and Hamilton, 1991) and has direct effects on cartilage and indirect effects on cartilage through IGF-I (Slootweg, 1993). Both ST and IGF-I increased fetal and neonatal longitudinal metatarsal bone growth in vitro, with the response arrested with the addition of IGF-I monoclonal antibody (Scheven and Hamilton, 1991). Because anti-IGF-I antibody decreased bone growth, this suggests that ST may work through locally produced IGF-I (Scheven and Hamilton, 1991). Martinez et al. (1991) demonstrated that systemic injection of ST caused an increase in bone-protein synthesis in the tibia of normal female rats without an increase in IGF-I concentrations, again, suggesting that the actions of ST have a direct effect on bone or mediated by autocrine or paracrine mechanism, independently.

Early et al. (1990b) demonstrated that ST administration to steers increased humerus length 4.5% and rate of growth in length 45%, and femur circumference growth by 18.7%. In steers which were treated with bST from 231 to 384 kg, the increase in bone growth with bST is possible because the proximal epiphysis of cattle ossifies when cattle are 18 to 24 months of age (Emara, 1937, Sisson, 1953). Johnsson et al. (1985) observed an increase in bone circumference of the femur and humerus of ST-treated lambs, and Butler-Hogg and Johnsson (1987) demonstrated an increase in bone weight in ST-treated lambs.

Although ST stimulates growth when given exogenously, research by Greiner (1993) showed that endogenous bST and IGF-I concentrations may not reflect differences in height. For example, unselected Hereford steers had an average frame score of 1.6 which was significantly lower than the average frame score of 5.3 for Herefords selected for growth. Although frame scores were different, plasma bST and IGF-I concentrations were greater in the unselected Herefords (3.70 and 880.5 ng/ml, respectively) than in Herefords selected for growth (3.31 and 795.3 ng/ml, respectively).

In human medicine, the focus of ST treatment is to prevent osteoporosis in the elderly (Slootweg, 1993). Johnsson et al. (1985) did not find a change in bone density of ST-treated lambs. Hardt et al. (1995) in a study evaluating the relationship between estrogenic implants, ST, IGF-I and skeletal characteristics did observe an increase in circulating ST concentrations with implantation of estradiol-benzoate progesterone and tended to see an increase in the breaking load of metacarpals of implanted steers which suggest an increase bone density. Hardt et al. (1995) also observed a decrease in metacarpal length with the estrogenic implant due to the fact the estrogens inhibit long bone growth.

## Effect of somatotropin on the carcass

*Carcass Characteristics.* A review of recent studies on the effect of ST administration on beef cattle carcass characteristics is summarized in Table 1-2. In the two studies by Moseley et al. (1992), hot carcass weight (HCW) decreased with increasing ST doses. This effect was evident in studies by Dalke et al. (1992) and Preston et al. (1995). Conversely, HCW increased in the study by Rumsey et al. (1996). Carcass weight was increased 7.4% in prepubertal heifers given ST for 15 wk in a study by Vestergaard et al. (1995), but not in an earlier study (Vestergaard et al., 1993). The difference in the response may be due to dose, Moseley et al. (1992) used the highest doses and Rumsey et al. (1995) used the lightest-weight cattle. In the summary by McBride and Moseley (1991), research demonstrated there was a positive response in carcass tissue accretion with ST administration, although, not necessarily statistically significant. There was also an increase in weights of non-carcass tissues (McBride and Moseley, 1991). Early et al. (1990a) and Johnsson et al. (1985) observed significant increases in non-carcass weight (NCW) in ST-treated steers and lambs, respectively.

Early et al. (1990b) attributed 75% of the increase in NCW to an increase weight of the gastro-intestinal tract. Early et al. (1990a) theorized that by administering bST to younger, light-weight cattle, the carcass component could be increased to a greater extent than the non-carcass components. If final weight does not change, but HCW decreases and NCW increases, changes in dressing

Table 1-2. Summary of recent studies on the effect of somatotropin on beef cattle carcass characteristics [a]

| Reference | Daily ST dose, μg/kg BW | HCW, kg [b] | Dressing percent [b] | Back fat, mm [b] | Ribeye area, cm $^{2,b}$ | Marbling score [b,c] | Yield grade [b] |
|---|---|---|---|---|---|---|---|
| Dalke, et al., 1992 [d] | 0 | 331 | 60.1 | 14.0 [e] | 80.6 | 510 [e] | 3.2 [e] |
| | 12 | 0 | +1.2 | -2.1 | +3.6 | -3.9 | -9.4 |
| | 24 | +1.5 | +.2 | -1.4 | +2.5 | -9.8 | -6.3 |
| | 49 | +1.8 | +.2 | -19.3 | +4.1 | -13.7 | -15.6 |
| Moseley et al., 1992, Exp. 1 | 0 | 334 [e] | 62.7 [e] | 19.4 [e,f] | 52.7 [f] | NG [g] | NG |
| | 33 | -2.1 ¶ | -2.2 ¶ | -9.3 ¶ | +7.4 ¶ | NG | NG |
| | 100 | -2.7 ¶ | -2.2 ¶ | -28.4 ¶ | +7.2 ¶ | NG | NG |
| | 300 | -9.0 ¶ | -6.4 ¶ | -62.4 ¶ | +6.6 ¶ | NG | NG |
| Moseley et al., 1992, Exp. 2 | 0 | 356 [e] | 63.2 [e] | 23.2 [e] | 71.8 [e,f] | NG | NG |
| | 8.25 | -1.1 † | -.9 † | -6.0 † | +4.1 † | NG | NG |
| | 16.5 | -1.4 † | -1.1 † | -6.5 † | +7.8 † | NG | NG |
| | 33 | -.8 † | -.9 † | -4.7 † | +8.8 † | NG | NG |
| | 66 | -3.1 † | -2.1 † | -22.8 † | +7.0 † | NG | NG |
| Preston et al., 1995 [h] | 0 | 329 | 63.1 | 11.2 [e] | 86.1 | 490 [e] | 2.4 [e] |
| | 25 | +.9 | +3.2 | -8.0 | +2.7 | -4.1 | -8.3 |
| | 51 | +.6 | -.5 | -15.2 | +1.7 | -6.1 | -12.5 |
| Rathmacher et al., 1996 [i] | 0 | 353 | 62.5 | 6.6 | 83.5 | NG | 2.5 |
| | 49.5 | -.4 | 0 | -17.3 | -1.9 | NG | -4.0 |
| Rumsey et al., 1996 | 0 | 147 | NG | NG | NG | NG | NG |
| | 100 | +5.5 † | NG | NG | NG | NG | NG |
| Schwarz et al., 1993 | 0 | 287 | 57.7 | NG | NG | NG | NG |
| | 62 | +1.8 | +1.2 | NG | NG | NG | NG |
| | 124 | +.7 | +.7 | NG | NG | NG | NG |

Table 1-2. (cont'd)

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[a]Duration of dose and initial body weight is presented in Table 1-1.

[b]Control values are given in actual units, bST doses are percent. change from controls; a difference does not indicate a statistical significance.

[c]400 = slight, 500 = small, 600 = modest.

[d] bST dose was given as 40, 80, and 160 mg/wk.

[e] Significant linear response ($P < .10$) with increasing bST dose.

[f] Significant quadratic response ($P < .10$) with increasing bST dose.

[g]Not given in tabular form or not determined.

[h]A 2 x 3 factorial experiment was conducted, with or without an estradiol benzoate progesterone-trenbolone acetate and bST doses of 0, 80, 160 mg/wk.

[i]A 2 x 2 factorial experiment was conducted; with or without 120 mg trenbolone acetate and 24 mg estradiol-17β and with or without 160 mg bST/wk.

¶Different from control ($P < .20$).

†Different from control ($P < .10$).

percent (DP) would occur. Although, Dalke et al. (1992) and Preston et al. (1995) did not see a change in DP with increasing ST doses, both Moseley et al. (1992) and Early et al. (1990a) observed a decrease when an increasing ST dose was administered.

The greatest effect of ST treatment on carcass characteristics is the decrease in carcass fat (McBride and Moseley, 1991; Table 1-2). Dalke et al. (1992), Moseley et al. (1992), and Preston et al. (1995) showed a linear decrease in carcass backfat of steers with increasing doses of ST administration. The most dramatic was a 62.4% decrease in backfat with a daily ST dose of 300 μg/kg BW. Peters (1986) observed a 24% reduction in backfat with bST administration following 29 d of treatment, but Early et al. (1990a) did not see a difference in backfat of steers administered ST for 112 d. Additionally, Enright et al. (1990) and Preston et al. (1995) demonstrated a decrease in kidney-pelvic-heart (KPH) fat with bST administration.

In regards to marbling score, intramuscular fat content, Preston et al. (1995), Dalke et al. (1992), and Schwarz et al. (1993) observed a dose-dependent decrease in marbling score with increasing concentrations of ST (see Table 1-2 for data from Preston et al., 1995 and Dalke et al., 1992). The study by Schwarz et al. (1993) determined a 13 to 28% reduction in marbling with 62 and 124 μg ST/kg BW, respectively, with controls having a marbling score of 3.83 on a scale of 1 to 5 where 1 is poor fat and 5 is extremely fat. In conjunction with the decrease in marbling observed by Schwarz et al. (1993), they also determined that the percentage of intramuscular fat was reduced ($P < .05$) 46.6% with a daily dose of

124 μg ST/kg BW. The decrease in marbling score was translated into a decrease number of animals achieving the USDA choice quality grade (Dalke et al., 1992; Moseley et al., 1992; Preston et al., 1995), although, Early et al. (1990a) did not see a change in Canadian carcass grade with bST administration.

There was a trend towards increased ribeye area (REA) with ST administration (Table 1-2). A significant linear or quadratic response in REA due to ST was only evident in the studies by Moseley et al. (1992). The greatest response in REA was observed with a daily ST dose of 33 μg/kg BW (Table 1-2). With a decrease in carcass backfat and KPH fat, and an increase in REA, there were improvements in carcass yield grade (Dalke et al, 1992; and Preston et al, 1995; Table 1-2). Moseley et al. (1992) did not demonstrate an effect on carcass yield grade with increasing dose of ST, but as mentioned previously, did observe an decrease in backfat and an increase in REA.

*Individual muscles and internal organs.* Butler-Hogg and Johnsson (1982) observed greater muscle weight throughout the carcasses of ewe lambs treated with bST. In regards to muscle groups (primal cuts of the carcass), Early et al. (1990b) observed an increase in the flank and shank primals, and hypothesized that the flank increased to accommodate the larger gastro-intestinal tract in bST animals. Elsasser et al. (1998) observed an increase in the Rectus femoris (RF), Triceps brachii (TB), and Supraspinatus (SS) muscles with bST or in combination with 20 mg 17-β estradiol benzoate plus 200 mg progesterone. The Semitendinosus (STMUS) and Psoas major (PM) were less responsive to the hormonal modifiers which may be related to the functions of the muscle. Elsasser et al., (1998) theorized the differences in response of muscles to ST treatment may be due to 1) the muscles are already increasing in size to their maximum potential given the nutrients available and 2) in relation to function, e.g. the RF , TB and SS are involved in locomotion and therefore may respond in conjunction with long bone growth as compared to the STMUS and PM which are involved with hindlimb flexor and vertebral posture, respectively.

Early et al. (1990b) did not see a significant affect of bST on the STMUS, but the Vastus lateralis muscle exhibited a 42% increase in growth. Also, Eisemann et al. (1989) did not observe an increase in STMUS weight with bST, but did observe a 11% increase in Longissimus weight but not relative to empty BW. Brameld et al. (1996) observed an increase in IGF-I mRNA in STMUS of pigs but not the Longissimus muscle after 7 d of bST administration, but neither muscle increased in weight. Beermann et al. (1990a) did show an increase in STMUS with pST administration up to 120 μg pST/kg BW which was due to individual muscle fiber hypertrophy.

As discussed previously, NCW was increased with long-term bST administration. Part of this increase would be increases in internal organs. Moseley et al. (1992), Early et al. (1990b) and Rumsey et al. (1996), reported increases in liver and kidney weights in bST-treated steers and Schwarz et al. (1993) in bST-treated heifers. Rumsey et al. (1996) observed an increase in spleen and heart weight, but Early et al. (1990b) did not. Early et al. (1990b) did however observe an increase in lung and trachea weight with bST treatment.

*Carcass composition and accretion rates.* A consistent effect of ST administration to growing animals is increased nitrogen retention (Eisemann et al., 1986b). In the study by Eisemann et al. (1986b), they reported a 500% increase in nitrogen retained by ST-treated heifers. The increase was due to a 11% decrease in urinary nitrogen loss. These findings are supported by a 16% increase in nitrogen retention in steers (Moseley et al., 1982), and a 19% increase in nitrogen retention in lambs (Pell et al., 1990) receiving ST. Wallace and Bassett (1966) believed that the increase in nitrogen retention shown with ST administration is dependent on the associated increase in plasma insulin. The increase in plasma insulin would drive more nutrients (e.g. amino acids and glucose) into cells fueling the anabolic effects.

Early et al. (1990c) observed a greater whole-body protein accretion with bST administration, but this was due to greater noncarcass protein accretion rather than in the carcass. Protein accretion was increased 22% with bST administration in Angus-Hereford crossbred steers (Rumsey et al., 1996). Rumsey et al. (1996) demonstrated a 23.5% decrease in lipid accretion after 56 d of bST administration in light-weight cattle (182 kg initial weight, and 266 kg average final weight.) and 100 μg bST/kg BW dose. Boisclair et al. (1994) demonstrated a greater protein accretion in the hindlimb of bST-treated steers.

In conjunction with the decrease in fat, the percent protein and water increased linearly with increasing levels of bST administration (Moseley et al., 1992). Early et al. (1990b) did not see a significant decrease in total steer carcass fat, but the total lean to fat ratio was increased with ST administration. A similar response was exhibited in lambs treated with ST (Pell et al., 1990). Treated lambs had carcasses with lower fat content, increased protein, and an increased lean to fat ratio (Pell et al., 1990).

*Product quality.* Growth modifiers may increase ADG, improve feed efficiency, increase protein and decrease fat, but if the product produced is not acceptable to the public, the point is mute. Moseley et al. (1992) saw a 17 to 95% reduction in the percent of carcasses grading choice. The 95% reduction was seen in steers receiving 300 μg bST/kg BW and they did not reach market weight. At 100 μg bST/kg BW, 70% fewer carcasses graded choice. Preston et al. (1995) documented a linear decrease in marbling score (6%), and percent carcasses grading USDA choice (58%) with increased bST dosages.

Few studies have evaluated the effect of ST in cattle on the resulting tenderness of the product. In young, light-weight (223 kg at harvest) prepubertal-Friesian heifers, treated with bST for 15 weeks, lean and fat color was improved and closer to the Danish ideal (Vestergaard et al., 1995). Additionally, there was a tendency for decreased intramuscular fat percentages with bST treatment, but bST did not affect tenderness (Vestergaard et al., 1995). Vestergaard et al. (1993) observed no effect of bST treatment on Longissimus dorsi muscle pigmentation, meat color, shear force or cooking loss. They did observe a decrease in intramuscular fat. Additionally, a trained-taste panel found no differences between loins prepared as steaks from control or bST-treated heifers (Vestergaard et al., 1993).

Allen and Enright (1989), as reported by Vestergaard et al., (1993), reported taste-panel scores for tenderness and overall acceptability to be slightly lower for bST-treated animals as compared to controls. An absence of difference in panel acceptability is consistent in the lack of affect of bST-treatment on collagen content and solubility (Vestergaard et al., 1993), and glycogen content of the meat (Vestergaard et al., 1995). Bovine ST administered for eight weeks to East Friesland, Oxford, and Texel sheep did not affect meat quality in regards to ultimate pH, lightness, hue, or saturation in the loin joint (Sinnett-Smith et al., 1989). In barrows, pST administered for 18 wk reduced sensory-panel scores for juiciness of loin chops and overall tenderness (Klindt et al., 1995). There was a linear decrease in juiciness of loin chops from boars as length of pST treatment increased. Loin chops from boars receiving pST for 18 weeks had lower boar taint intensity than control boars.

Somatotropin does not always show an affect on tenderness, but when there is an effect, it is negative (Klindt, 1995). Goodband et al. (1990), Solomon et al. (1988), and Beermann et al. (1990a) observed an increase in shear force values of pork chops with pST treatment. Hagen et al. (1991) and Goodband et al. (1990) demonstrated a decrease in tenderness scores assigned by a sensory panel to meat from pST-treated pigs. A consumer study demonstrated that consumers showed no difference in preference for loin roasts from control or pST-treated pigs, but consumers did prefer ham roasts from control versus pST-treated pigs (Prusca et al., 1993).

*Combination of ST and other anabolic agents.* When ST is combined with another anabolic agents such as estradiol (Enright et al., 1990), TBA plus estradiol

(Preston et al., 1992; Rathmacher et al., 1996), or a β-agonist (Maltin et al., 1990; Hansen et al., 1997b); the combined affect is additive for specific traits. The use of estradiol and ST in feedlot steers increased ADG 12.8% and 19.3% over only ST-treatment and control steers, respectively. Also, the addition of estradiol to ST-treated steers improved feed efficiency 10% and 14.5% over only ST-treated and control steers, respectively (Enright et al., 1990).

Combining ST and TBA plus estradiol did not increase feedlot performance or alter carcass characteristics as compared to these compounds given separately (Rathmacher et al., 1996). In the study by Rathmacher et al. (1996), implanting cattle with TBA plus estradiol improved feedlot performance (ADG and feed efficiency), HCW, and REA more than administration of bST. Administering bST did alter carcass composition by increasing the weight of muscle and decreasing the fat when combined with TBA plus estradiol. Preston et al. (1995) demonstrated an additive response between ST and TBA plus estradiol on ADG and feed efficiency. Although alone, the steroid implant increased ADG and feed efficiency to a greater extent than ST alone.

In veal calves, the use of the β-agonist, clenbuterol, and ST improved feed efficiency over clenbuterol-treated calves, but only tended to improve feed efficiency over ST-treated calves. Average daily gain was not significantly different between the clenbuterol, ST plus clenbuterol, and ST treatments; although, clenbuterol plus ST tended to increase ADG 6.6% over the growth promotants individually (Maltin et al., 1990). Hansen et al. (1997b) showed additive effects of pST and the β-agonist, salbutamol, given to pigs as evidenced by increased feed efficiency, carcass protein and water accretion, longissimus muscle area, and STMUS weight.

**Lipogenesis**

Adipose tissue is responsible for more than 90% of the fatty acid (FA) synthesis in the ruminant and the majority of FA synthesis in the pig and guinea-pig (Vernon, 1980). This differs from man and birds where the liver is the main site of FA synthesis and the rat, mouse, and rabbit in which both the liver and AT synthesize substantial amounts of FA (Vernon, 1980). Acetate is the primary carbon source for FA synthesis in ruminants unlike rats, where glucose is the primary precursor. In mature ruminants, most glucose is derived from gluconeogenesis rather than derived from carbohydrate digestion and absorption in the small intestine as in monogastric animals (Vernon, 1980; Fahey, 1988). Therefore, glucose is needed to be spared for basal metabolism (Vernon, 1980). Lactate, pyruvate, propionate, methylmalonate, butyrate, and β-hydroxybutyrate are used to some extent for FA synthesis (Vernon, 1980). The use of propionate leads to odd-chained fatty acids and methylmalonate produces branched-chain FA (Vernon, 1980).

The three critical (or control) enzymes in the pathway of FA synthesis are acetyl CoA synthase (ACS), acetyl CoA carboxylase (ACC) and fatty acid synthase (FAS; Vernon, 1980). The process of FA synthesis (palmitic acid, 16 carbons) requires 8 acetyl CoA and 14 molecules of nicotinamide dinucleotide-phosphate (NADPH; Vernon, 1980). The primary source of NADPH is from the pentose-phosphate pathway. NADP-isocitrate dehydrogenase (ICD) provides the additional NADPH needed for FA synthesis above what can be produced from the pentose-phosphate pathway (Vernon, 1980).

*Regulation of lipogenesis.* Lipogenesis is regulated by both plasma metabolites and hormones (Vernon, 1980). Increased plasma acetate and glucose will increase FA synthesis. Increased plasma glucose is rarely observed in ruminants (Vernon, 1980). The increase in dietary FA reduces FA synthesis in the adipocyte of the ruminant (Vernon, 1980).

Acetyl-CoA carboxylase is regulated by both phosphorylation/ dephosphorylation and by changes in enzyme concentration (Wolf, 1996). Fatty acid synthase is only regulated by a change in enzyme concentration (Wolf, 1996). The change in enzyme concentration was found to occur via the action on the rate of mRNA transcription. Although in a summary by Girard et al. (1994), they suggest that the increase in FAS mRNA may be due to post-translational stabilization rather than only an increase in transcription. Vernon (1980) states that changes in NADPH production is determined by the rate of FA synthesis.

Total fat content of steers increases as the age at harvest increases (Koch et al., 1979; Cianzio et al., 1985; Loy et al., 1988). Associated with the increase in quantity of adipose tissue is the decrease in the number of adipocytes per gram of tissue (Cianzio et al., 1985). Pothoven et al. (1975) observed a 62% decrease in in vitro lipogenesis as crossbred steers increased in BW from 363 to 505 kg. The decrease in lipogenesis as BW increases is associated with an increase in adipocyte size and fewer cells per unit weight of tissue (Hood and Allen, 1973).

*Effect of somatotropin on lipogenesis.*

Somatotropin has been found to decrease FA synthesis in adipose tissue (AT) treated in vitro (Vernon, 1982; Sinnett-Smith and Woolliams, 1989) and Walton and Etherton (1986) demonstrated that ST can antagonize insulin's stimulation of lipogenesis in cultured porcine AT. Kramer et al. (1993) observed a 35% decrease in FA synthesis, as measured by tritium incorporation into FA, and a 56% decrease in malic enzyme activity in pigs treated with pST for 24 d. Just as with ICD, malic enzyme generates NADPH to be used in FA synthesis (Zubay, 1988).

*Glucose transport.* Harris et al. (1993) observed an 86% reduction in glucose incorporated in FA after barrows were treated 11 d with pST and reduced FAS and ICD activity (67 and 31%, respectively). Because AT biopsies are in a net degradative state a soon as they are collected, in vitro measurements of lipogenesis may be underestimates (Kramer et al., 1993). Dunshea et al. (1992c) utilized an in vivo method to determine glucose utilization rates for lipogenesis and the effect which pST had on them. Rates of glucose incorporated into lipids were reduced 76%. Specifically, glucose incorporated into triglyceride-FA was reduced 78% as compared to glucose incorporated into triglyceride-glycerol which was reduced 66%. Donkin et al. (1996) found the mRNA abundance of GLUT 4, the major insulin regulated glucose transporter in adipocytes, was not decreased with pST administration, but Kilgour et al. (1995) determined that altering plasma ST concentration in the rat caused the GLUT 4 protein to translocate from the intracellular pool to the plasma membrane when ST was decreased.

*Insulin and insulin resistance*. Blood insulin concentrations increase in ruminants that are treated with ST (Davis et al., 1969; Wagner and Veenhuizen, 1978; Hart et al., 1984; Eisemann et al., 1986a). If insulin stimulates lipid accretion, ST must be blocking insulin's affect by making the adipocytes insulin resistant. Insulin resistance is the subnormal biologic response to a specific insulin level (Moller and Flier, 1991). Insulin resistance is observed in genetically obese mice following ST administration (Roupas et al., 1991).

Studies by Walton et al. (1987) support the results of Roupas et al. (1991). Walton et al. (1987) used dose response curves to demonstrate that pST decreases the sensitivity of AT explants to insulin. Both the basal and maximally-stimulated conversion of glucose to lipid were reduced 50% and the insulin concentration which produced the half-maximum response was increased 10 fold. In addition, Walton et al. (1987) demonstrated that not only had the adipose tissue from ST-treated animals become insulin resistant, but IGF-I resistant as well. An experiment by Vernon et al. (1991a) can in part explain how lipogenesis is decreased in insulin-resistant AT.

Vernon et al. (1991a) determined the effect of insulin, dexamethasone (a synthetic glucocorticoid) and ST on FA synthesis and ACC activity of AT from wethers. Insulin and dexamethasone acted synergistically to increase FA synthesis, but this affect was blocked by ST. Although ST clearly decreased insulin's effect of FA synthesis, the total activity of ACC was unchanged. The proportion of ACC in the active state correlated to the effects seen in FA synthesis. Insulin increased activation of ACC whereas the addition of dexamethasone did not.

Somatotropin did not inhibit ACC activation after 24 h of incubation, but completely blocked the effect of insulin and dexamethasone following a 48 h incubation. The mechanism for ST blockage of insulin's action is unclear, but it is not due to a decrease in insulin binding or insulin receptor kinase activity as determined by Magri et al. (1990) in pig adipocytes. These findings suggest that a post-receptor mediator of insulin action may be affected (Roupas et al., 1991; Vernon et al., 1991; Magri et al., 1990).

*GTP-binding proteins.* One way ST may induce insulin resistance is to uncouple the insulin receptor from its signal transduction GTP-binding protein (G protein). The G proteins are heterotrimeric proteins comprised of $\alpha$, $\beta$, $\gamma$ subunits (Simon et al., 1991). The action of ligand binding to a receptor activates the G protein which induces the exchange of guanosine diphosphate (GDP) bound to the $\alpha$ subunit for guanosine triphosphate (GTP). The binding of GTP causes the $\alpha$ subunit to dissociate from the $\beta\gamma$ heterodimer. The $\alpha$ subunit-GTP complex and $\beta\gamma$ heterodimer can interact with effector proteins that are second messengers. Examples of second messengers are phosphodiesterase, phospholipase C, adenylate cyclase, phospholipase A2, and ion channels. Each second messenger is stimulated by a stimulatory $G_s$ protein and inhibited by an inhibitory $G_i$ protein (Simon et al., 1991). Work done by Roupas et al. (1991) demonstrated that ST antagonized the phosphotidylinositol phospholipase C (PI-PLC) stimulation by insulin. Although PI-PLC activity was unchanged, the results suggested ST interfered with the mechanism of signaling. As stated above, G proteins require GTP to become activated. Roupas et al. (1991) demonstrated the activation of PI-

PLC by the addition of GTP[γS], a hydrolyzable GTP analog, to the membranes from saline-treated mice. When GTP[γS] was incubated with membranes of adipocytes from ST-treated mice, PI-PLC was not stimulated. This finding suggests ST interferes with $G_i$ protein activation of PI-PLC by insulin. What happens to the $G_s$ protein of the PI-PLC pathway is unknown. In addition, ST effects on the G proteins of the adenylate cyclase pathway are unclear.

*Change in hormone activity and amount.* Vernon et al. (1991a) determined in culture, ST decreased the activation of ACC of AT from wethers. Magri et al. (1990) demonstrated a decrease in the lipogenic enzyme activities of FAS, glucose-6-phosphate dehydrogenase, 6-phosphogluconate dehydrogenase, and malic enzyme in AT of barrows treated for 7 d with pST. Additionally, Magri et al. (1990) determined that glucose transport into adipocytes was reduced 62% with pST administration, but insulin binding to the adipocyte nor the insulin receptor's tyrosine kinase activity were affected. Roupas et al. (1991) discovered that ST interferes with the signal transmission of a G protein between the insulin receptor and PI-PLC, thereby, even though insulin binding is not inhibited (Magri et al., 1990) its signal is being interrupted. Borland et al. (1994) determined that a short-lived protein may also be needed for ST to inhibit lipogenesis in sheep AT. This was determined after actinomycin D, an inhibitor of protein synthesis, blocked ST depression of lipogenesis in vitro. Ornithine carboxylase activity was shown to increase during ST treatment and coincided with the decrease in lipogenesis (Borland et al., 1994). Additionally, a polyamine may be needed for the full ST affect (Borland et al., 1994).

In addition to decreasing enzyme activation and interfering with signal transduction, ST alters ACC (Liu et al, 1994) and FAS (Mildner and Clarke, 1991; Harris et al., 1993; Donkin et al., 1996) synthesis. Liu et al. (1994) observed a 40% decrease in ACC mRNA in pST-treated barrows. Similarly, Harris et al (1993) demonstrated a 74% decrease in FAS mRNA with pST treatment for 11 d and Donkin et al. (1996) determined that FAS mRNA decreased in a linear fashion in porcine adipocytes with increased dosage of pST.

No change in ICD activity was observed in lactating ewes (Vernon et al., 1991a) and lactating cows (Lanna et al., 1995), although FAS activity decreased. In a similar fashion, Ingle et al. (1973) observed a decrease in in vitro lipogenesis, as measured by acetate incorporation into FA, with significant reduction in ACS and ACC with fasting; but did not show a significant decrease in ICD although, numerically activity decreased 15 to 30%. Additionally, Ingle et al. (1972) observed a tendency in ruminant AT for the dehydrogenase to have greater activity when rates of FA synthesis were greater.

**Lipolysis**

Lipolysis is the mobilization of AT lipids for use by other tissues of the body and requires the hydrolytic cleavage of triacylglycerols to glycerol and free FA (Vernon, 1980). Hormone-sensitive lipase (HSL) catalyzes the rate limiting step of lipolysis in adipocytes (Cordle et al., 1986), and hydrolyzes triacylglycerol to diacylglycerol and free fatty acids. The last step is the conversion of 2-monoacylglycerol to free fatty acids and glycerol and is catalyzed by monoacylglycerol lipase (Belfrage, 1985).

Reversible phosphorylation controls the activity of HSL. Activation of HSL results from phosphorylation catalyzed by cyclic AMP-dependent protein kinase (Cordle et al., 1986) and deactivated by dephosphorylation with protein phosphatase 2C (Sztalryd and Kraemer, 1994). Egan et al. (1992) demonstrated that the lipolytic stimulation of adipocytes caused the translocation of HSL from the cytosol to the lipid droplet resulting in an increase in lipolysis.

Catecholamines such as epinephrine and norepinephrine result in an almost immediate increase in plasma NEFA with a corresponding increase in plasma glycerol concentration. These compounds interact with the adipocytes βAR to increase the rate of lipolysis. Catecholamine stimulation of lipolysis can be decreased with both α- and β-adrenergic blocking agents (Vernon, 1980). Norepinephrine can be increased by stimulation of the sympathetic nervous system due to handling, injecting experimental animals, cold exposure, or hypoxia, and therefore, increase lipolysis.

Insulin is the primary antilipolytic hormone in ruminants and causes a reduction in plasma NEFA and glycerol concentration within minutes after being administered (Vernon, 1980). Insulin not only decreases the rate of lipolysis, but also decreases the rate of FA release from AT by stimulating glucose uptake and FA re-esterification. The actions of insulin on lipolysis may act through a low-$K_m$ phosphodiesterase or by inhibiting adenylate cyclase activity (Vernon, 1980). Glucose decreases plasma glycerol concentration and glycerol entry rates in sheep when administered intravenously. This effect is primarily due to an increase in insulin (Vernon, 1980). Unlike insulin and glucose, glucagon is a mild lipolytic stimulator (Vernon, 1980).

Pothoven et al. (1975) found no correlation between basal and stimulated lipolysis. Rule et al, (1992) observed a 134% increase in basal glycerol release per mg protein with increased BW of Holstein steers, from 277 to 528 kg. Because the main control of HSL activity is by phosphorylation/dephosphorylation (Vernon, 1980), an increase in basal glycerol release without an increase in epinephrine-stimulated lipolysis suggests a change in enzyme activity without a change in enzyme concentration. The same quantity of enzyme when maximally stimulated would have similar glycerol release rates. Greater lipolytic rates with changes in BW were observed in AT from perirenal (309%), omental (200%), and intermuscular (111%) depots than inner or outer backfat (Rule et al., 1992) without a change in stimulated lipolysis. Pothoven et al. (1975) observed an increase in basal glycerol release as crossbred steers increased in weight from 363 to 505 kg, but a decrease in epinephrine-stimulated lipolysis.

*Effect of somatotropin on lipolysis*

Hart et al. (1984) did not find an increased lipolytic activity in AT incubated with bST as measured by glycerol release per 4 h/g of tissue. Doris et al. (1996) found that basal glycerol release in AT was increased 59% in vitro with in vivo ST administration to sheep for 7 d. The AT from ST-treated sheep also responded to a greater extent to the β-agonist, isoproterenol, than AT from control sheep. Additionally, AT from ST-treated sheep responded less to the antilipolytic agent, $N^6$-

phenylisoproyladenosine (PIA), an adenosine analog, than control AT (Doris et al., 1996). Doris et al. (1996) did not find an increase in glycerol response to a catecholamine with ST administration. An increase in glycerol release was not observed when sheep (Vernon, 1982; Hart et al., 1984) and swine (Walton and Etherton, 1986) AT were treated in vitro with ST. Additionally, Kramer et al. (1993) and Sinnett-Smith and Woolliams (1989) did not observe an increase in glycerol release from AT of pigs and sheep treated with ST in vivo.

Dunshea et al. (1992a) suggested that the increase in lipolytic activity may in part be related to decreased insulin sensitivity, which would decrease the inhibition of lipolysis. Increased lipolytic activity may also be the result of a heightened sensitivity or responsiveness to lipolytic stimuli as suggested by Boisclair et al. (1997) and discussed previously. Through calculating grams of triglyceride mobilized per day, Dunshea et al. (1992b) determined a nearly 50% increase in lipid mobilization with pST (56 to 109 g of triglyceride mobilized per day). Although when compared to the reduction in lipid accretion ( > 200 g/d), enhanced lipolysis would constitute approximately 25% of the reduction in daily lipid accretion, the balance being reduced lipogenesis.

Peters (1986) observed an increase in plasma NEFA response area to a single epinephrine challenge with ST administration, although Peters (1986) saw a greater response with feed restriction than with ST treatment. Likewise, Sechen et al. (1990) found that lactating cows receiving bST had greater response in circulating levels of NEFA at all doses of epinephrine, and an increase in the maximum response of plasma glycerol from epinephrine challenges. As discussed earlier, glycerol response relates to lipolysis, whereas, NEFA alterations reflect mobilization (Sechen et al., 1990). Lanna et al. (1995) did not observe a increase in basal glycerol release in vitro, but an increase in HSL activity of AT was observed with bST administration to lactating cows (Lanna et al., 1995 and Liesman et al., 1995).

*Beta and alpha-2 adrenergic system.* The second possible mechanism ST enhances lipolysis of AT is to increase the number of β-receptors as compared to $\alpha_2$ receptors. Beta receptors are mediated through $G_s$ proteins and stimulate cyclic AMP through the adenylate cyclase pathway (Levitzki, 1988) and would stimulate lipolysis. Alpha-2 receptors inhibit cyclic AMP and therefore inhibit lipolysis (Levitzki, 1988). Watt et al. (1991) showed that the binding of β-receptors increased as compared to $\alpha_2$ receptors when sheep AT was incubated with ST.

Roupas et al. (1991) suggests that if ST inhibits the $G_i$ protein, then the $G_s$ protein axis would allow greater activation and subsequent stimulation of lipolysis. Doris et al. (1994) demonstrated in rats that ST alters the amount of $G_{i2}$ proteins in rat AT, which inhibits the cyclic AMP signaling systems and inhibits HSL. Decreased suppression of HSL allows greater stimulation of the enzyme producing increased lipolysis. Doris et al. (1996) did not find altered quantities of the $G_i$ protein, but found that ST alters the cyclic AMP-based signaling systems of AT by several mechanisms. The first, by increasing the maximum rate of β-adrenergic-stimulated lipolysis, due to an increase in the number of βAR; and the second by decreasing the inhibition of antilipolytic agents.

*Inhibition of antilipolytic agents.* Lipolysis might be enhanced by decreasing the response of AT to antilipolytic agents such as adenosine and prostaglandin $E_1$ or the local production of the antilipolytic agent, prostaglandin $E_2$ by the adipocyte (Doris et al., 1996). Adenosine's actions on AT mimic those of insulin and include increased glucose uptake, inhibition of lipolysis and enhanced lipoprotein lipase activity (Carey, 1995). Extracellular adenosine in AT could originate as adenine nucleotides from purinergic neurons, as adenosine transported out of endothelial cells and adipocytes, or adenine nucleotides transported out of adipocytes (Carey, 1995). Doris et al. (1996) demonstrated that AT from bST-treated sheep responded less (a higher rate of lipolysis) to the adenosine analog PIA than control sheep.

As with PIA, lipolysis in AT from bST-treated sheep was inhibited by prostaglandin $E_1$ (PGE) to a lesser extent than AT from control sheep. (Doris et al., 1996). Additionally, $PGE_2$ concentrations were lower in bST-treated sheep (Doris et al., 1996). Adipocytes release arachidonic acid when stimulated with catecholamines which can be used to synthesize $PGE_2$ by the stromal-vascular cells of AT (Richelsen, 1992). Although there was an associated increase in plasma glycerol with the decrease in $PGE_2$, the cause and effect is not clear (Doris et al., 1996).

It is clear that ST is a potent modifier of growth when given to feedlot cattle. In some circumstances ST increases ADG, decreases DMI and improves feed efficiency. Research has shown that ST can alter the composition of the carcass by decreasing the lipid content and increasing protein. Early et al., (1990a) suggested that ST should be given early in the feeding period and for a longer period of time to observe its full potential and to reap the benefits of increased red meat yield. Previous research has demonstrated the effect ST has on lipid metabolism. The majority of the decrease is through a decrease in lipogenesis but enhancement of lipolysis is possible. The question remains, what portion of the reduced lipid accretion can be attributed to lipolysis and at what point does it occur. The two studies which follow will try to answer these questions.

## Chapter 2

# USE OF GROWTH PROMOTING SUBSTANCES FOR INCREASED SKELETAL AND LEAN TISSUE GROWTH OF HOLSTEIN STEERS[1]

## Abstract

A study was conducted to evaluate the effectiveness of long-term bovine somatotropin (bST) administration to growing-finishing Holstein steers at the beginning, end or during the entire feeding period on lean, skeletal, and carcass measurements. One hundred-sixty Holstein steer calves (185 kg) were blocked into four weight groups to determine the long-term (354 d) effect. Steers were randomly allocated to four treatments (10 steers/treatment) within a block. Treatments were control, no bST (C-C); bST d 0 to 182 (bST-C); bST d 183 to harvest (C-bST); and bST d 0 to harvest (bST-bST). Steers received a s.c. injection of bST or placebo at 14-d intervals. Doses were 320 mg bST/injection from d 0 to 112 and 640 mg bST/injection from d 113 to harvest. The last treatment was administered 31 d before harvest. Steers received a 14% CP diet from d 0 to 182 and 11.5% CP from d 183 to harvest consisting of dry, whole-shelled corn and a pelleted protein-mineral supplement. Steers were harvested when BW per block averaged 615 kg. During the first 182 d, bST-C and bST-bST steers were heavier, with greater ($P$ < .05) ADG, feed efficiency, hip height and hip height gain as compared with C-C and C-bST steers. Steers receiving bST during the first part of the study had lower ($P$ < .10) carcass fat measurements but similar protein composition than control steers. From d 183 to harvest, cattle on all treatments had similar ADG, but C-bST steers

[1]This study was funded in part by Lilly Research Laboratories, Greenfield, IN and the Michigan Agricultural Experiment Station

had reduced ($P < .05$) daily DMI and greater feed efficiency than bST-C steers. Steers receiving bST (C-bST, bST-C, and bST-bST) had greater ($P < .05$) hip height and skeletal growth than C-C steers. Noncarcass weight was increased and dressing percent reduced ($P < .05$) in C-bST and bST-bST steers as compared with C-C and bST-C steers. Measurements of carcass fatness including quality grade was reduced ($P < .05$) the greatest in bST-bST steers as compared to C-C while bST-C and C-bST carcasses were intermediate. Steers receiving bST had greater ($P < .05$) carcass bone, protein and water composition and greater ($P < .05$) protein accretion than C-C steers. Bovine somatotropin was effective in reducing carcass fat and increasing edible lean. Administering bST to young, light-weight steers increased skeletal growth and noncarcass weight, but did not increase the total carcass weight and reduced the quality of the carcass.
**Key words**: Somatotropin, Steers, Lean, Skeletal growth, Carcass measurements

## Introduction

A greater awareness and demands by the consumer for healthier beef products has prompted the beef industry to wage a "war on fat". Emphasis on producing lean beef which maintains consumer acceptance is a key objective. Identification of production strategies which accomplish this goal has led researchers to investigate exogenous growth promotants such as somatotropin (ST).

Research has documented ST ability to stimulate growth and reduce carcass lipid content in pigs (Krick et al. 1993), lambs (Butler-Hogg and Johnsson, 1987), and cattle (Early et al., 1990a; Moseley et al., 1992; Preston et al., 1995; Rumsey et al., 1996). Previous results in beef cattle administered bovine ST (bST) have demonstrated greater increases in noncarcass weight than lean and skeletal tissue (Early et al., 1990a). Additionally, as cattle on high-concentrate diets increase in weight and age, carcass lipid mass increases at a greater rate than carcass protein (Owens et al., 1995). To alter carcass lipid and protein content, administration of bST to younger animals during peak periods of lean and skeletal tissue growth may increase the effectiveness of the exogenous hormone on economically important tissues. Therefore, a study was designed to evaluate the effectiveness of long-term bST administration to growing-finishing Holstein steers at the beginning, end or during the entire feeding period on lean, skeletal and organ growth; carcass characteristics and composition; serum IGF-I concentrations; and liver IGF-I mRNA abundance.

## Materials and Methods

*Animal Management.* This study was completed under the approval of the Michigan State University All University Committee on Animal Use and Care (AUF # 10/90-308-02) and under an INAD (6673-C004 - Bovine Somatotropin) issued to Michigan State University. Sixty-four to 71 d prior to the start of the study, 243 Holstein steers (116 kg) were received from Indiana and Wisconsin at the Beef Cattle Teaching and Research Center at East Lansing, MI. Upon arrival, steers were placed in partially-covered pens (4.3 m x 11.9 m, 10 to 12 steers/pen) and fed 1.36 kg of dry, whole-shelled corn, .91 kg medicated-pelleted supplement (Table

Table 2-1 - Guaranteed analysis and ingredients of medicated-supplement starter pellet[a,b,c]

| Nutrient | Guaranteed analysis |
|---|---|
| Crude protein, minimum | 25.0% |
| Crude fat, minimum | 1.0% |
| Crude fiber, maximum | 9.0% |
| Calcium, minimum | 1.5% |
| Calcium, maximum | 2.5% |
| Phosphorus, minimum | 1.0% |
| Salt (NaCl), minimum | 2.0% |
| Salt (NaCl), maximum | 3.0% |
| Vitamin A, minimum | 110,000 IU/kg |
| Vitamin $D_3$, minimum | 55,000 IU/kg |
| Vitamin E, minimum | 220 IU/kg |

[a]Ingredients: Processed grain by-products, soybean meal, meat and bone meal, linseed meal, sunflower meal, dehydrated alfalfa meal, ethoxyquin (a preservative), molasses products, monocalcium phosphate, dicalcium phosphate, calcium carbonate, sodium bicarbonate, salt, vitamin A acetate, D-activated animal sterol (source of vitamin $D_3$), vitamin E supplement, riboflavin supplement, calcium pantothenate, niacin supplement, choline chloride, vitamin $B_{12}$ supplement, ethylenediamine dihydriodide, menadione dimethylpyrimidinol bisulfite (source of vitamin K activity), manganous oxide, iron sulfate, copper sulfate, cobalt carbonate, magnesium oxide, zinc oxide, potassium chloride, and sodium selenite.

[b]Contains 2.2 g oxytetracycline/ kg of supplement.

[c]Rebound® supplement, Kent Feeds, Inc., Muscatine, IA.

2-1), and had ad libitum access to second cutting alfalfa hay and water. Steers were ear-tagged, vaccinated against IBR, $PI_3$, BVD, BRSV, and were mass medicated with 10 cc of an antibiotic mixture (225 ml long-acting penicillin, 225 ml of spectinomycin, and 50 ml of vitamin B complex). Animals with rectal temperatures of 40 °C or higher were treated for two additional days with the described antibiotic mixture.

Two weeks after arrival, steers received a booster vaccination against IBR, $PI_3$, BVD, BRSV, and initial vaccinations against *Hemophilus somnus* and *Clostridial* organisms. Steers were mass medicated with oxytetracycline (10 cc/steer, 100 mg/ml oxytetracycline), checked for growth promotant implants, dehorned and castrated as needed .

Thirty-four days prior to the initiation of the study, the medicated supplement was removed from the diet, and replaced by a 50% CP pellet (Table 2-2), and steers were given a 2 ml injection of Vitamin E and Selenium (Mu-SE®, Schering-Plough Animal Health, Kenilworth, NJ). The steers were fed a 14% CP diet consisting of 86% dry, whole-shelled corn and 14% pelleted supplement until the initiation of the study.

One hundred and sixty eight steers (185 kg) were selected from the initial 243 animals based on breed characteristics, ADG, and health history. Eight steers were used as an initial harvest group to determine initial tissue weights (Table A-1a) and body composition (Table A-1b). The remaining 160 steers were divided into four weight blocks and randomly assigned to one of four treatments (10 steers$\bullet$treatment$^{-1}\bullet$block$^{-1}$). The four treatments were:

Table 2-2. Guaranteed analysis and ingredients of pelleted supplement[a]

| Nutrient | Guaranteed analysis |
|---|---|
| Crude protein, minimum[b] | 50.0% |
| Crude fat, minimum | .4% |
| Crude fiber, maximum | 4.0% |
| **Active drug ingredient** | **Content** |
| Monensin sodium | 330 mg/kg |
| Tylosin phosphate | 132 mg/kg |

[a]Ingredients: soybean meal, calcium carbonate, urea, flash dried blood meal, corn distillers dried grains with solubles, salt, vitamin A acetate, D-activated animal sterol (source of vitamin $D_3$), vitamin E supplement, ethylenediamine dihydriodide, manganous oxide, ferrous sulfate, copper sulfate, cobalt carbonate, zinc oxide, and sodium selenite.

[b]Includes no more than 10.0% equivalent crude protein from non-protein nitrogen.

| | | |
|---|---|---|
| 1) | Control: no bST, d 0 to harvest | C-C |
| 2) | Control: d 0 to 182, bST: d 183 to harvest | C-bST |
| 3) | bST: d 0 to 182, Control: d 183 to harvest | bST-C |
| 4) | bST: d 0 to harvest | bST-bST |

Steers were housed in partially covered pens (4.3 m x 11.9 m) with ad libitum access to feed and water. The diet consisted of dry, whole-shelled corn and a pelleted supplement (Table 2-2); and formulated to meet or exceed NRC (1984) requirements. During the first 182 d, steers received a 14% CP diet and a 11.5% CP diet from d 183 to harvest, based on component analyses.

Two steers from each pen (32 steers total, 16 control, 16 bST treated) were randomly selected for harvest when treatments were changed (intermediate harvest). These steers received their last treatment injection on d 168 and remained with their treatment group until d 199 when steers were transported to a commercial-harvest facility for processing. In order to address the objective of strategic timing of bST administration, 64 steers remained on their initial treatment after d 182, or were switched to the opposite treatment to provide the four different treatment groups as previously described. Steers were harvested when weight blocks were predicted to reach 615 kg and a 31 d withdrawal period from last treatment was observed. Blocks were harvested on d 322, 350, 364, and 377, with final weights of 611, 609, 602, and 619 kg, respectively. The INAD required a 31 d withdrawal period from the last bST dose before cattle went to harvest.

If a steer gained (ADG) less than 50% of its pen-mates for two consecutive weight periods (28 d), the steer was removed from the study. Thirty steers were removed from the study. These included: 22 for gaining 50 % less than their pen mates, 3 for respiratory problems, 2 died, 1 was lame, 1 was not completely castrated, and 1 was incorrectly treated prior to harvest (see Appendix A-2).

*Preparation and administration of treatments.* Bovine somatotropin (Lilly Research Laboratories, Greenfield, IN) and control treatments were preloaded in 10 cc syringes and frozen till used. The carrier agent was white wax. One hour before administration, the required number of bST and control treatments were thawed at room temperature. Steers received a s.c. bST or control (placebo) injection (16 gauge needle) at 14-d intervals beginning on d 0. From d 1 to 42, injections were administered in the mid-thoracic region just caudal to the shoulder, on alternating sides. From d 43 to harvest, treatments were given s.c. in the perirectal area. Dosages of bST administered were 320 mg bST/injection (22.9 mg/d, lot # 48631) from d 0 to 112 and 640 mg bST/injection (45.7 mg/d, lot # 48632) from d 113 to harvest. The change in dosage after 112 d were as directed by the sponsor and helped maintain the bST dose relative to BW. Control steers received a similar volume of carrier agent as the bST treatment steers. Treatments were administered between 0730 and 1100.

*Feedlot performance.* Initial, intermediate (d 182), and final weights were calculated as the average of weights taken on two consecutive days. Interval weights were determined every 14 d. Orts were weighed weekly to determine daily DMI. Feed efficiency was calculated as ADG (g) divided by daily DMI (kg/d) for a specific time period.

*Skeletal growth.* Skeletal growth was assessed through hip-height measurements (Altitude Stick, NASCO, Fort Atkinson, WI) on d 0, and 1 (averaged for initial hip height), 181, 183 (averaged for d 182 hip height), and on two consecutive days prior to harvest (averaged for final hip height). Skeletal growth (cm/d) was calculated for each period (d 0 to 182, d 183 to harvest, and d 0 to harvest) of the study.

At harvest, the right front limb was separated from the carcass proximal to the carpo-metacarpal joint (knee), placed in a labeled-plastic bag and returned to the Michigan State University Meat Laboratory for dissection. The hide, tendons, ligaments, muscle, and fat were removed from the bones, and the metacarpal bone was separated from the carpus and phalanges. The metacarpus was frozen for future analyses. Third metacarpal bone length was determined and the bones were sectioned at their midpoint and measurements obtained according to Coble et al. (1971). Medial and lateral width and depth (Figure 2-1), and circumference of the bone section were determined. Total cross-sectional area (TCA) and marrow cavity area (MCA) were determined using a compensating polar planimeter (Keuffel and Esser Co., Germany). Bone area was determined by difference (TCA - MCA). Bone volume was determined by water displacement and used to calculate bone density (g/cc).

*Carcass measurements.* At harvest, hot carcass (HCW), lungs, liver, spleen, heart, kidney, and semitendinosus muscle (STMUS) were weighed. Samples of the liver were collected from the last weight block (Block 1, lowest initial BW) to be harvested, frozen in liquid N for mRNA analysis and stored at -80 °C until analysis. After a 24-h, post-harvest chill; ribeye area (REA), 12th-rib backfat, kidney-pelvic-heart fat (KPH), marbling score, and USDA quality grade were determined.

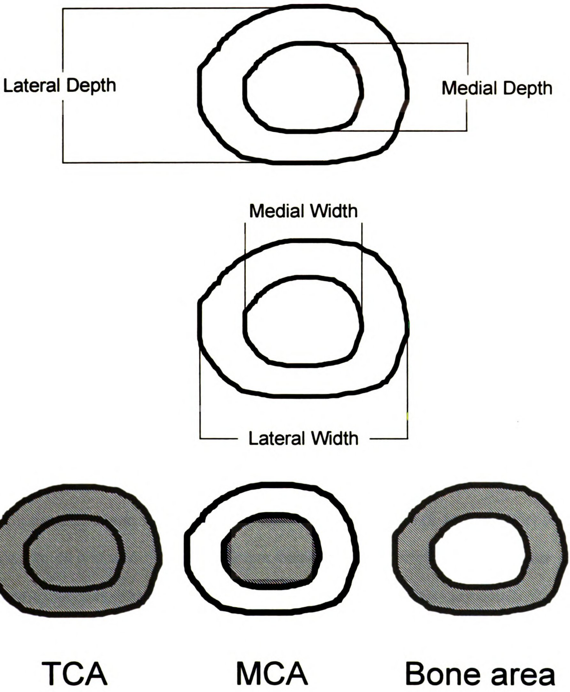



Figure 2-1. Lateral and medial measurements of sectioned metacarpals, and total cross sectional area (TCA), marrow cavity area (MCA) and bone area.

Noncarcass weight (NCW), dressing percent (DP) and yield grade were calculated. Noncarcass weight was calculated as the difference between the final harvest weight and HCW. The 9th through 13th rib sections were removed from the left side of the carcass for compositional determination and transported to the Michigan State University Meats Laboratory. The 9-10-11 rib sections were separated from the larger rib portion (Hankins and Howe, 1946), weighed and the soft tissue was separated from bone. The bones and soft tissue from each rib were weighed. The soft tissue was ground three times (once coarsely, and twice finely) with mixing in between each grind to ensure uniformity. Approximately 500 g of sample was collected and placed into a Whirlpak bag (NASCO, Fort Atkinson, WI) and stored at -30 °C. The frozen sample was homogenized with liquid N in an industrial Waring blender. Tissue samples were analyzed for DM, CP and ether-extractable lipid (EEL).

Tissue sample DM was determined in triplicate by placing 2 g of homogenized tissue in a desiccated-labeled aluminum pan (5 cm diameter) and dried for 48 h in a 55 °C oven. Tissue moisture was determined by difference. Ether-extractable lipid was determined in triplicate using samples previously dried. A cotton ball was placed in the center of each aluminum pan and the sides folded inward to prevent loss of sample and the cotton ball. The dried samples were placed in a Soxhalet apparatus and extracted with petroleum ether for 24 h. Ether-extractable lipid was calculated as the loss of weight during ether extraction.

Crude protein was analyzed in duplicate for total-Kjeldahl N (CP = N * 6.25, AOAC, 1984) using a Technicon auto-analyzer system (Bran + Luebbe Inc., Tarrytown, NY). Percent carcass bone, lipid, protein and moisture were calculated based on equations by Hankins and Howe (1946, Table A-10). Accretion rates of lipid and protein were determined from equations developed by Anderson et al. (1988) using initial harvest data and average treatment intermediate harvest data.

*Blood collection and Serum IGF-I assay.* Blood samples were collected on d 0, 7, 14, 21, 28, and 35 at the beginning of the study and prior to final harvest 7, 14, 21, and 28 d following the last treatment. To reduce influence of ST spikes on IGF-I concentrations, the evening prior to blood collection, steers were removed from feed for 16 h, and the following morning, fed .5 h prior to having blood collected by jugular venipuncture. Blocks (4 pens) were staggered every 1 h with feeding started at 0700. Blood was collected in a 10 ml, sterile blood-collection tube (Vacutainer Brand, Becton Dickinson and Co., Rutherford, NJ). Blood samples were allowed to coagulate at room temperature for .5 h and then stored at 4 °C overnight. Serum was harvested after centrifugation (959 x g, Beckman J2-21 refrigerated centrifuge, Beckman Instruments Inc. Palo Alto, CA) for 15 min at 5 °C and stored in 12 x 75 mm polypropylene tubes (Sarstedt, Newton, NC) at -20 °C until analyzed. Serum IGF-I concentrations were measured on 2 steers from each pen by radioimmunoassay (Sharma et al., 1994) after removal of insulin-like growth factor binding proteins by formic acid-ethanol extraction (Bruce et al., 1991; Sharma et al., 1994).

*Liver IGF-I mRNA abundance.* Liver IGF-I mRNA abundance was determined by Northern-blot hybridization as described by Sharma et al. (1994). Total liver RNA was isolated from 1 g of tissue using the RNA STAT-60™ reagents and procedure (Tel-Test "B", Inc. Friendswood, TX). Concentration of single-stranded RNA was determined spectrophotometrically at a wavelength of 260 nm. Samples of total RNA (20 µg) were electrophoresed on agarose-formaldehyde gels, and the separated RNA bands were electrophoretically transferred to nylon membranes. Membranes containing liver RNA were hybridized with a $^{32}P$-labeled human IGF-I cDNA (Bell et al., 1984), and the abundance of mRNA for IGF-I was quantified by densitometric scanning of the resulting band. Liver mRNA abundance was expressed as arbitrary densitometric units.

*Statistical analysis.* The study was designed as a completely randomized block. Feedlot performance (BW, ADG, DMI, and feed efficiency) was analyzed with the GLM procedure of SAS (1994) with block and treatment in the model and the pen as the experimental unit. Means for traits evaluating performance from d 0 to 182 were separated using a contrast statement to determine the difference between control (C-C and C-bST) and bST (bST-C and bST-bST) treatments during the first part of the study. Performance trait means from d 183 to harvest, were separated using a Tukey's test for all pair-wise comparisons and a contrast statement to determine the difference between control (C-C and bST-C) and bST (C-bST and bST-bST) treatments during the last part of the study.

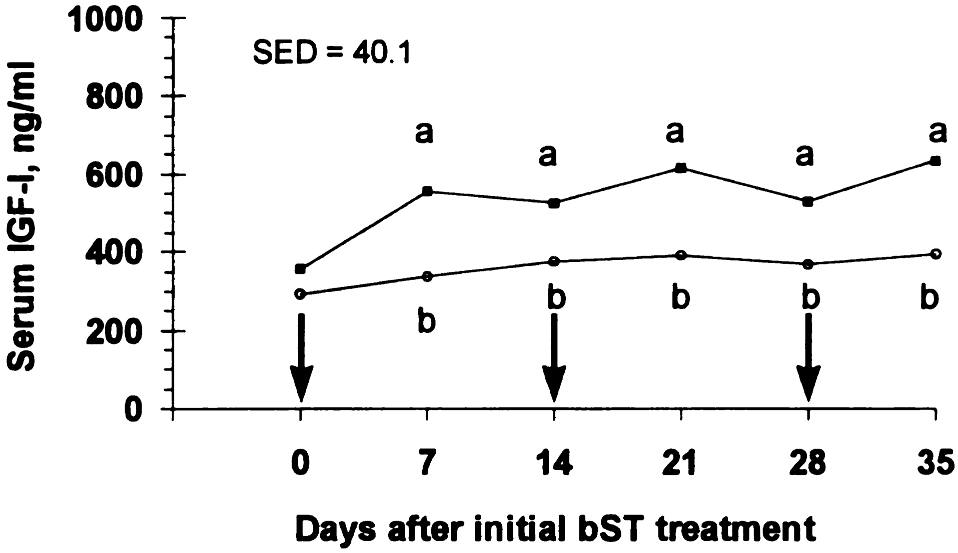
Hip height, hip-height gain, metacarpal bone characteristics, carcass characteristics, carcass composition and tissue weights were analyzed with the GLM procedure of SAS (1994) with block and treatment in the model and the animal as the experimental unit. Least square treatment means were calculated and separated using the probability of difference function. Differences between control and bST treatments for each part of the study were evaluated with contrast statements as before.

Serum IGF-I concentrations were analyzed using the univariate repeated-measures analysis of SAS (1994) with block and treatment in the model and using the animal as the experimental unit. Treatment means within a day were separated by procedure outlined in Gill (1987). In the case of serum IGF-I concentrations from the last weight block to be harvested, concentrations were analyzed with only treatment in the model. Liver IGF-I mRNA abundance was analyzed with the GLM procedure of SAS (1994) with treatment in the model and least square means separated with the probability of difference function.

One control steer, from the intermediate harvest group, was removed from the study because it received an incorrect treatment three days prior to harvest. All individual data was omitted. As discussed previously, an additional 30 steers were removed from the study and individual data omitted (see Table A-2). Raw data is provided in Tables A-3 to A-11.

## Results

*Serum IGF-I Concentrations.* Steers receiving bST had 151% greater ($P <$ .01) serum IGF-I concentrations from d 7 through d 35 of the study as compared to control steers (Figure 2-2). Following the final treatment injection, 31 d prior to harvest, C-bST and bST-bST steers had 298 and 223 % greater ($P <$ .05) serum IGF-I concentrations 7 and 14 d following the last treatment, respectively, than C-C




and bST-C steers (Figure 2-3). Twenty-one days following the last treatment, bST-

Figure 2-2. Effect of treatment, control (○) or bST (■), on serum IGF-I concentrations after initial treatment on d 0 and subsequent treatments as indicated by arrows. [a,b]Means with unlike letters differ ($P < .01$).

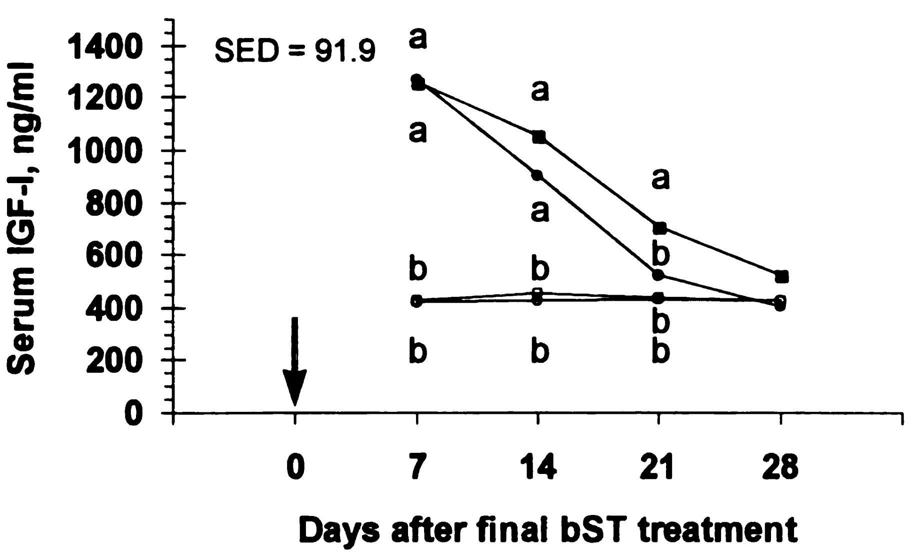



Figure 2-3. Effect of treatment, C-C (○), C-bST (●), bST-C (□), or bST-bST (■), on serum IGF-I concentrations after final treatment 31 d prior to harvest as indicated by the arrow. [a,b]Means with unlike letters differ ($P < .05$).

bST steers had 163 % greater ($P < .05$) serum IGF-I concentrations than C-C, bST-C, and C-bST steers. All steers had similar serum IGF-I concentrations 28 d following the last treatment injection.

*Feedlot performance.* Steers receiving bST during the first 182 d of the study (bST-C and bST-bST) had 5% greater BW ($P < .01$) than control steers (C-C and C-bST, Table 2-3). However, at the end of the experiment, steers had similar BW. Average daily gain during the first 182 d was 8.9% greater ($P < .01$) in steers receiving bST (bST-C and bST-bST) than control steers (C-C and C-bST). Treatment had no effect on ADG during the latter part of the study or overall.

Dry matter intake was similar among treatments for the first 182 d of the study. During the latter part of the study, C-bST steers had 9.4, 11.6, and 9.7% lower ($P < .05$) DMI compared with C-C, bST-C and bST-bST steers, respectively. Overall, C-bST steers had 7% lower ($P < .01$) DMI than C-C and bST-C steers. Steers receiving bST during the latter part of the study (C-bST and bST-bST) had lower DMI ($P < .05$) during that same period and over the entire study.

Feed efficiency was 9% greater ($P < .01$) in bST treated steers (bST-C and bST-bST) during the first 182 d as compared to control steers (C-C and C-bST). Steers receiving bST only during the latter part of the study (C-bST) had 25.6% greater ($P < .05$) feed efficiency during the latter part of the study and 6.8 % greater feed efficiency overall than bST-C steers. Steers receiving bST during the latter phase (C-bST and bST-bST) of the study had greater ($P < .01$) feed efficiency during the latter part of the study and over the entire study than C-C and bST-C steers.

Table 2-3. Effect of bovine somatotropin on body weight, average daily gain, daily dry matter intake and feed efficiency

| | Treatments | | | | | Probability | |
|---|---|---|---|---|---|---|---|
| Trait | C-C | C-bST | bST-C | bST-bST | SEM | Model | Contrast |
| No. of pens | 4 | 4 | 4 | 4 | | | |
| Body weight, kg | | | | | | | |
| Initial | 185 | 185 | 185 | 185 | 1.5 | .0001 | .81[a] |
| d 183 | 419 | 419 | 440 | 439 | 4.8 | .0002 | .002[a] |
| Final | 599 | 608 | 611 | 622 | 6.3 | .21 | .13[b] |
| Average daily gain, kg | | | | | | | |
| d 0 to d 182 | 1.29 | 1.29 | 1.41 | 1.40 | .03 | .08 | .004[a] |
| d 183 to Final | 1.06 | 1.10 | 1.00 | 1.06 | .03 | .07 | .11[b] |
| d 0 to Final | 1.17 | 1.20 | 1.21 | 1.24 | .02 | .14 | .21[b] |
| Daily dry matter intake, kg | | | | | | | |
| d 0 to d 182 | 6.79 | 6.52 | 6.61 | 6.68 | .09 | .0005 | .93[a] |
| d 183 to Final | 8.29[w] | 7.51[x] | 8.50[w] | 8.32[w] | .15 | .01 | .01[b] |
| d 0 to Final | 7.54[w] | 7.02[x] | 7.56[w] | 7.50[wx] | .11 | .01 | .03[b] |
| Feed efficiency, g gain/kg DMI | | | | | | | |
| d 0 to d 182 | 190 | 198 | 214 | 209 | 3.4 | .0006 | .001[a] |
| d 183 to Final | 128[wx] | 147[w] | 117[x] | 128[wx] | 4.6 | .01 | .009[b] |
| d 0 to Final | 156[w] | 171[y] | 160[wx] | 165[xy] | 3.0 | .01 | .007[b] |

[a]C-C and C-bST versus bST-C and bST-bST.
[b]C-C and bST-C versus C-bST and bST-bST.
[w,x,y]Means with unlike superscript letters differ ($P < .05$).

*Skeletal growth.* On d 182, hip height was increased 1.2% ($P < .01$) in steers receiving bST during the first part of the study (bST-C and bST-bST) as compared to control steers (C-C and C-bST, Table 2-4). Steers receiving bST during the entire study (bST-bST) had 3.3, 1.4, and 2.2% greater ($P < .05$) hip heights at harvest than C-C, C-bST, and bST-C, respectively. Steers receiving bST during only one part of the study, C-bST and bST-C, had 1.8 and 1.1% greater ($P < .05$) hip heights at harvest than C-C steers, respectively. At harvest, steers receiving bST during the latter part of the study (C-bST and bST-bST) had 8.8% greater ($P < .01$) hip heights than control steers (C-C and bST-C). Daily hip height gain was increased ($P < .01$) 8% in steers receiving bST during the first 182 d (bST-C and bST-bST) than control steers (C-C and C-bST). Steers receiving bST during the latter part of the study (C-bST and bST-bST) had 66% greater ($P < .01$) daily hip height gain from d 182 to harvest than C-C and bST-C steers. Overall (d 0 to harvest), bST-bST steers had 15, 7, and 10% greater ($P < .05$) daily hip height gain than C-C, C-bST and bST-C steers, respectively. Steers receiving bST during one part of the study (C-bST and bST-C) had 8 and 5% greater ($P < .05$) daily hip height gain than C-C steers.

Intermediate-harvest metacarpal bone characteristics were similar for all treatments (Table 2-5). Steers receiving bST throughout the entire experiment had greater ($P < .05$) lateral bone depth than bST-C steers at harvest. Bone area tended to be 4% greater ($P < .10$) in bST-bST steers than C-C steers. Bones of C-C steers were 3% denser ($P < .05$) than C-bST steers. (Table 2-6). At harvest, steers receiving bST during the latter part of the study (C-bST and bST-bST)

Table 2-4. Effect of bovine somatotropin on hip height and daily hip-height gain[a]

| Trait | Treatments | | | | | | | | Probability | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C-C | SE | C-bST | SE | bST-C | SE | bST-bST | SE | Model | Contrast |
| Hip height, cm | | | | | | | | | | |
| d 0 | 109.4 | .4 | 109.7 | .4 | 109.3 | .4 | 109.3 | .4 | .0001 | .47[b] |
| d 182 | 132.4 | .5 | 132.2 | .5 | 133.6 | .5 | 134.1 | .5 | .001 | .001[c] |
| Final | $136.7^{y}$ | .6 | $139.2^{x}$ | .6 | $138.2^{x}$ | .6 | $141.2^{w}$ | .7 | .002 | .0001[c] |
| Daily hip height gain, mm | | | | | | | | | | |
| d 0 -182 | 1.26 | .02 | 1.24 | .02 | 1.34 | .02 | 1.36 | .02 | .0001 | .0001[b] |
| d 183 - Final | $.24^{x}$ | .02 | $.42^{w}$ | .02 | $.26^{x}$ | .02 | $.41^{w}$ | .02 | .0001 | .0001[c] |
| d 0 - Final | $.78^{y}$ | .01 | $.84^{x}$ | .01 | $.82^{x}$ | .01 | $.90^{w}$ | .01 | .0001 | .0001[c] |

[a]Least square means.
[b]C-C and C-bST versus bST-C and bST-bST.
[c]C-C and bST-C versus C-bST and bST-bST.
$^{w,x,y}$Means with unlike superscript letters differ ($P < .05$).

Table 2-5. Effect of bovine somatotropin on intermediate-harvest metacarpal bone characteristics[a]

| Trait | Treatments | | | | Probbility | |
|---|---|---|---|---|---|---|
| | Control (C-C, C-bST) | SE | bST (bST-C, bST-bST) | SE | Model | Contrast[b] |
| Length, cm | 21.8 | .1 | 21.8 | .14 | .28 | .89 |
| Medial width, mm | 18.6 | .6 | 18.9 | .6 | .63 | .77 |
| Lateral width, mm | 35.1 | .6 | 36.0 | .6 | .28 | .30 |
| Medial depth, mm | 14.0 | .4 | 13.7 | .4 | .54 | .67 |
| Lateral depth, mm | 26.1 | .5 | 25.7 | .4 | .59 | .55 |
| Circumference, mm | 108.5 | 1.5 | 110.1 | 1.5 | .22 | .45 |
| TCA, $cm^{2}$ [c] | 8.3 | .3 | 8.3 | .3 | .63 | .94 |
| MCA, $cm^{2}$ [d] | 2.9 | .2 | 2.9 | .2 | .90 | .90 |
| Bone area, $cm^{2}$ | 5.4 | .1 | 5.4 | .1 | .32 | .75 |
| TCA/MCA | 2.9 | .1 | 2.9 | .1 | .98 | .99 |
| Density, g/cc | 2.0 | .02 | 2.0 | .02 | .98 | .58 |

[a]Least square means.
[b]Probability of difference: control versus bST.
[c]Total cross-sectional area of metacarpal bone.
[d]Marrow cavity area.

Table 2-6. Effect of bovine somatotropin on final-harvest metacarpal bone characteristics[a]

| | Treatments | | | | | | | | Probability | |
|---|---|---|---|---|---|---|---|---|---|---|
| Trait | C-C | SE | C-bST | SE | bST-C | SE | bST-bST | SE | Model | Contrast[b] |
| Length, cm | 22.44 | .11 | 22.55 | .11 | 22.59 | .12 | 22.51 | .12 | .08 | .85 |
| Medial width, mm | 19.3 | .4 | 19.4 | .4 | 18.9 | .4 | 19.7 | .4 | .66 | .58 |
| Lateral width, mm | 38.6 | .4 | 39.2 | .4 | 38.5 | .4 | 39.4 | .4 | .48 | .29 |
| Medial depth, mm | 13.8 | .3 | 14.1 | .3 | 13.9 | .3 | 14.4 | .3 | .21 | .45 |
| Lateral depth, mm | $27.5^{wx}$ | .3 | $28.0^{wx}$ | .3 | $27.3^{x}$ | .3 | $28.3^{w}$ | .3 | .20 | .06 |
| Circumference, mm | 116.6 | 1.0 | 118.2 | 1.0 | 116.2 | 1.0 | 118.6 | 1.1 | .56 | .06 |
| TCA, $cm^{2}$[c] | 9.3 | .2 | 9.6 | .2 | 9.3 | .2 | 9.6 | .2 | .66 | .08 |
| MCA, $cm^{2}$[d] | 2.9 | .1 | 3.1 | .1 | 2.9 | .1 | 3.0 | .1 | .66 | .26 |
| Bone area, $cm^{2}$ | $6.4^{k}$ | .1 | $6.5^{jk}$ | .1 | $6.4^{jk}$ | .1 | $6.6^{j}$ | .1 | .68 | .12 |
| TCA/MCA | 3.3 | .1 | 3.2 | .1 | 3.3 | .1 | 3.3 | .1 | .64 | .61 |
| Density, g/cc | $1.98^{w}$ | .02 | $1.92^{x}$ | .02 | $1.94^{wx}$ | .02 | $1.93^{wx}$ | .02 | .0001 | .22 |

Table 2-6. (cont'd)

[a]Least square means.
[b]Probability of difference:  C-C and bST-C versus C-bST and bST-bST.
[c]Total cross-sectional area of metacarpal bone.
[d]Marrow cavity area.
[j,k]Means with unlike superscript letters differ ($P < .10$).
[w,x]Means with unlike superscript letters differ ($P < .05$).

tended to have greater lateral bone width ($P < .10$) lateral bone depth ($P < .10$), bone circumference ($P < .01$), and TCA ($P < .10$) than control steers (C-C and bST-C).

*Carcass characteristics, composition and organ weights.* After 182 d, harvest weight, HCW, NCW, DP, measures of REA or backfat were similar among treatments as determined in the intermediate harvest group (d 199, Table 2-7). Steers receiving bST for 182 d had 30% lower ($P < .05$) KPH, 10% lower ($P < .10$) marbling score, 6% lower ($P < .05$) USDA quality grade, and 12% lower ($P < .05$) calculated yield grade than control steers.

At final harvest, C-bST and bST-bST had 5.5% greater ($P < .01$) NCW, and 3% lower ($P < .01$) DP (Table 2-8). Steers receiving bST only during the latter part of the study (C-bST) tended to have greater carcass ($P < .10$) REA expressed as $cm^2$/kg HCW than bST-C steers at the final harvest. Backfat thickness at final harvest was 24% lower ($P < .05$) in bST-bST carcass than C-C and bST-C carcasses. Steers receiving bST during the latter part of the study (C-bST and bST-bST) had 40% less KPH than C-C and bST-C carcasses. Marbling score decreased ($P < .05$) 21, 19, and 31% in C-bST, bST-C, and bST-bST carcasses, respectively, as compared to C-C carcasses. Steers receiving bST throughout the study (bST-bST) had 13% lower ($P < .05$) marbling scores than steers receiving bST during only one part of the study (C-bST and bST-C). Quality grade was decreased ($P < .05$) 7, 7 and 12% in C-bST, bST-C, and bST-bST carcasses, respectively, as compared to C-C carcasses. Steers receiving bST throughout the study (bST-bST) had 5% lower ($P < .05$) quality grade than C-bST and bST-C.

Table 2-7. Effect of bovine somatotropin on intermediate-harvest carcass characteristics[a,b]

| | Treatments | | | | Probability | |
|---|---|---|---|---|---|---|
| Trait | Control (C-C, C-bST) | SE | bST (bST-C, bST-bST) | SE | Model | Contrast[c] |
| Number of steers | 15 | | 16 | | | |
| Harvest wt., kg | 439 | 5 | 448 | 5 | .0001 | .20 |
| HCW, kg | 247 | 4 | 251 | 3 | .0006 | .45 |
| NCW, kg | 192 | 3 | 197 | 3 | .001 | .15 |
| DP, % | 56.3 | .4 | 55.9 | .4 | .57 | .50 |
| Ribeye area, $cm^2$ | 64.9 | 1.3 | 66.4 | 1.2 | .84 | .41 |
| Ribeye area, $cm^2$/kg HCW | .263 | .005 | .266 | .004 | .03 | .73 |
| Backfat, mm | 3.4 | .3 | 3.0 | .3 | .3 | .37 |
| KPH, % | 3.4 | .16 | 2.4 | .15 | .004 | .001 |
| Marbling score[d] | 461 | 18 | 413 | 17 | .26 | .06 |
| Quality grade[e] | 16.9 | .3 | 15.9 | .3 | .21 | .04 |
| % Choice | 26.7 | | 12.5 | | | |
| % Select | 60.0 | | 43.8 | | | |
| % Standard | 13.3 | | 43.8 | | | |
| Calculated yield grade | 2.4 | .08 | 2.1 | .08 | .04 | .02 |

[a]Least square means.
[b]d 199 of study, steers received last treatment on d 168.
[c]Probability of C-C and C-bST versus bST-C and bST-bST.
[d]400 = slight, 500 = small.
[e]15 = high standard, 16 = low select, 17 = high select.

Table 2-8. Effect of treatment on final-harvest carcass characteristics [a]

| | Treatments | | | | | | | | Probability | |
|---|---|---|---|---|---|---|---|---|---|---|
| Trait | C-C | SE | C-bST | SE | bST-C | SE | bST-bST | SE | Model | Contrast [b] |
| No. of steers | 25 | | 25 | | 26 | | 24 | | | |
| HCW, kg | 358 | 4.4 | 355 | 4.3 | 362 | 4.4 | 360 | 4.5 | .95 | .75 |
| NCW, kg | $240^{x}$ | 3.5 | $253^{w}$ | 3.5 | $248^{x}$ | 3.5 | $262^{w}$ | 3.6 | .0003 | .001 |
| DP, % | $60.0^{w}$ | .31 | $58.4^{x}$ | .30 | $59.4^{w}$ | .31 | $57.9^{x}$ | .31 | .0001 | .001 |
| REA, $cm^2$ | 78.2 | 1.5 | 80.3 | 1.5 | 77.9 | 1.5 | 79.0 | 1.6 | .54 | .67 |
| REA, $cm^2$/kg HCW | $.219^{jk}$ | .004 | $.226^{j}$ | .004 | $.216^{k}$ | .004 | $.219^{jk}$ | .004 | .15 | .26 |
| Backfat, mm | $6.80^{w}$ | .51 | $5.64^{wx}$ | .50 | $6.59^{w}$ | .51 | $5.09^{x}$ | .52 | .03 | .07 |
| KPH, % | $3.3^{w}$ | .1 | $2.0^{x}$ | .1 | $3.1^{w}$ | .1 | $1.8^{x}$ | .1 | .0001 | .001 |
| Marbling score [b,d] | $657^{w}$ | 17 | $517^{x}$ | 17 | $533^{x}$ | 17 | $456^{y}$ | 18 | .0001 | .001 |
| Quality grade [d] | $19.1^{w}$ | .2 | $17.7^{x}$ | .2 | $17.8^{x}$ | .2 | $16.8^{y}$ | .2 | .0001 | .001 |
| % Prime | 16.0 | | 0 | | 0 | | 0 | | | |
| % Choice | 80.0 | | 65.4 | | 72.0 | | 25.0 | | | |
| % Select | 4.0 | | 30.8 | | 28.0 | | 66.7 | | | |
| % Standard | 0 | | 3.8 | | 0 | | 8.3 | | | |
| Calculated yield grade | $3.0^{w}$ | .1 | $2.5^{x}$ | .1 | $3.0^{w}$ | .1 | $2.5^{x}$ | .1 | .0001 | .001 |

Table 2-8. (cont'd)

[a]Least square means.
[b]Probability of contrast: C-C and bST-C vs. C-bST and bST-bST.
[c]400 = slight, 500 = small, 600 = modest, 700 = moderate.
[d]16 = low select, 17 = high select, 18 = low choice, 19 = average choice.
[j,k]Means with unlike superscript letters differ ($P < .10$).
[w,x,y]Means with unlike superscript letters differ ($P < .05$).

Calculated yield grade of C-bST and bST-bST carcasses were 16.7% lower ($P < .05$) than C-C and bST-C carcasses.

Semitendinosus muscle, liver, lung, and spleen weights did not differ between treatments of the intermediate-harvest group (Table 2-9). Steers receiving bST during the first part of the study had smaller hearts relative to BW than control steers, but bST steers tended to have larger ($P < .10$) kidney weights on an absolute (9.2%) and relative (7.1%) basis than control steers.

At the conclusion of the study, C-bST and bST-bST steers had 6.9% greater ($P < .05$) STMUS than C-C steers (Table 2-10). Relative to BW, C-bST steers had 5.2 % greater ($P < .05$) STMUS than C-C steers. Relative to HCW, bST-C and bST-bST steers had 7.8 and 6.3% greater ($P < .05$) STMUS than C-C steers. Liver weights of bST-bST steers were 7.5% greater ($P < .05$) than C-C steers. Steers receiving bST throughout the entire study (bST-bST) had 16.3, 12.5, and 11.1% greater ($P < .05$) spleen weight than C-C, C-bST, and bST-C steers, respectively. When expressed on a carcass weight basis, bST-bST steers had 11.4 and 9.6% greater spleen weights than C-C and C-bST steers. The bST-bST steers had 23, 10.4, and 12.6% greater ($P < .05$) kidney weight than C-C and C-bST and bST-C steers. Absolute kidney weights of C-bST steers were 11.3% greater ($P < .05$) than C-C steers. Relative to BW, bST-bST steers had 18.9 and 9.6% greater ($P < .05$) kidney weight than C-C and bST-C steers.

Carcass bone content of the intermediate-harvest group was similar among treatments (Table 2-11). Lipid content of bST carcasses were 11% less

Table 2-9. Effect of bovine somatotropin on intermediate-harvest semitendinosus muscle and internal organ weights[a,b]

| | Treatments | | | | Probability | |
|---|---|---|---|---|---|---|
| Basis | Control (C-C, C-bST) | SE | bST (bST-C, bST-bST) | SE | Model | Contrast[c] |
| Semitendinosus muscle wt. | | | | | | |
| g | 1610 | 44 | 1626 | 42 | .16 | .79 |
| g/kg BW | 3.66 | .08 | 3.63 | .08 | .28 | .75 |
| g/kg HCW | 6.51 | .13 | 6.48 | .12 | .31 | .89 |
| Liver wt. | | | | | | |
| g | 5918 | 189 | 6034 | 182 | .86 | .66 |
| g/kg BW | 13.54 | .45 | 13.49 | .44 | .28 | .94 |
| Lung wt. | | | | | | |
| g | 6000 | 179 | 5775 | 173 | .80 | .37 |
| g/kg BW | 13.73 | .40 | 12.92 | .39 | .08 | .16 |
| Spleen wt. | | | | | | |
| g | 929 | 45 | 1011 | 43 | .36 | .20 |
| g/kg BW | 2.11 | .10 | 2.26 | .09 | .64 | .31 |
| Heart wt. | | | | | | |
| g | 1653 | .03 | 1550 | 45 | .12 | .13 |
| g/kg BW | 3.78 | .10 | 3.46 | .10 | .08 | .03 |
| Kidney wt. | | | | | | |
| g | 1172 | 35 | 1280 | 35 | .28 | .04 |
| g/kg BW | 2.67 | .08 | 2.86 | .08 | .16 | .08 |

[a] Least square means.
[b] d 199 of study, steers received last treatment on d 168.
[c] for contrast Control versus bST.

Table 2-10. Effect of treatment on final-harvest semitendinosus muscle and internal organ weights[a]

| | Treatments | | | | | | | | Probability | |
|---|---|---|---|---|---|---|---|---|---|---|
| Basis | C-C | SE | C-bST | SE | bST-C | SE | bST-bST | SE | Model | Contrast[b] |
| Semitendinosus muscle, wt. | | | | | | | | | | |
| g | 2289[x] | 51 | 2447[w] | 51 | 2393[wx] | 51 | 2446[w] | 52 | .18 | .04 |
| g/kg BW | 3.83[x] | .07 | 4.03[w] | .07 | 3.92[wx] | .07 | 3.93[wx] | .07 | .17 | .14 |
| g/kg HCW | 6.39[x] | .12 | 6.89[w] | .12 | 6.61[wx] | .12 | 6.79[w] | .12 | .03 | .005 |
| Liver, wt. | | | | | | | | | | |
| g | 6935[x] | 161 | 7130[wx] | 159 | 7159[wx] | 161 | 7453[w] | 164 | .23 | .13 |
| g/kg BW | 11.61 | .24 | 11.74 | .24 | 11.76 | .24 | 11.97 | .25 | .21 | .50 |
| Lung, wt. | | | | | | | | | | |
| g | 7098 | 174 | 7308 | 172 | 7320 | 175 | 7360 | 182 | .07 | .48 |
| g/kg BW | 11.90 | .29 | 12.04 | .29 | 12.01 | .29 | 11.87 | .30 | .27 | .99 |
| Spleen, wt. | | | | | | | | | | |
| g | 1098[x] | 39 | 1135[x] | 39 | 1149[x] | 40 | 1278[w] | 40 | .03 | .04 |
| g/kg BW | 1.84[x] | .06 | 1.87[x] | .06 | 1.89[wx] | .07 | 2.05[w] | .07 | .11 | .14 |

Table 2-10. (cont'd)

| | Treatments | | | | | | | | Probability | |
|---|---|---|---|---|---|---|---|---|---|---|
| Basis | C-C | SE | C-bST | SE | bST-C | SE | bST-bST | SE | Model | Contrast[b] |
| Heart, wt. | | | | | | | | | | |
| g | 2005 | 50 | 2076 | 49 | 2104 | 50 | 2122 | 51 | .09 | .38 |
| g/kg BW | 3.36 | .08 | 3.43 | .08 | 3.46 | .08 | 3.41 | .09 | .09 | .92 |
| Kidney, wt. | | | | | | | | | | |
| g | 1210 | 42 | $1347^{x}$ | 41 | $1322^{xy}$ | 41 | $1488^{w}$ | 42 | .0001 | .001 |
| g/kg BW | $2.01^{x}$ | .07 | $2.21^{wx}$ | .06 | $2.18^{x}$ | .06 | $2.39^{w}$ | .07 | .0002 | .002 |

[a]Least square means.
[b]Probability of contrast C-C and bST-C versus C-bST and bST-bST.
[w,x,y]Means with unlike superscript letters differ ($P < .05$).

Table 2-11. Effect of bovine somatotropin on intermediate-harvest carcass composition and tissue accretion rates[a,b]

| | Treatments | | | | Probability | |
|---|---|---|---|---|---|---|
| Trait | Control (C-C, C-bST) | SE | bST (bST-C, bST-bST) | SE | Model | Contrast[c] |
| Carcass composition, % | | | | | | |
| Bone | 16.7 | .3 | 17.4 | .3 | .41 | .12 |
| Protein | 14.2 | .2 | 14.3 | .2 | .71 | .69 |
| Lipid | 21.2 | .8 | 18.7 | .8 | .20 | .03 |
| Water | 48.8 | .5 | 50.1 | .5 | .14 | .07 |
| Protein accretion rates, g/d | | | | | | |
| d 0 to 199 | 85.7 | 3.7 | 90.6 | 3.5 | .65 | .34 |
| Lipid accretion rates, g/d | | | | | | |
| d 0 to 199 | 220.9 | 10.3 | 193.8 | 9.9 | .17 | .07 |

[a]Least square means.
[b]d 199 of study, steers received last treatment on d 168.
[c]Probability of contrast Control versus bST.

($P < .05$) and water content 4% greater ($P < .10$) than control carcasses. Carcass protein accretion rates were similar among treatments, but lipid accretion of bST carcasses from d 0 to 199 tended to be 11% lower ($P < .10$) than in control steers.

Steers receiving bST throughout the entire experiment had the greatest increase ($P < .05$) in carcass bone, protein, and water composition and the greatest decrease ($P < .05$) in carcass lipid relative to C-C carcasses (Table 2-12). Steers which received bST during only one part of the study (C-bST and bST-C) had greater ($P < .05$) carcass bone, protein, and water; and lower ($P < .05$) lipid content than C-C steers, but not to the extent of the bST-bST treatment. Steers receiving bST only during the latter part of the study had greater bone and less lipid than bST-C steers.

Steers receiving bST during the latter part of the study (C-bST and bST-bST) had 18.6 and 14.3% greater ($P < .05$) protein accretion from d 199 to harvest than C-C steers. Overall, bST-bST had the greatest protein accretion, followed by bST-C steers, C-bST steers and C-C steers. Lipid accretion was reduced ($P < .05$) 39.8% for steers receiving bST during the latter portion of the study as compared to C-C and bST-C steers from d 199 to harvest. Overall, bST-bST had the lowest lipid accretion ($P < .05$) followed by C-bST, bST-C, and C-C steers.

Abundance of IGF-I mRNA in the liver was similar for all treatments following final harvest of Block 1 steers (Figure 2-4, top panel). Serum IGF-I concentrations were 310% greater ($P < .05$) in C-bST and bST-bST steers 7 d after final treatment as compare to C-C and bST-C steers (Figure 2-4, bottom panel). Fourteen days following final treatment, bST-bST and C-bST steers had 268% and

Table 2-12. Effect of treatment on final-harvest carcass composition and tissue accretion rates[a]

| | Treatments | | | | | | | | Probability | |
|---|---|---|---|---|---|---|---|---|---|---|
| Trait | C-C | SE | C-bST | SE | bST-C | SE | bST-bST | SE | Model | Contrast[b] |
| Carcass composition, % | | | | | | | | | | |
| Bone | 14.9[z] | .2 | 16.1[x] | .2 | 15.4[y] | .2 | 16.8[w] | .2 | .0001 | .001 |
| Protein | 13.6[y] | .1 | 14.3[x] | .1 | 14.2[x] | .1 | 14.7[w] | .1 | .0001 | .001 |
| Lipid | 27.5[w] | .5 | 22.6[y] | .5 | 24.5[x] | .5 | 20.1[z] | .5 | .0001 | .001 |
| Water | 45.9[y] | .4 | 48.5[x] | .4 | 47.4[x] | .4 | 49.5[w] | .4 | .0001 | .001 |
| Protein accretion rates, g/d | | | | | | | | | | |
| d 199 to harvest[c] | 88.7[x] | 4.1 | 101.4[w] | 4.0 | 94.3[wx] | 4.1 | 105.2[w] | 4.2 | .007 | .005 |
| d 0 to harvest | 86.0[y] | 2.1 | 92.6[x] | 2.1 | 93.6[wx] | 2.1 | 99.0[w] | 2.1 | .0005 | .005 |
| Lipid accretion rates, g/d | | | | | | | | | | |
| d 199 to harvest[c] | 302.0[w] | 14.4 | 183.3[x] | 14.2 | 267.8[w] | 14.4 | 159.4[x] | 14.7 | .0001 | .001 |
| d 0 to harvest | 253.6[w] | 6.8 | 203.4[y] | 6.7 | 226.3[x] | 6.8 | 180.8[z] | 6.9 | .0001 | .001 |

Table 2-12. (con'd)

[a]Least square means.
[b]Probability of contrast C-C and bST-C versus C-bST and bST-bST.
[c]Average intermediate harvest treatment values were used to calculate d 199 composition.
[w,x,y,z]Means with unlike superscript letters differ ($P < .05$).

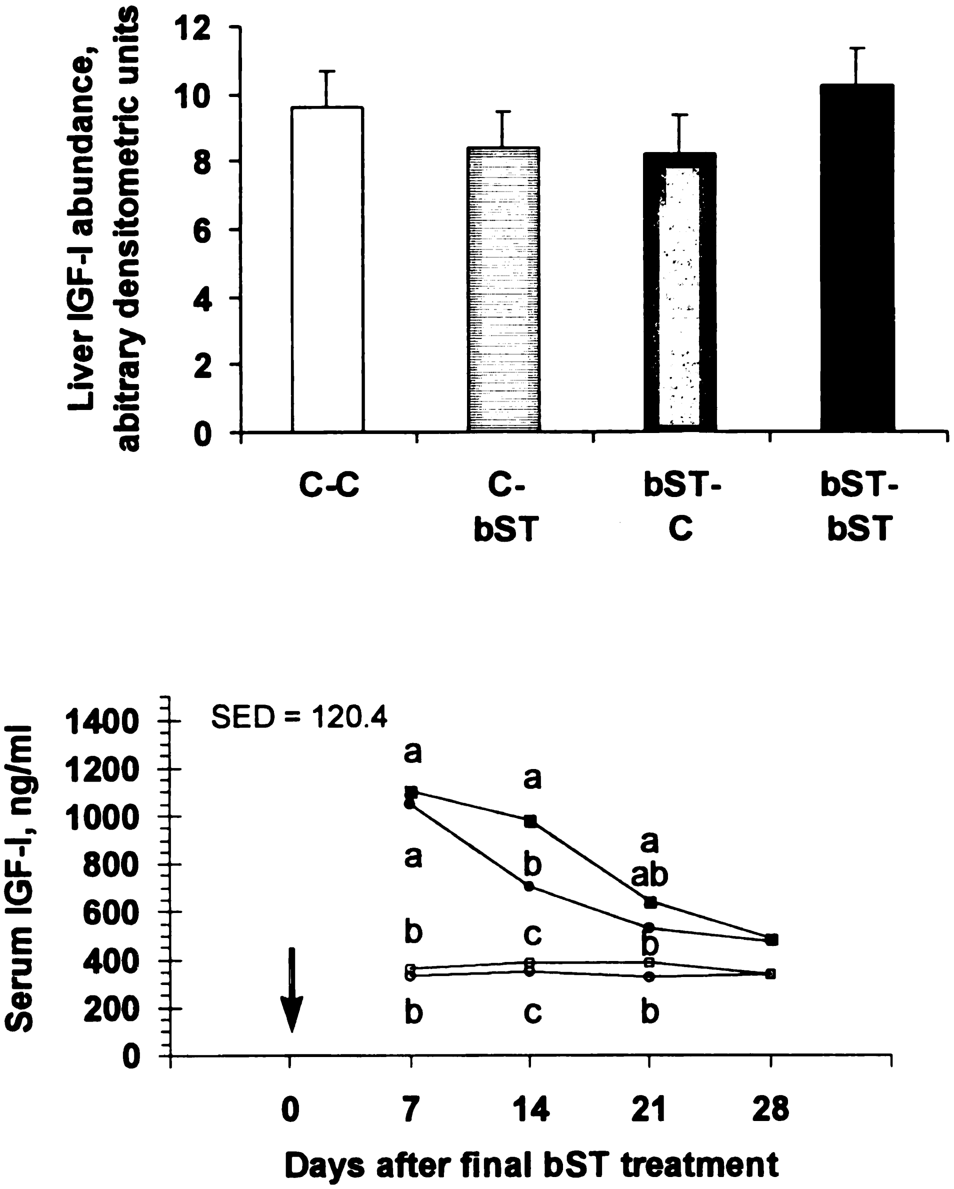



Figure 2-4- Top panel -Effect of treatment on liver IGF-I mRNA abundance from Block 1 final harvest steers. Bottom panel - Serum IGF-I concentrations 7 to 28 d following the last treatment in C-C (○), C-bST (●), bST-C (□), or bST-bST (■) Block 1 steers. [a,b,c]Means with unlike superscripts differ (*P* < .05).

192%, respectively, greater serum IGF-I concentrations than C-C and bST-C steers. Serum IGF-I concentrations of bST-bST steers was 181% greater 21 d after final treatment than C-C and bST-C steers. All treatments had similar serum IGF-I concentrations 28 d after final harvest.

## Discussion

*IGF-I Concentration.* An increase in serum IGF-I concentration in bST-treated steers is consistent with previous research (Enright et al., 1990; Moseley et al., 1992; Roeder et al. 1994; Preston et al., 1995). Roeder et al. (1994) observed elevated IGF-I concentrations with peak concentrations (30% above pretreatment values) being reached 40 h after an initial 160 mg bST/kg BW treatment. Preston et al. (1995) saw a 20% increase in serum IGF-I concentration after 14 d of administration. This increase is considerably less than the present study's 151% increase. In Roeder et al. (1994), serum bST concentrations peaked one day after a single bST treatment and were back to pretreatment values after three days, but serum IGF-I concentrations did not drop as rapidly. After 22 wk of bST administration to steers, Enright et al. (1990) demonstrated that IGF-I concentrations returned to control concentrations five days after the last treatment of 40 µg/kg BW. In the present study, IGF-I concentration returned to base line 14 to 28 d after the last bST treatment, with the difference due to an increased dosage.

*Feedlot performance.* Preston et al. (1995) did not find a difference in final BW after 84 or 119 d of bST treatment. Moseley et al. (1992) found a decrease in final BW with bST concentrations above 33 µg/kg BW, because ADG was significantly reduced, and at a dose of 300 μg/kg BW, the severe reduction in ADG prevented harvest at a similar weight endpoint.

Previous research has shown a 4 to 24% increase in ADG of feedlot cattle with bST administration (Early et al., 1990, Moseley et al., 1992, Preston et al., 1995, Rumsey et al., 1996). Moseley et al. (1992) found that ADG increased in cattle receiving up to 33 μg bST/kg BW but no further increase was observed with 66, 100, or 300 μg bST/kg BW. Rumsey et al. (1996) observed the greatest increase in ADG with 100 μg bST/kg BW, whereas, Preston et al. (1995) saw a modest 4% increase in ADG with 12.5 and 25 μg bST/kg BW daily.

The present study only observed an increase in ADG within the first 182 d of the study. This is consistent with Early et al. (1990a) which reported an increase in ADG during the first 8 d of a 112 d study. Both Rumsey et al. (1996) and Preston et al. (1995) used short-study periods (56 and 84 to 119 d, respectively). Therefore, it appears that bST may increase in ADG in the short term, but may not show improvement in longer-term studies (> 300 d).

The lack of response in ADG during the latter part of the study may be a function of dietary CP content. Rumsey et al. (1996), Early et al. (1990a), Moseley et al. (1992), and Preston et al. (1995) used diets containing 21, 16.7, 16.5 and 13.9% CP, respectively. These values are considerably higher than the 11.5% used by the author during the latter part of this study. The CP content used by the author was sufficient to allow .85 to 1.37 kg of ADG based on the low and high treatment DMI, respectively (NRC, 1984). The compounding effect of reduced intakes associated with bST is discussed later.

The effect of bST on DMI is not consistent among previous studies. Rumsey et al. (1996) observed an increase in DMI with bST administration, Preston et al. (1995) and Moseley et al. (1992) reported a decrease with increasing levels of bST, and Early et al. (1990a) saw no effect. McBride and Moseley (1991) suggest that in animals which may have deposited fat, the administration of bST increases the amount of circulating nutrients which can not be fully utilized by the animal, therefore, the animal reduces its DMI to compensate. Conversely, animals which are growing rapidly and have little body fat may need to increase intake to satisfy nutrient demand as a result of bST administration. Rumsey et al. (1996) started with light-weight cattle (182 kg), whereas, Preston et al. (1995) and Moseley et al. (1992) used cattle that were heavier (378 kg and 393 kg, respectively), and Early et al. (1990a) used cattle which were intermediate (229 kg) in size. In the present study, DMI intake was not affected by bST treatment during the initial 182 d of the study. The largest decrease in intake was observed in C-bST steers which only received bST during the latter part of the study. These steers had greater body fat than the bST-bST and bST-C steers after 182 d of bST administration, and therefore, would fit the theory suggested by McBride and Moseley (1991).

As discussed previously, the lower CP concentration of the diet and reduced DMI associated with bST treatment may have prevented expression of increased gain with bST administration. Research in pigs have shown that the supplementation of additional lysine and CP allows greater bST-mediated gains (Krick et al., 1993). Additionally, there is evidence that cattle implanted with anabolics have greater potential for growth if fed diets higher in CP content (Bartle and Preston, 1994).

Either by increasing ADG, decreasing DMI, or both, feed efficiency increases with bST administration. The present study demonstrated an increase in efficiency during the latter part of the study which is in agreement with Preston et al. (1995), Rumsey et al. (1996), and Early et al. (1990a). Moseley et al. (1991) saw an increase in feed efficiency with increasing bST concentration up to 100 μg bST/kg BW. At 300 μg bST/kg BW, ADG was reduced so drastically in relation to DMI, that efficiency decreased.

*Skeletal and bone growth*. Although hip height increased 5 cm (3.3%) from C-C to bST-bST steers, increased length of the metacarpal (front limb bone) was not apparent. Loy et al. (1988) also observed an increase in hip height in estrogenic-implanted steers over controls steers without a corresponding increase in metacarpal length. Early et al. (1990b) observed a 1.3 cm increase in humerus length in steers administered bST, but not in the length of the femur, tibia or radius. The question then arises whether there was differential bone growth rates between the front and rear limbs; do non-significant increases in length occur in multiple bones with an additive effect; or do changes in the angle of joints occur to increase hip height?

Bovine ST administration increased lateral width, lateral depth, circumference, and bone surface area of the metacarpal bone; and the percent bone in the carcass. This is in agreement with research in ewe lambs receiving bST (Johnsson et al., 1985). In contrast to the present study, Johnsson et al. (1985) did not see a change in bone density. Johnsson et al. (1985) observed an increase in bone circumference of the femur and humerus. Daily growth in circumference was also observed in the femur of bST-treated steers (Early et al., 1990b). In the current study, increased skeletal growth was evident after 182 d of bST administration by greater hip height, although no other measure were affected at that time.

The proximal epiphysis of cattle ossifies when cattle are 18-24 months of age (Emara, 1937 and Sisson, 1953 as referenced by Grant et al., 1972). Therefore, bST should have been able to stimulate long-bone growth throughout the study. This is supported by the fact that the bST-bST steers had the greatest hip height for the entire experiment, bST-C and C-bST steers were intermediate, and C-C has the shortest hip height. There was no difference in daily hip height gain between C-bST and bST-bST during the latter part of the study, suggesting that bST continued to have the ability to stimulate long-bone growth. It is obvious that long-bone growth decreased by two-thirds from the first part of the study to the second, which is in agreement with the sigmoidal growth curve of meat animals in which bone matures first (Boggs and Merkel, 1993).

Using data from both the intermediate and final harvest groups, hip height was positively correlated with metacarpal length ($r = .53$, $P < .01$), lateral width ($r = .50$, $P < .01$), lateral depth ( $r = .51$, $P < .01$), TCA ($r = .53$, $P < .01$), and MCA ($r = .23$, $P < .01$). Metacarpal length was negatively correlated with bone density ($r = -.28$ $P < .002$), positively correlated with lateral width ($r = .28$ $P < .002$) lateral depth ($r = .32$ $P < .001$), bone circumference ($r = .32$ $P < .001$), TCA ($r = .36$, $P < .001$), and bone area ($r = .38$, $P < .001$).

*Carcass measurements.* Moseley et al. (1992) observed a significant linear decrease in HCW with increasing amount of bST administration (0 to 300 μg bST/kg BW). Preston et al. (1995) found no affect of bST on HCW, but Rumsey et al. (1996) found an increase in HCW with bST treatment. Moseley et al. (1992) and Early et al. (1990a) found a decrease in DP with bST administration. The present study did not see an affect on HCW but did see a decrease in DP. The cause for the decrease in DP was a result of an increase in NCW at final harvest. Early et al. (1990b) attributed 75% of the increase in NCW to an increased weight of the gastrointestinal tract (GIT), but this was not evident in Rumsey et al. (1996) data and was not measured in the present study. Therefore most of the weight gained as a result of bST treatment would end up in the offal bin and not on the rail.

Early et al. (1990a) theorized that by administering bST to younger, light-weight cattle, the carcass component could be increased to a greater extent than the noncarcass components. The present study started with cattle that were 45 kg lighter and used a higher dose of bST throughout the study than Early et al. (1990a). Not only did the present study not see an increase in the carcass component as compared to NCW, but NCW was increased to a greater extent than that observed by Early et al. (1990a) which may be the result of harvesting Holstein steers 226 kg heavier than the Herefords used by Early et al. (1990a).

Ribeye area was only greater in C-bST steers as compared with bST-C steers, and there was not difference between control and bST-treated steers. Preston et al (1995) and Peters (1986) did not see an increase in REA with bST administration, but Moseley et al (1996) observed a 4 to 8% increase with bST doses of 8.25 to 300 µg bST/kg BW.

As discussed, bST was a potent modifier of carcass fat. After 182 d of treatment, bST reduced KPH fat percent, marbling score, USDA quality grade, and the number of carcasses grading USDA choice. At the conclusion of the study, backfat was also reduced. Peters (1986) observed a 24% reduction in backfat with bST administration following 29 d of treatment. Moseley et al. (1992) saw a 9 to 62% reduction in backfat and a 17 to 95% reduction in the percent of carcasses grading USDA choice. The 95% reduction was in steers receiving 300 µg bST/kg BW which failed to reach market weight. At 100 µg bST/kg BW, 70% fewer carcasses graded USDA choice. Preston et al. (1995) documented a linear decrease in backfat (15%), KPH fat (28%), marbling score (6%), and percent USDA choice (58%) with daily treatments of 0, 25 and 51 µg bST/kg BW. However, Early et al. (1990a) did not see a difference in backfat or Canadian carcass grade in bST-treated cattle. As fat decreased, red meat yield increased in the present study as evidenced by a reduction in yield grade. This agrees with Preston et al. (1995) in which bST reduced yield grade scores by 12.5%.

In this experiment, long-term bST administration increased the weight of STMUS both in absolute and relative terms, but did not increase REA, as discussed. Early et al. (1990b) and Eisemann et al. (1989) did not see a significant effect of bST on the STMUS. Early et al. (1990b) demonstrated that bST increased vastus lateralis daily muscle growth 42%. Eisemann et al. (1989) observe an 11% increase in longissimus weight but not relative to empty BW. In regards to muscle groups (primal cuts of the carcass), Early et al. (1990b) observed an increase in the flank and shank primals, and hypothesized that the flank increased to accommodate the larger GIT in bST animals. Additionally, Butler-Hogg and Johnsson (1982) observed greater muscle weight in ewe lambs treated with bST. Beermann et al. (1990) showed an increase in STMUS with porcine ST administration up to 120 μg pST/kg BW which was due to individual muscle fiber hypertrophy.

Noncarcass weight was increased with long-term bST administration. A portion of this increase occurred in the internal organs. In this study, the liver, spleen, and kidney were increased in absolute values and the spleen and kidney increased in relative value with bST administration. This agrees with Moseley et al. (1992), Early et al. (1990b) and Rumsey et al. (1996), who reported increased liver and kidney weights with bST treatment. Rumsey et al. (1996) observed an increase in spleen and heart weight, but Early et al. (1990b) did not. Early et al. (1990b), however, observed an increase in lung and trachea weight with bST administration.

Early et al. (1990c) observed a greater whole-body protein accretion with bST administration, but this was due to greater noncarcass protein accretion and not that of the carcass. In another study, protein accretion was increased 22% with bST administration in Angus-Hereford crossbred steers (Rumsey et al., 1996). The lower dietary CP in the present study may not have allowed the greatest nutrient repartioning to take place and limited protein gain and total ADG as discussed.

Somatotropin decreased lipid accretion to a greater extent when lipid accumulation was the greatest (12.5% from d 0 to 199 and 43% from d 199 to harvest). Rumsey et al. (1996) demonstrated a 23.5% decrease in lipid accretion after 56 d of bST administration in light-weight cattle (182 kg initial weight, and 266 kg average final weight.) with a 100 µg bST/kg BW dose. Even though bST does decrease lipid accretion, it does not prevent it entirely.

*Liver IGF-I mRNA concentration.* No differences were found in liver IGF-I mRNA at harvest. Insulin-like growth factor-I mRNA abundance has been shown to increase in the porcine liver (Grant et al. 1991; Coleman et al., 1994; Ramsay et al., 1995), adipose tissue (Coleman et al., 1994; Ramsay et al., 1995), and to a smaller extent in the vastus lateralis muscle (Ramsay et al., 1995) of pigs following pST treatment. Brameld et al. (1996) observed an increase in IGF-I mRNA in STMUS of pST-treated pigs, whereas Ramsay et al., (1995) found no response. Both Coleman et al. (1994) and Ramsay et al. (1995) observed no increase in IGF-I mRNA in the longissimus muscle of pST-treated pigs. Additionally, Johnson et al. (1998) demonstrated a 150% increase in liver IGF-I mRNA in wether lambs 24 days after implantation of a combined trenbolone acetate-estradiol implant with a concomitant increase in blood IGF-I concentrations. In the present study, serum IGF-I concentrations were similar to control steers 28 d post-administration of bST and would explain the lack of difference in mRNA abundance. The abundance of IGF-I mRNA decreases rapidly after reaching its peak stimulation by ST. Matthews et al. (1986) and Isgaard et al. (1989) demonstrated the rise to peak quantities and a return to pretreatment values of IGF-I mRNA abundance in the liver and gastrocnemius muscle, respectively, within 12 h after a single ST injection in mice.

*Carcass Value.* On an economic basis, the goal of using bST is to produce greater quantities of red meat without sacrificing the quality of the product which would make it unacceptable to the consumer. Using an average grid pricing system (USDA, 1998) based on quality grade, yield grade and HCW; Table 2-13 demonstrates the premiums and discounts using average treatment values. All carcasses fell within the acceptable HCW range (250 to 431 kg, 550 to 950 lb). Although C-bST and bST-bST carcasses had lower yield grades and therefore greater cutability, the added value of the increased lean did not compensate for the reduced quality grade, and would be valued at $41.64 less than C-C carcasses. Carcasses from bST-C steers are not only discounted for quality grade, but also are discounted for yield grade and, therefore, had $50.26 lower carcass value than C-C carcasses.

Some of the loss in carcass value could be offset by the lowered DMI and reduced feed cost, but handling charges (every two weeks) or cost of the product would need to be accounted for as well. A leaner carcass that contains an acceptable quality is difficult to produce especially when marbling is the last fat to be deposited and its during this period that bST has its greatest negative influence on fat accretion. Before the use of bST is looked at seriously, the premium between yield grades 2 and 3 needs to be increased to be adequately rewarded for production of lean meat.

## Implications

Administering bovine somatotropin to young, light-weight Holstein steers did increase skeletal growth and reduce carcass fat content, thereby producing a leaner product. Somatotropin increased weight of noncarcass components

Table 2-13. Effect of treatment on carcass premium, discounts, and value[a,b]

| Criteria | Treatments | | | |
|---|---|---|---|---|
| | C-C | C-bST | bST-C | bST-bST |
| Carcass Value Adjustments, $/kg | | | | |
| Quality grade[c] | 0 | -.14 | -.14 | -.14 |
| Yield grade[d] | -.002 | .022 | -.002 | .022 |
| Total | -.002 | -.118 | -.142 | -.118 |
| Carcass Value, $ | | | | |
| Deviation from base[e] | -.72 | -42.36 | -50.98 | -42.36 |

[a]Based on the National carcass premiums and discounts for harvest steers and heifers (USDA Market News, June 29, 1998).

[b]USDA choice base.

[c]Adjustments for quality grade: Select ($-.14/kg).

[d]Adjustments for yield grade: 2.5 - 3.0 ($+ .022/kg), 3.0 - 3.5 ($- .002/kg).

[e]Based on total carcass value adjustments x 359 kg average carcass weight and represents the deviation from the value of a USDA choice carcass.

without increasing carcass weight. Steers receiving somatotropin during the entire study showed the greatest effects with the majority of lipid reduction occurring during the latter part of the study. Somatotropin did increase protein accretion and therefore red meat yield, but not to the extent that would compensate, economically, for the loss in carcass quality. Additionally, the use of bovine somatotropin would not be practical until a longer delivery mechanism is developed.

Chapter 3

# LONG-TERM BOVINE SOMATOTROPIN ADMINISTRATION TO GROWING-FINISHING HOLSTEIN STEERS DECREASED LIPOGENESIS AND INCREASED LIPOLYSIS[1,2]


## Abstract

The objective of this study was to determine whether long-term bovine somatotropin (bST) administration to Holstein steers would alter measures of lipogenesis and lipolysis in growing-finishing Holstein steers. Twenty-eight Holstein steers (460 kg) were blocked by weight (2 replicates /block) and randomly assigned to initial harvest (8 steers), control (no bST, C; 10 steers) or bST (100 µg/kg BW, 10 steers) treatment. Treatments were administered daily via s.c. injection during the 115 d study. Steers were individually penned indoors (3.9 $m^2$) with ad libitum access to water and a diet containing whole-shelled corn, soybean meal, and a pelleted supplement. Blood was collected via jugular venipuncture on d 0, 3, 17, 30, 52, and 87 and analyzed for plasma IGF-I,.insulin, glucose, glycerol and NEFA. Three perirectal adipose tissue (AT) biopsies were collected from each steer, one during each of the periods 5 to 16 d prior to treatment, 40 to 49 d, and 103 to 112 d of the trial. Lipogenesis was measured in triplicate in vitro as tritium incorporation into fatty acids, fatty acid synthase activity, and NADP-isocitrate dehydrogenase activity. Lipolysis was measured in triplicate in vitro by glycerol release into the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[2] The author would like to thank Patty Weber, Sharon Debar, and Michelle Mater for their laboratory assistance and expertise.

medium with and without epinephrine stimulation. In vivo lipolytic potential was determined by dose response-epinephrine challenges administered intravenously beginning on d -24, 32 and 95, with a single epinephrine concentration (0, .1, .2, .4, .8, 1.2, and 1.6 μg/kg BW) administered each day for seven consecutive days. Plasma NEFA responses were measured over a 20 min period after the epinephrine challenge. Bovine ST chronically increased ($P < .05$) plasma glucose, glycerol, IGF-I, insulin, and NEFA concentrations. Lipogenesis, measured as tritium incorporation and fatty acid synthase activity in AT, was reduced ($P < .10$) after 40 d of treatment in the bST group. Basal glycerol release was increased ($P < .05$) after 103 d of bST treatment. Maximum response to the epinephrine challenge was increased in bST steers during challenges after 6 and 15 weeks of treatment. Based on this study, bST treatment decreased lipogenesis and increased lipolysis in AT of growing-finishing Holstein steers in positive energy balance.
**Key Words**: Steers, Somatotropin, Lipogenesis, Lipolysis

## Introduction

The initial experiment conducted by this author (Chapter 2) demonstrated a decrease in carcass lipid, backfat, kidney-pelvic-heart (KPH) fat, marbling score, USDA quality grade, and calculated yield grade of bovine somatotropin (bST)-treated steers. Treatment with bST reduced daily lipid accretion 12% during the first 182 d of treatment, and 20 to 29% the last 172 d of the study as compared to controls. Fat accretion increased 37% in control steers as time on feed increased whereas fat accretion decreased 18% for steers receiving bST. Clearly, bST had a significant effect on the lipid deposition of steers, especially during the period when fat accretion was accelerated.

The decrease in carcass lipid can be accomplished through decreased lipogenesis or increased lipolysis. Somatotropin treatment has been shown to reduce fatty acid synthesis (Vernon, 1982; Walton and Etherton, 1986; Sinnett-Smith and Woolliams, 1989), fatty acid synthase activity (FAS, Harris et al., 1993; Kramer et al., 1993), and fatty acid sythase mRNA protein (Harris et al., 1993). In more recent studies, ST has been shown to increase lipolysis through increased number of β-adrenergic receptors (Watt et al., 1990) and the reduced inhibitory effects of adenosine and prostaglandin $E_1$ and $E_2$ (Doris et al., 1996). While most studies have concentrated on the ruminant at maintenance or lactation, this study will evaluate the influence of bST on growing animals in positive energy balance. Specifically, the objective of this experiment was to determine the effects of long-term bST administration to Holstein steers on lipogenesis and lipolysis throughout the growing-finishing period.

## Materials and Methods

*Animal management.* This project was approved by the Michigan State University All-University Committee on Animal Use and Care (AUF# 06/94-141-01) and conducted under an INAD (6673-C004 - Bovine somatotropin) issued to Michigan State University. Twenty-eight Holstein steers (460 kg) were individually identified; vaccinated against IBR, $PI_3$, and *Clostridial* organisms; and implanted with estradiol benzoate-progesterone (Implus, The Upjohn Co., Kalamazoo, MI).

Steers were selected from a larger group of 40 steers to provide experimental units that were uniform in BW, frame size and body condition. The steers were blocked by weight and randomly assigned to 1 of 3 groups; initial harvest (8 steers); placebo-treated (control, 10 steers), or bST-treated (10 steers). The initial harvest group was used to determine initial carcass characteristics and composition. The remaining 20 steers were housed in an environmentally controlled room (12 h light: 12 h dark) in individual slotted-floor pens (2.0 m x 1.8 m, 3.6 $m^2$) with ad libitum access to feed and water.

Steers were adapted to the environment and fed a whole-shelled corn and pellet diet for 10 d prior to initiation of the study (Figure 3-1). On a DM basis, the diet contained 86.3% dry, whole-shelled corn; 12.4% protein-mineral pellet (Table 3-1); and 1.3% soybean meal. The diet was formulated to contain 14% CP (13.4% actual CP) and met NRC (1984) requirements for minerals and vitamins. Steers were fed twice daily, 60% at 0800 and 40% at 1500. Sufficient feed was offered to allow 5% to remain. Orts were weighed daily. Steers were removed from their pens weekly, weighed, had blood collected, and turned into a common outdoor dirt exercise lot for two hours.

To assess in vivo lipolysis, epinephrine challenges were conducted on d -24 to -18, d 32 to 38, and d 95 to 101 (Figure 3-1). In vitro measures of lipogenesis and lipolysis were performed on adipose tissue (AT) from biopsies collected between d -16 to -5, d 40 to 49, and d 103 to 112 of the study. Details of the epinephrine challenge and AT biopsies are discussed later. One control steer was

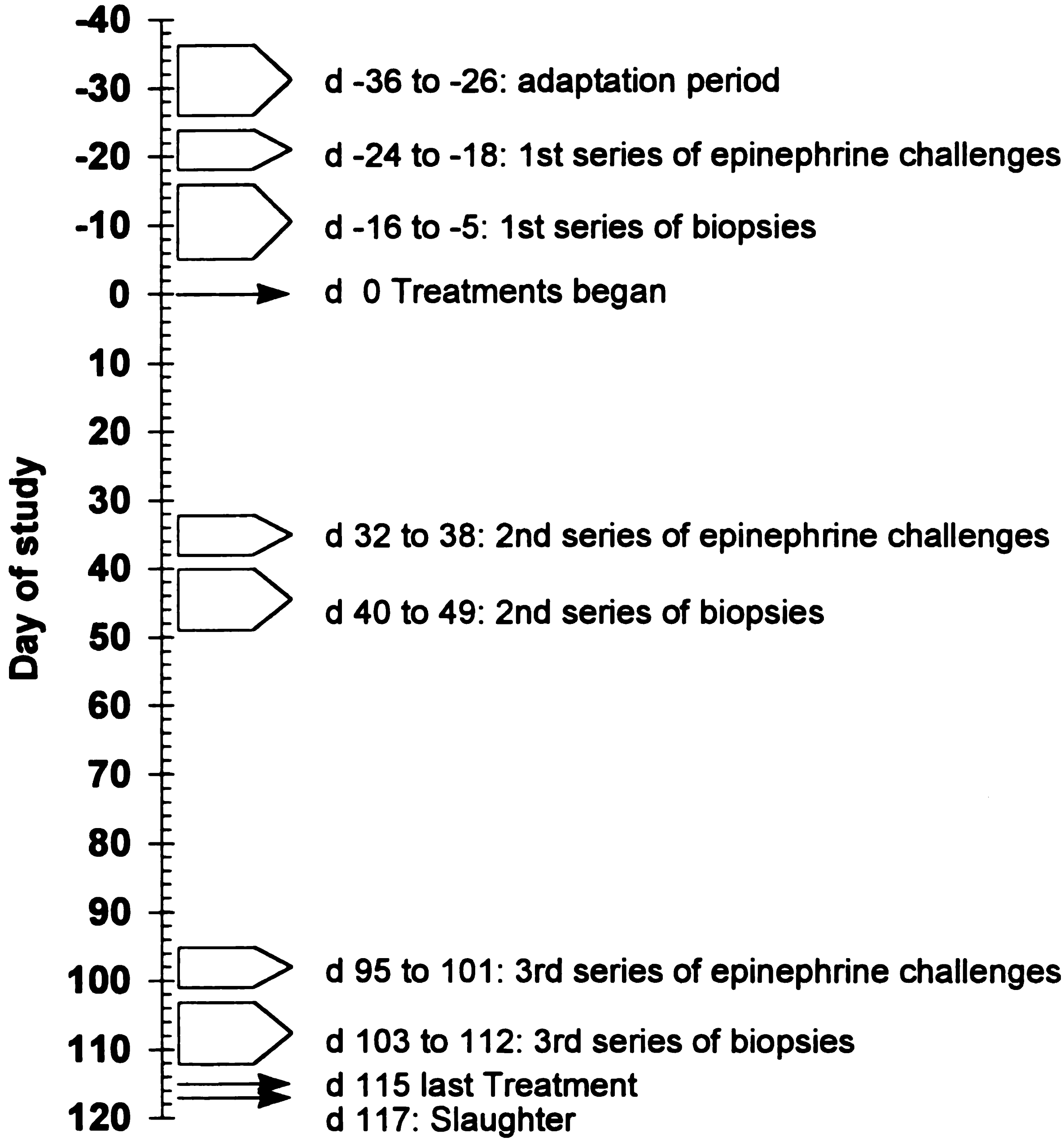


Figure 3-1 - Schedule of epinephrine challenges and adipose tissue biopsies.

Table 3-1. Guaranteed analysis and ingredient content of the pelleted supplement[a]

| Nutrient | Guaranteed analysis |
|---|---|
| Crude protein, minimum[b] | 50.0% |
| Crude fat, minimum | .4% |
| Calcium, minimum | 5.0% |
| Calcium, maximum | 6.0% |
| Phosphorus, minimum | 1.0% |
| Salt (NaCl), minimum | 2.0% |
| Salt (NaCl), maximum | 2.5% |
| Potassium, minimum | 2.0% |
| Vitamin A, minimum | 22000 IU/kg |
| **Active Drug Ingredient** | **Content** |
| Monensin Sodium | 220 mg/kg |
| Tylosin phosphate | 66 mg/kg |

[a]Ingredients: soybean meal, calcium carbonate, urea, flash dried blood meal, corn distillers dried grains with solubles, salt, vitamin A acetate, D-activated animal sterol (source of vitamin $D_3$), vitamin E supplement, calcium iodate, manganous oxide, ferrous sulfate, copper sulfate, cobalt carbonate, zinc oxide, sodium selenite.

[b]Does not included more than 18.5% equivalent CP from non-protein nitrogen.

removed from the study on d 17 due to lameness.

*Treatments.* A daily placebo or bST injection (100 μg/kg BW, Lilly Research Laboratories, Greenfield, IN) were administered subcutaneously in the mid-thoracic region just caudal to the shoulder between 0800 and 0900. The treatment was divided between two injection sites each day and alternated daily between the left and right side of the animal. Every two days, crystalline bST (Somidobove, Elanco Products Co., Indianapolis, IN, 92% potent, Lot # 014BM3) was dissolved in .01 M sodium phosphate buffer and adjusted to pH 7 at a concentration of 1 mg bST/ml. Control steers received .1 cc of .01 M sodium phosphate buffer /kg BW. Dosages of treatments were adjusted weekly based on BW and continued through d 115 (116 treatments). Treatment concentration remained constant and volume of treatment varied to deliver the required dose.

*Bovine somatotropin absorption time course.* Prior to the third series of epinephrine challenges (d 94), the rate at which bST was absorbed from a s.c. injection into the peripheral circulation was determined. The animals were fitted with an indwelling jugular catheter on the previous day. Blood samples were collected every 30 min beginning at 0630 and continued to 1800 for a total of 24 samples. Steers received treatments between 0730 and 0800 and were fed at 0930 and 1500. The blood was collected in a 10 cc syringe and dispensed into a 7 ml, sterile blood-collection tubes containing 10.5 mg EDTA and .014 mg potassium sorbate (Vacutainer Brand, Becton Dickinson and Co., Rutherford, NJ) to prevent coagulation. The filled tube was inverted several times and chilled in an ice water bath until centrifugation. Plasma was separated by centrifugation at 959 x g

(Beckman J2-21 refrigerated centrifuge, Beckman Instruments Inc. Palo Alto, CA) for 20 min at 4 °C and stored in 12 x 75 mm polypropylene tubes (Sarstedt, Newton, NC) at -20 °C until analyzed. Plasma bST concentration was determined with a double antibody radioimmunoassay (RIA, Gaynor et al., 1995).

*Plasma metabolite and hormone analyses.* Blood samples were collected on d 0, 3, 10, 17, 24, 30, 52, 59, 73, and 87 by jugular venipuncture into 7 ml, sterile blood-collection tubes containing 10.5 mg EDTA and .014 mg potassium sorbate (Vacutainer Brand, Becton Dickinson and Co., Rutherford, NJ); and processed and stored as described earlier.

Plasma insulin-like growth factor-I (IGF-I) was measured by RIA (Sharma et al., 1994) after removal of insulin-like growth factor binding proteins by formic acid-ethanol extraction (Bruce et al., 1991; Sharma et al., 1994). Plasma nonesterified fatty acid (NEFA) concentrations were analyzed with an enzymatic kit (WAKO Chemicals, Dallas, TX) using a 96-well, micro-plate as described by Johnson and Peters (1993) and used the procedures of McCutcheon and Bauman (1986) to dilute reagents. Plasma glycerol concentrations were determined with a enzymatic kit (Procedure No. 337, Sigma Chemicals, St. Louis, MO) by placing 20 μl of sample into 1 ml of triglyceride (GPO-Trinder) blank reagent. Concentrations of plasma glucose were assayed by a enzymatic kit (Procedure 510, Sigma Chemicals, St. Louis, MO). Plasma insulin was analyzed using an ImmuChem™ Coated Tube $^{125}I$ RIA kit (ICN Pharmaceuticals, Inc., Costa Mesa, CA).

*Animal performance.* Animal performance was characterized by body weight (BW), average daily gain (ADG), daily dry matter intake (DMI) and feed efficiency.

Initial and final weights were determined from the average of weights taken on two consecutive days (d -1 and 0, and d 115 and 116). Feed intake was determined daily and averaged across the periods d 0 to 30 and d 31 to 115. Samples of all feed ingredients were collected daily, composited weekly, and analyzed for dry matter (DM, 48 h in a 55 °C oven) and crude protein (CP, total-Kjeldahl N, CP = N * 6.25, Technicon auto-analyzer system, Bran + Luebbe Inc., Tarrytown, NY). Feed efficiency was calculated as grams of gain divided by kilograms of DMI over the same intervals as daily DMI.

*Carcass characteristics, composition, and accretion rates.* The initial harvest group and the 20 treated steers were harvested at a commercial packing plant. At the time of harvest, liver weight and hot carcass weight (HCW) were determined. After a 24-h, post-harvest chill; ribeye area (REA), 12th-rib backfat, KPH fat, marbling score, and USDA quality grade were determined. Non-carcass weight (NCW), dressing percent (DP) and yield grade (Boggs and Merkel, 1984) were calculated. Non-carcass weight was calculated as the difference between final weight and HCW.

The 9th through 13th ribs section was removed from the left side of each carcass for compositional determination and transported to the Michigan State University Meats Laboratory. The 9-10-11 rib portion was separated from the larger rib section (Hankins and Howe, 1946), weighed and the soft tissue was separated from bone. The bones and soft tissue from each rib were weighed. The soft tissue was ground three times (once coarsely, and twice finely) with mixing in between each grind to ensure uniformity. Approximately 500 g of sample was collected and placed into a Whirlpak bag (NASCO, Fort Atkinson, WI) and stored at -30 °C. The frozen sample was homogenized with liquid N in an industrial Waring blender. The samples were analyzed for DM, CP and ether-extractable lipid (EEL).

Tissue sample DM was determined in duplicate by placing 2 g of homogenized tissue in a desiccated-labeled aluminum pan and dried for 48 h in a 55 °C oven. Tissue moisture was determined by difference. Crude protein was analyzed in duplicate for total-Kjeldahl N (CP = N * 6.25, AOAC, 1984) using a Technicon auto-analyzer system (Bran + Luebbe Inc., Tarrytown, NY). Ether-extractable lipid was determined in triplicate by placing 2 g of sample in a desiccated-weighed and numbered #1 filter paper circle (Whatman Inc., Fairfield, NJ). The filter paper was folded to prevent loss of sample, secured with paper clips, and dried for 48 h in a 55 °C oven. The dried samples were placed in a Soxhalet apparatus and extracted with petroleum ether for 24 h. Ether-extractable lipid was calculated as the amount of dry weight lost after ether extraction. Percent carcass bone, lipid, protein and moisture were calculated based on equations by Hankins and Howe (1946). Accretion rates of lipid and protein were determined from equations developed by Anderson et al. (1988).

*Adipose tissue biopsy procedure.* Adipose tissue biopsies were collected from steers within a 10 d period with 4 steers (1 block) biopsied every second day. Steers were moved from their pens prior to the morning feeding and treatment, and placed in individual stalls. The left or right perirectal area was clipped and scrubbed clean. Under the direction of a veterinarian, the animal was given epidural anesthesia (2% Lidocaine hydrochloride, - without epinephrine) to effect.

Using sterile technique and instruments, an incision was made over the sacral-siatic ligament. Using forceps and blunt scissors, 3 to 5 g of AT was excised. The excised AT was divided between Krebs-Ringer-bicarbonate buffer (KRBB, pH 7.4), or .25 M sucrose solution (pH 7.4) each maintained at 37 °C for transport to the laboratory.

The subcutaneous tissues of the biopsy site were sutured with #2 chromic gut and the skin was closed with #3 monofilament suture. Steers received an i.m. injection of penicillin G procaine (22,000 units/ kg BW, Anthony Products Co., Arcadia CA) in the neck and were monitored closely to prevent complications. One bST steer (#184) developed an infected biopsy site after the second biopsy. The site was flushed with a warm Betadine® solution for three days (twice a day), then with warm water, six days, until the wound closed. The wound healed and the steer finished the study.

*In vitro lipogenesis.* In vitro lipogenesis was assessed as the amount of $^3H$ incorporated into fatty acids (FA, Mulvaney, 1984). Triplicate samples (100 mg) from each biopsy sample were sliced with a microtome and placed in 25 ml Erlenmeyer flasks containing oxygenated- KRBB with 100 μCi $^3H_2O$/ml and incubated for 2 h at 37 °C. Following incubation, the tissue slices were rinsed three times with saline solution and placed in 50 ml culture tubes containing 10 ml of a KOH:ethanol solution (3:7 vol/vol; 30% KOH: 95% ethanol) for digestion and saponification overnight in a 60 °C water bath. Lipids were extracted from each sample with 5 ml of petroleum ether and vortexed for 1 min. The petroleum ether which contained the nonsaponifiable lipids was aspirated and discarded. This extraction procedure was repeated to ensure complete separation of the lipid fraction. The remaining soaps were converted to FA with 1.5 ml of 12 N HCl. Fatty acids were extracted three times with the addition of 5 ml petroleum ether followed by 1 min of vortexing. After each extraction, the petroleum ether, top layer, was aspirated off and transferred to a scintillation vial. The ether was evaporated under a hood overnight and 10 ml of a non-aqueous scintillation fluid (ScintiVerse®, Fisher Scientific, Pittsburgh, PA) was added. Radioactivity was determined in a liquid-scintillation counter (efficiency for counting $^3H$ = 65.6%).

Based on equations of Mulvaney (1984), the assumption that pure water in the incubation media has a molarity of 55, and the specific radioactivity (DPM/mol) of the media; the nanomoles of $^3H$ converted to FA per minute per gram of tissue could be calculated from:

$$FA = CPM \times (1/E) \times (1/t) \times (1000/wt) \times (1/SA)$$

where CPM = the counts/minute of the samples
E = the efficiency of the liquid scintillation counter counting tritium
t = time of incubation in minutes
wt = weight of the AT slice in milligrams
SA = specific activity of the media

*In vitro lipolysis.* Glycerol release into the media in the absence and presence of epinephrine was used as a measure of in vitro lipolysis. Six AT slices (100 mg) cut as previously described were placed into 25 ml Erlenmeyer flasks containing 3 ml of KRBB media (prepared as before with the addition of 30 mg/ml of essentially fatty acid free bovine serum albumin; A-6003, Sigma Chemical Co., St. Louis, MO). Three of the flasks contained 25 µM epinephrine-HCl (E-4642, Sigma Chemical Co., St. Louis, MO). The slices were incubated for 2 h in a shaking water bath at 37 °C. After incubation, the KRBB was removed by aspiration and transferred into glass test tubes (12 x 75 mm) and chilled on ice until assayed in triplicate for glycerol with the glycerol enzymatic food analysis kit (No. 148270, Boehringer Mannheim Biochemicals, Indianapolis, IN). The reagents were diluted 1:3 with Milli-Q water (Dickerson, 1990) and the change in NADH was read at 340 nm (Varian® Cary 2200 UV-VIS spectrophotometer, Sugarland, TX).

*Enzyme activity.* Five hundred milligrams of AT were homogenized (Polytron, Brinkmann Instruments, Westbury, NY) in 5 ml of .25 M sucrose solution (37 °C) in a 15 ml Corex tube for 10 s bursts and centrifuged at 20,000 x g (Sorvall RC-5, DuPont Instruments, Newtown, CT) at 4 °C for 20 min. The supernatant was removed and placed in 12 x 75 mm glass test tubes for enzyme activity measurements. Triplicate analyses were performed for each AT sample.

Fatty acid synthase (EC 2.3.1.85) activity (Muesing and Porter, 1975) was measured as the conversion of acetyl CoA and malonyl CoA to palmitate utilizing NADPH. The disappearance of NADPH over time was measured as the change in absorbance over time at 340 nm and 30 °C (Varian® Cary 3 UV-VIS spectrophotometer, Sugarland, TX).

NADP-isocitrate dehydrogenase (ICD, EC 1.1.1.42) activity (Plaut, 1962) was measured as the conversion of isocitrate to $\alpha$-ketoglutarate producing NADPH. The appearance of NADPH over time was measured as the change in absorbance over time measured at 340 nm and 30 °C. Following both enzyme assays, the tissue supernatant was frozen until soluble protein content was determined by folin-phenol procedure (Lowry et al., 1951). Enzyme activity was expressed as units/mg protein.

*Epinephrine challenges.* Steers were fitted with an indwelling jugular cannula on the day before initiation of each series of epinephrine challenges. Epinephrine challenges ( 0, .1, .2, .4, .8, 1.2, and 1.6 µg/ kg BW) were administered over seven days, with one dose concentration administered per day (Sechen et al., 1990). Epinephrine HCl (1 mg/ml, The Butler Co., Columbus OH) was diluted with sterile saline (.15 M NaCl) to a concentration of 100 µg/ml. Epinephrine challenges (2-5 ml) were injected via the jugular catheter immediately followed by 4 ml of sterile saline. Epinephrine challenges were administered to nine steers at 0930 and the other ten at 1030. The latter group was treated and fed an hour later on days challenges were administered. Blood samples were withdrawn from cannulas at -30, -15, -10, -5, 0, 2.5, 5, 10, 15, 20, 30, 45, and 120, 125, and 130 min post-epinephrine infusion (starting at 1000 and 1100 for each group of 10 steers, respectively) into a 10 cc syringe. Collected whole blood was dispensed into a 7 ml, sterile blood-collection tube containing 10.5 mg EDTA and .014 mg potassium sorbate (Vacutainer Brand, Becton Dickinson and Co., Rutherford, NJ) to prevent coagulation. The filled tube was inverted several times and chilled in an ice-water bath until centrifugation. Plasma was separated by centrifugation at 959 x g (Beckman J2-21 refrigerated centrifuge, Beckman Instruments Inc., Palo Alto, CA) for 20 min at 4°C and stored in 12 x 75 mm polypropylene tubes (Sarstedt, Newton, NC) at -20 °C until analyzed for NEFA, glycerol and glucose concentrations. Plasma NEFA concentrations were assayed as previously outlined on all samples. Plasma glycerol and glucose concentrations were analyzed on samples from the third series of challenges using the 1.6 μg epinephrine/ kg BW dose.

Non-esterified fatty acid and glycerol responses to the epinephrine challenge were calculated as area under the response curve from 0 to 20 min post-challenge (SAS program provided in Figure B-1). Response areas were corrected for differences in base-line concentration (the average of samples collected -30, -15, -10 , -5, 0, 120, 125, and 130 min relative to the challenge). The NEFA response area for each dose was used to construct a dose-response curve for each animal utilizing the non-linear regression procedure of SAS (1994). A segmental curve was fitted to each set of challenges comprised of a quadratic curve to a plateau (maximum response, $R_{max}$, Figure B-1). When developing curves, the response of the 0 μg/kg BW was set at 0. If a plateau was not reached, within the range of epinephrine dosages, the responses for the 1.2 and 1.6 μg/kg BW dose (6 curves) or the .8 to 1.6 μg/kg BW doses (4 curves) were averaged and the curve recalculated. The epinephrine dose which gave half of $R_{max}$, the $ED_{50}$, was calculated using the quadratic portion of the curve. Of the 19 steers completing the study, one steer did not have the first two series of epinephrine challenges completed due to problems with the catheter.

*Statistical analysis.* This study was designed as a completely randomized block. Animal performance was analyzed using the GLM procedure of SAS (1994) with treatment and block in the model as class variables. Least square means were calculated and separated with probability of difference function. Plasma hormones and metabolites were analyzed using the univariate repeated-measures analysis of SAS (1994) with treatment and block in the model as class variables and least square means, treatment and day within treatment, separated by a procedure outlined by Gill (1987). Tritium incorporation, enzyme activity, and glycerol release were analyzed using the mixed procedure of SAS (Littell et al., 1996) with the spatial power law covariance structure to account for the unequally spaced repeated measures. The epinephrine challenge maximum response, $R_{max}$, and $ED_{50}$ were analyzed using the mixed procedure of SAS (Littell et al., 1996) with an autoregressive covariance structure assuming equally spaced repeated measures. Measures of lipogenesis and lipolysis utilized treatment and block in the model as class variables, whereas $R_{max}$, and $ED_{50}$ utilized treatment and replicate in the model as class variables.

## Results

*Bovine somatotropin time course and blood metabolites.* Plasma bST concentrations began to increase ($P < .05$) above baseline within .5 h after the s.c. injection of bST and remained elevated 10 h when blood collection stopped (Figure 3-2). Somatotropin concentrations peaked 1.5 h after bST administration. Prior to treatment, bST concentrations were similar between treatments for at least 1.5 h.

Prior to the start of treatment, bST steers had 34% greater ($P < .05$) plasma IGF-I concentration than control steers (Figure 3-3). Three days following initial bST treatment and continuing throughout the entire study, bST steers had 112 to 157% greater plasma IGF-I concentration than control steers. Steers receiving bST averaged 88% greater ($P < .01$) plasma NEFA concentration and 45% greater ($P < .01$) plasma glycerol concentration from d 3 to 87 than control steers (Figure 3-4

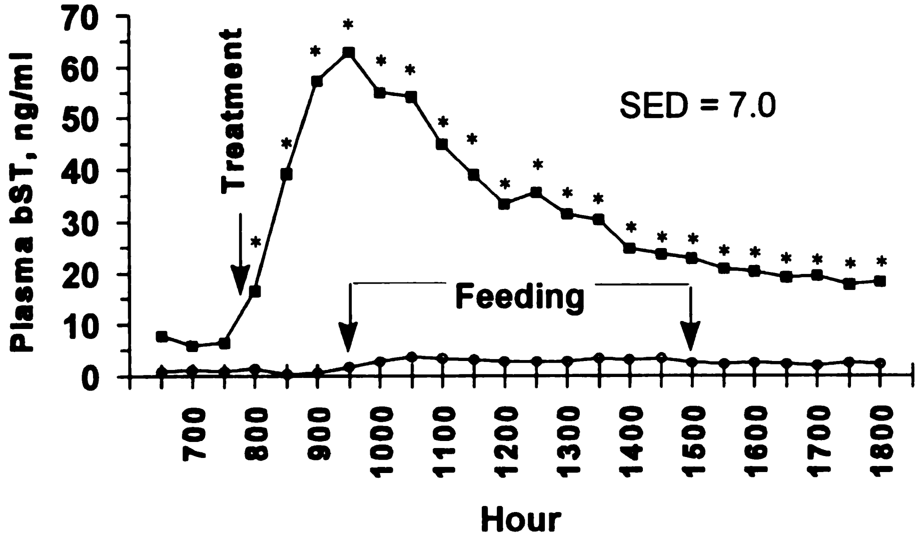


Figure 3-2 - Plasma bovine somatotropin concentrations over an 11.5-h period in Holstein steers treated with either a daily injection of sodium phosphate (O) or bovine somatotropin (■). *bST steers differ from control steers ($P < .05$).

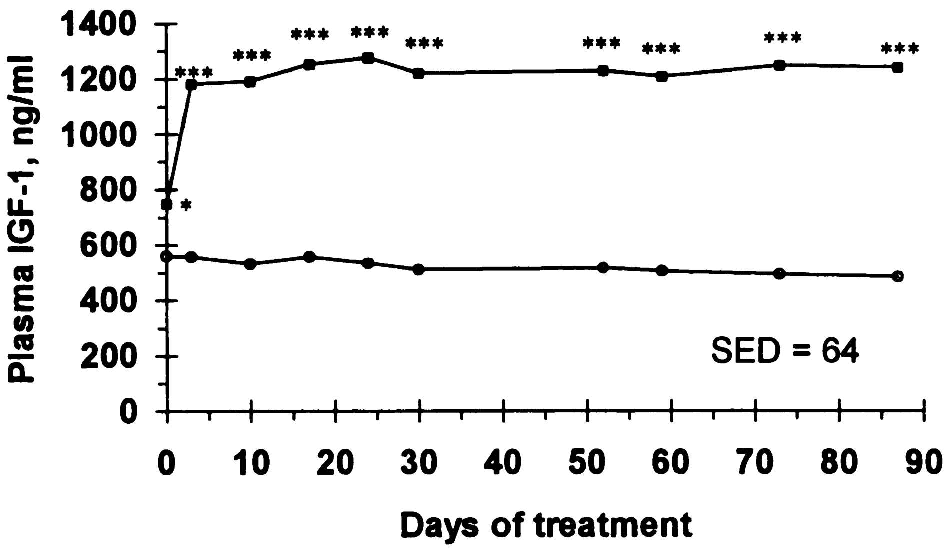


Figure 3-3 - Plasma IGF-I concentrations versus days of treatment in Holstein steers treated with either a daily injection of sodium phosphate (O) or bovine somatotropin (■). *bST steers differ from control steers ($P < .05$). ***bST steers differ from control steers ($P < .001$).

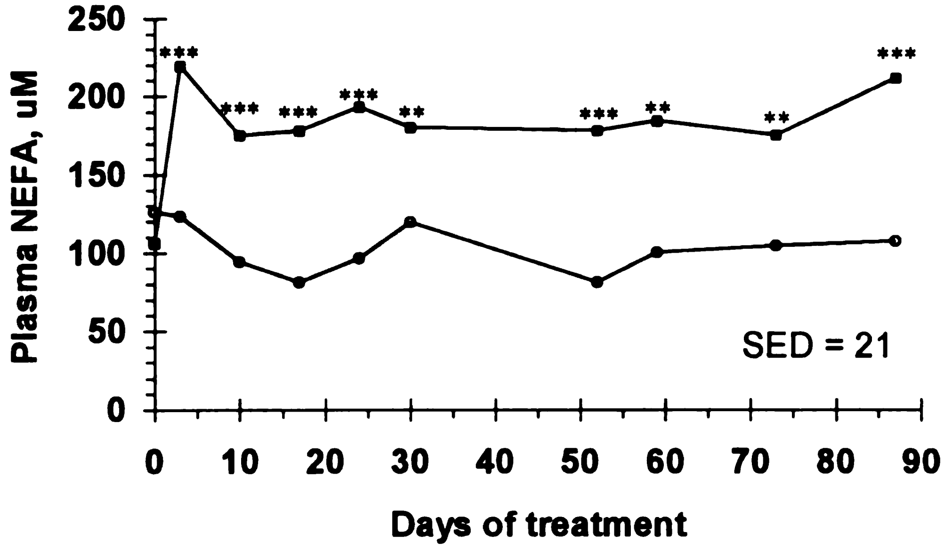


Figure 3-4 - Plasma NEFA concentrations versus days of treatment in Holstein steers treated with either a daily injection of sodium phosphate (O) or bovine somatotropin (■). **bST steers differ from control steers ($P$ < .01). ***bST steers differ from control steers ($P$ < .001).

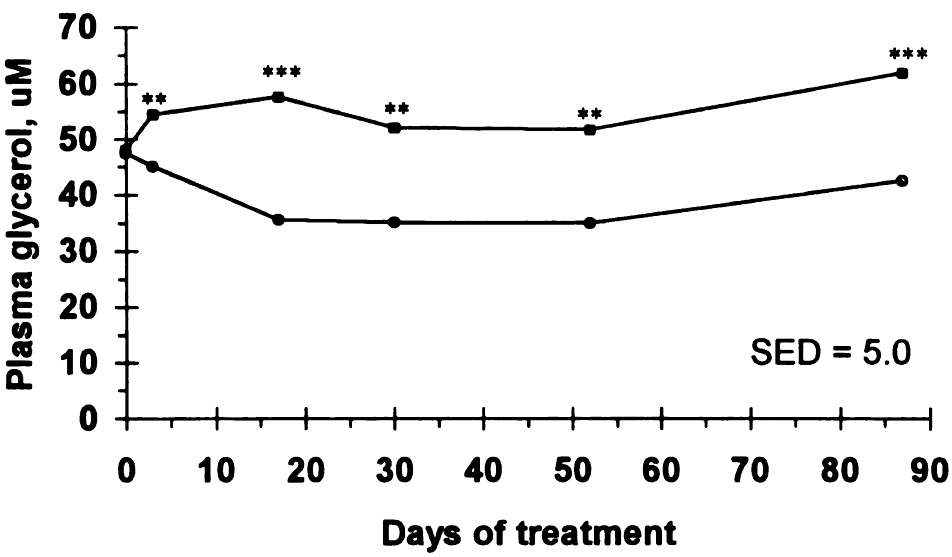


Figure 3-5 - Plasma glycerol concentrations versus days of treatment in Holstein steers treated with either a daily injection of sodium phosphate (O) or bovine somatotropin (■). **bST steers differ from control steers ($P$ < .01). ***bST steers differ from control steers ($P$ < .001).

and 3-5, respectively). On average, bST steers had 11% greater ($P < .05$) plasma glucose concentration from d 3 to 87 than control steers (Figure 3-6). From d 17 to 87, bST steers had 665% greater ($P < .05$) plasma insulin concentration than control steers (Figure 3-7).

*Feedlot performance.* Steers receiving bST tended to have 3% greater ($P < .10$) live weight than control steers after 30 d of treatment (Table 3-2). Any advantage gained in the first 30 d was not maintained throughout the entire study. The greater BW after 30 d of treatment was due to bST steers having 43% greater ($P < .05$) ADG during this period, but as with BW, no improvement in ADG was evident from d 31 to d 115.

Dry matter intake was similar for treatments during the first 30 d of the study, but during the remaining 85 d, DMI tended to be 9% lower ($P < .10$) in bST steers than controls. Over the entire study, treatments had similar daily DMI and protein intake. Feed efficiency of bST steers was 47% greater ($P < .01$) during the initial 30 d of the study and 19% greater ($P < .05$) over the entire study.

*Carcass characteristics, composition and accretion.* Steers had similar HCW, but steers receiving bST tended to have 6% greater ($P < .10$) NCW and 2% lower DP ($P < .10$) than control steers (Table 3-3). There was no difference between treatments in liver weight. Ribeye area, as expressed on a HCW basis was 9% larger ($P < .05$) in bST steers than control steers. Measures of carcass fatness were reduced with bST administration. Bovine somatotropin decreased backfat 28% ($P < .05$), KPH fat percentage 50% ($P < .001$), marbling score 21% ($P < .001$), and USDA quality grade 9% ($P < .001$). Administration of bST decreased

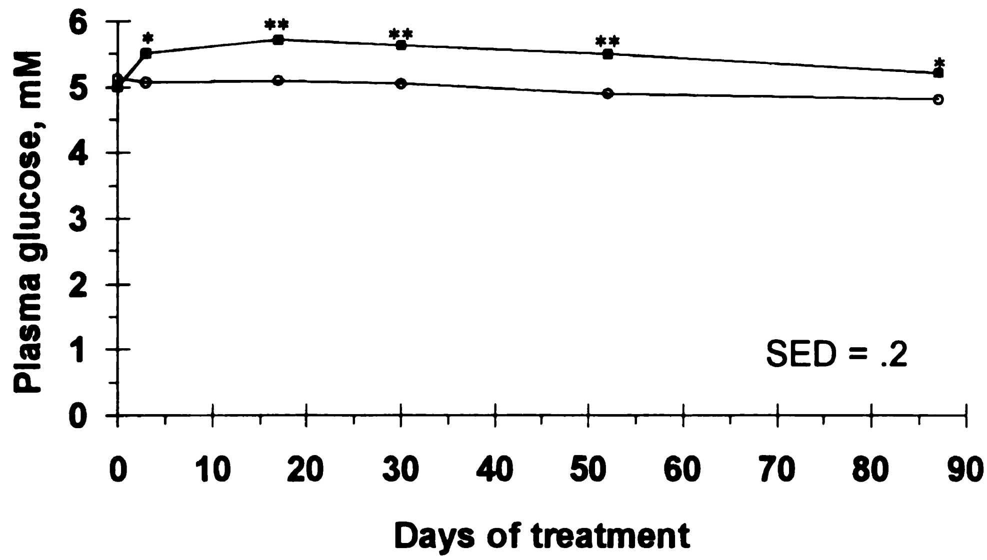


Figure 3-6 - Plasma glucose concentrations versus days of treatment in Holstein steers treated with either a daily injection of sodium phosphate (O) or bovine somatotropin (■). *bST steers differ from control steers ($P$ < .05). **bST steers differ from control steers ($P$ < .01).

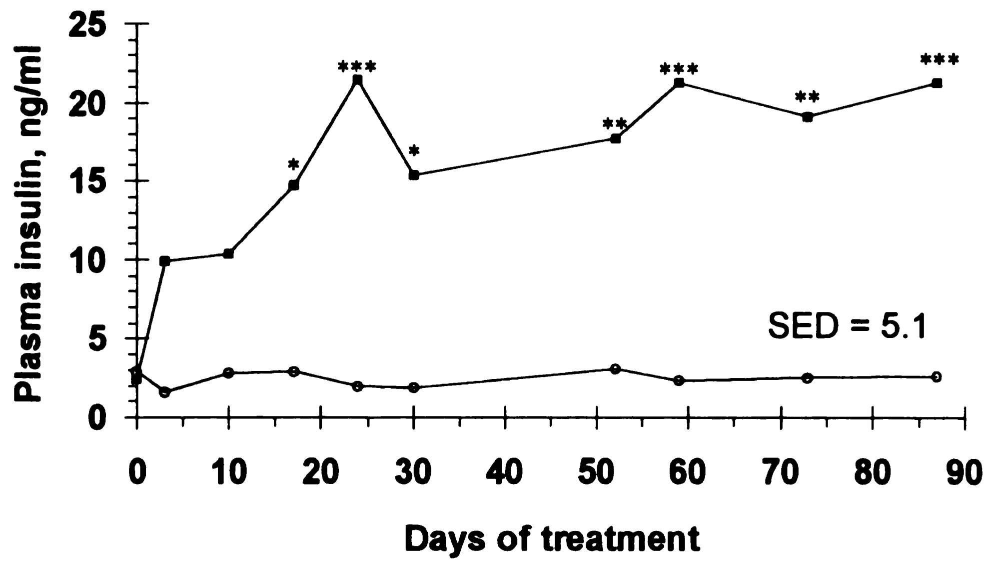


Figure 3-7 - Plasma insulin concentrations versus days of treatment in Holstein steers treated with either a daily injection of sodium phosphate (O) or bovine somatotropin (■). *bST steers differ from control steers ($P$ < .05). **bST steers differ from control steers ($P$ < .01). ***bST steers differ from control steers ($P$ < .001).

Table 3-2. Effect of bovine somatotropin on feedlot performance[a]

| | Treatments | | | | Probability | |
|---|---|---|---|---|---|---|
| Trait | Control | SE | bST | SE | Model | Contrast[b] |
| No. of steers | 9 | | 10 | | | |
| Body weight, kg | | | | | | |
| Day 0 | 460 | 3.9 | 460 | 3.6 | .91 | .97 |
| Day 30 | 502 | 6.6 | 519 | 6.2 | .20 | .08 |
| Day 115 | 594 | 11.3 | 608 | 10.6 | .38 | .37 |
| Average daily gain, kg | | | | | | |
| Days 0 to 30 | 1.38 | .17 | 1.97 | .16 | .15 | .03 |
| Days 31 to 115 | 1.09 | .08 | 1.05 | .07 | .60 | .74 |
| Days 0 to 115 | 1.15 | .08 | 1.28 | .08 | .35 | .28 |
| Dry matter intake, kg/d | | | | | | |
| Days 0 to 30 | 9.81 | .36 | 9.52 | .34 | .29 | .57 |
| Days 31 to 115 | 9.78 | .34 | 8.88 | .32 | .19 | .07 |
| Days 0 to 115 | 9.79 | .33 | 9.05 | .31 | .21 | .12 |
| Protein intake, g/d | | | | | | |
| Days 0 to 115 | 1312 | 44 | 1214 | 41 | .21 | .12 |
| Feed efficiency, g gain/kg DMI | | | | | | |
| Days 0 to 30 | 140 | 15 | 206 | 14 | .09 | .007 |
| Days 31 to 115 | 110 | 5 | 116 | 5 | .35 | .47 |
| Days 0 to 115 | 118 | 5 | 140 | 5 | .07 | .01 |

[a]Least square means.
[b]Probability of difference: Control versus bST.

Table 3-3. Effect of bovine somatotropin on carcass characteristics[a]

| Characteristic | Treatments | | | | Probability | |
|---|---|---|---|---|---|---|
| | Control | SE | bST | SE | Model | Contrast[b] |
| Hot carcass wt., kg | 355 | 7.1 | 355 | 6.6 | .45 | .98 |
| Noncarcass wt., kg | 240 | 5.8 | 254 | 5.4 | .36 | .10 |
| Dressing percent | 59.7 | .51 | 58.3 | .48 | .51 | .07 |
| Liver wt., | | | | | | |
| g | 8634 | 228 | 9029 | 213 | .11 | .22 |
| % of BW | 1.45 | .03 | 1.48 | .03 | .32 | .43 |
| Ribeye area, | | | | | | |
| $cm^2$ | 77.1 | 2.7 | 83.7 | 2.7 | .66 | .11 |
| $cm^2$/kg HCW | .216 | .006 | .236 | .006 | .20 | .03 |
| Backfat, mm | 6.1 | .58 | 4.4 | .54 | .29 | .04 |
| KPH, % | 2.2 | .06 | 1.1 | .06 | .0001 | .001 |
| Marbling score[c] | 560 | 12.3 | 445 | 11.5 | .0003 | .001 |
| Quality grade[d] | 18.1 | .19 | 16.4 | .18 | .0008 | .001 |
| % Choice | 78 | | 0 | | | |
| % Select | 22 | | 100 | | | |
| Calculated yield grade | 2.7 | .14 | 2.0 | .13 | .03 | .002 |

[a]Least square means.
[b]Probability of difference for Control versus bST.
[c]400 = slight, 500 = small.
[d]19 = Choice°, 18 = Choice$^-$ 17 = Select$^+$, 16 = Select$^-$.

($P < .01$) calculated yield grade 26% and therefore increased red meat yield.

Carcass composition was altered significantly with bST administration (Table 3-4). Steers administered bST had 11% greater ($P < .001$) bone, 9% greater ($P < .001$) protein, and 10% greater ($P < .001$) water composition of the carcass and 38% greater protein accretion than control steers. Lipid composition of the carcass was decreased 32% ($P < .001$) with 70% lower ($P < .001$) lipid accretion in bST steers than control steers. Efficiency of protein accretion was increased ($P < .001$) 50% with bST administration.

*Lipogenesis.* Measures of in vitro lipogenesis, tritium incorporation, and enzyme activity are presented in Table 3-5. Tritium incorporation into AT was decreased ($P < .05$) by 54 and 56% for control and bST steers, respectively, from pretreatment through 103 d of the study. Tritium incorporation was decreased 45% ($P < .05$) in AT from bST steers than control steers during the second biopsy period, 40 d of treatment, but treatments were similar during the last biopsy period. Similarly, FAS and ICD decreased ($P < .10$) throughout the study in AT from control and bST steers. Fatty acid synthase activity tended to be lower ($P < .10$) in AT of bST steers than controls during the second biopsy period. Isocitrate dehydrogenase activity was similar between treatments throughout the study, but activity in AT of bST steers decreased sooner than controls. The correlations between tritium incorporation and FAS and ICD activity were $r = .41$ ($P = .002$) and $r = .40$ ($P < .001$), respectively. The correlation between FAS and ICD was $r = .77$ ($P < .001$).

Table 3-4. Effect of bovine somatotropin on carcass composition and accretion rates[a]

| Variable | Treatments | | | | Probability | |
|---|---|---|---|---|---|---|
| | Control | SE | bST | SE | Model | Contrast[b] |
| Carcass composition, % | | | | | | |
| Bone | 15.0 | .3 | 16.6 | .2 | .09 | .001 |
| Protein | 13.2 | .2 | 14.4 | .2 | .007 | .001 |
| Lipid | 25.6 | .7 | 17.3 | .7 | .0001 | .001 |
| Water | 47.1 | .5 | 52.0 | .4 | .0002 | .001 |
| Carcass accretion rates, g/d | | | | | | |
| Protein | 92 | 8 | 127 | 8 | .09 | .01 |
| Lipid | 355 | 29 | 106 | 27 | .0009 | .001 |
| Efficiency of protein accretion | | | | | | |
| Day 0 to 115[c] | 70 | 6 | 105 | 5 | .02 | .001 |

[a]Least square means.
[b]Probability of difference for Control versus bST.
[c]daily g protein accretion/ kg daily dietary protein intake.

Table 3-5. Effect of bovine somatotropin on tritium incorporation into fatty acids, fatty acid synthase activity, and isocitrate dehydrogenase activity[a]

| Period | Control | bST |
|---|---|---|
| | nmol $^3$H converted to fatty acid•min$^{-1}$•100 mg$^{-1}$[b] | |
| d -16 to -5 | 3.44[x] | 3.15[x] |
| d 40 to 49 | 2.50[xy] | 1.37[y*] |
| d 103 to 112 | 1.59[y] | 1.39[y] |
| | Fatty acid synthase activity, units•mg protein$^{-1}$[c] | |
| d -16 to -5 | 10.96[j] | 13.29[x] |
| d 40 to 49 | 6.83[k] | 3.12[y†] |
| d 103 to 112 | 7.62[jk] | 4.57[y] |
| | NADP-Isocitrate dehydrogenase activity, units•mg protein$^{-1}$[d] | |
| d -16 to -5 | 281.6[x] | 284.5[x] |
| d 40 to 49 | 210.5[xy] | 153.8[y] |
| d 103 to 112 | 160.9[y] | 135.8[y] |

[a]Least square means.
[b]SED = .47.
[c]SED = 2.25.
[d]SED = 41.1.
[j,k]Means within columns and response variable with unlike superscripts differ (*P* < .10).
[x,y]Means within columns and response variable with unlike superscripts differ (*P* < .05).
†Differs from Control within period (*P* < .10).
*Differs from Control within period (*P* < .05).

*Lipolysis.* Basal-glycerol release (Table 3-6) was increased ($P < .05$) 42% in AT from bST steers after 103 d of treatment as compared to AT from control steers. Epinephrine-stimulated glycerol release was similar between treatments at all biopsy periods. Nonesterified fatty acid response to an epinephrine challenge was used as an in vivo measure of lipolysis. Response curves for NEFA are presented in Figure 3-8 with descriptive statistics in Table 3-7. The maximum NEFA response ($R_{max}$) to an epinephrine challenge was 84 and 40% greater ($P < .01$) in bST steers during the $6^{th}$ and $15^{th}$ week of treatments as compared to control steers. Within bST steers, the $R_{max}$ ($P < .05$) was 76 and 65% greater than pretreatment values during the $6^{th}$ and $15^{th}$ week of treatment, respectively. The $ED_{50}$ dose was higher ($P < .05$) in bST steers prior to the start of the study, but during treatment, the $ED_{50}$ dose was similar between treatments at both series of challenges. The plasma glycerol response to a 1.6 μg epinephrine/kg BW response (Figure 3-9) was similar between treatments. The correlation between basal glycerol release and $R_{max}$ was $r = .32$ ($P = .02$). There was not a significant correlation between basal glycerol release in vitro nor $R_{max}$ with the area under the glycerol response curve.

## Discussion

*Bovine somatotropin time course and blood metabolites.* Plasma ST concentrations were similar between controls and bST treatment for 1.5 h prior to each daily treatment. Peak plasma ST concentrations occurred within 2 h after the s.c. injection. This is a similar pattern to Eisemann et al. (1986a), Enright et al.

Table 3-6. Effect of somatotropin treatment on basal and epinephrine-stimulated glycerol release[a]

| Period | Control | bST |
| --- | --- | --- |
| Basal, nmol glycerol released• $2h^{-1}$•100 mg $tissue^{-1b}$ | | |
| d -16 to -5 | 73.5 | 93.6 |
| d 40 to 49 | 95.4 | 106.5 |
| d 103 to 112 | 83.4 | 118.5 * |
| Stimulated, nmol glycerol released• $2h^{-1}$•100 mg $tissue^{-1c}$ | | |
| d -16 to -5 | 261.4 | 284.1 |
| d 40 to 49 | 261.1 | 274.9 |
| d 103 to 112 | 265.2 | 282.2 |

[a]Least square means.
[b]SED = 16.5.
[c]SED = 29.6.
*Differs from Control within period ($P < .05$).

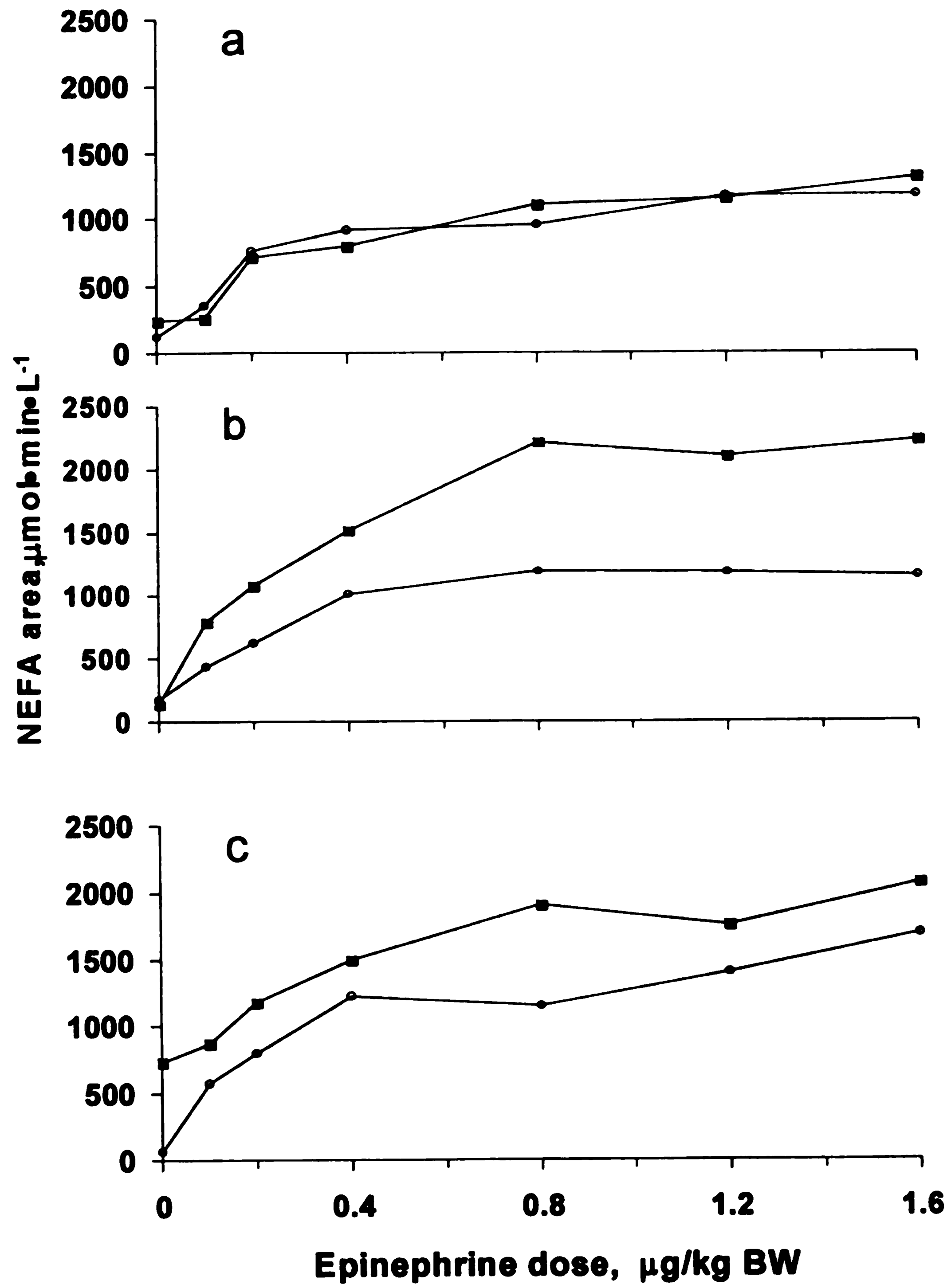


Figure 3-8 - Response in plasma concentrations of NEFA to varying doses of epinephrine during 3 weeks prior to treatment (panel a) and after 6 (panel b) and 15 weeks (panel c) of control (O) or bST (■) treatment. Analyses of individual animal curves are in Table 3-7.

Table 3-7. Estimates of $R_{max}$ and $ED_{50}$ of nonesterified fatty acids area epinephrine dose-response curves[a]

| Week | Control | bST |
|---|---|---|
| | $R_{max}$, µmol•min•L$^{-1b}$ | |
| -3 | 1094 | 1246$^{x}$ |
| 6 | 1192 | 2198$^{y,***}$ |
| 15 | 1465 | 2056$^{y,**}$ |
| | $ED_{50}$, µg epinephrine•kg BW$^{-1c}$ | |
| -3 | .16 | .27$^{*}$ |
| 6 | .19 | .24 |
| 15 | .19 | .22 |

[a]Least square means.

[b]SED = 206.

[c]SED = .05.

[x,y,z]Means within columns and response variable with unlike superscripts differ ($P < .05$).

*Differs from Control within week ($P < .05$).

**Differs from Control within week ($P < .01$).

***Differs from Control within week ($P < .001$).

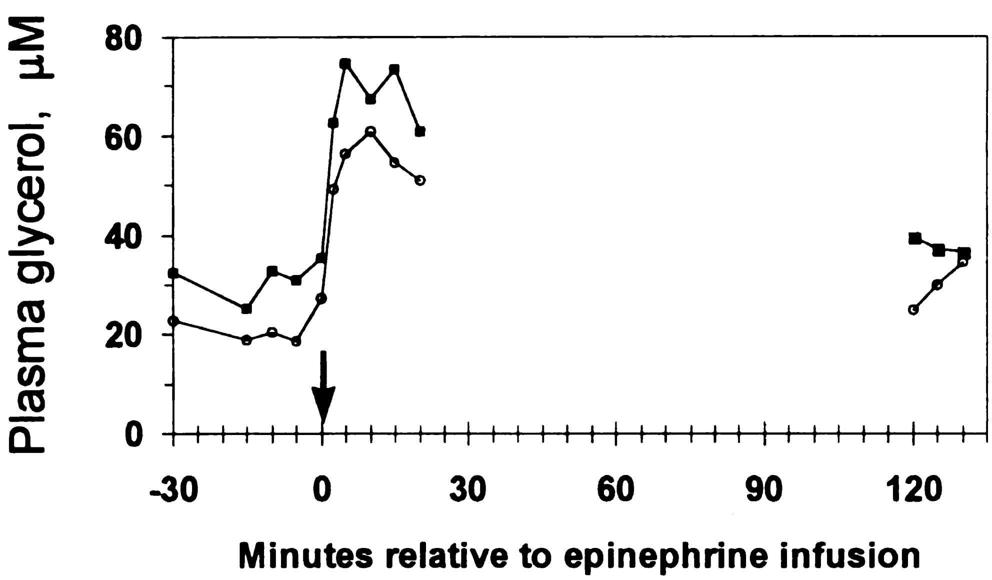


Figure 3-9 - Response in plasma glycerol concentrations to a 1.6 µg/kg BW epinephrine infusion (arrow) during the 15th week of treatment with either control (O) or bST (■). Area under the response curve (0 to 20 min. after infusion) was calculated using data points -30 to 0 and 120 to 130 min. relative to infusion as the base line. Control area under the curve = 604 ± 100 µM•min and bST area under the curve = 648 ± 94 µM•min.

(1990) and Boisclair et al. (1994) with 29.2 IU bST/d, 40 μg bST/kg BW and 120 μg bST/kg BW, respectively. Enright et al. (1990) and Boisclair et al. (1994) observed a peak in plasma ST concentrations 1 h after administration with a gradual decline to baseline by 12 h. In the present study, elevated plasma ST concentrations persisted for 11.5 h after injection.

Similar to the first study (Chapter 2), and consistent with previous research (Moseley et al., 1992; Roeder et al., 1994; Preston et al., 1995; and Enright et al., 1990) bST administration increased plasma IGF-I concentrations. In growing lambs, plasma IGF-I concentration increased after one week of treatment and increased three-fold after ten weeks of ST administration (Pell et al., 1990).

Both plasma NEFA and glycerol concentrations increased dramatically in the present study. This is in agreement with Eisemann et al. (1986) who observed a chronic elevation in plasma NEFA in growing beef heifers, but Enright et al. (1990) and Peters (1986) observed no plasma NEFA increase in growing steers, and Pell et al. (1990) demonstrated no effect in growing lambs treated with ST. Dunshea et al. (1992a) demonstrated an increase in plasma NEFA and glycerol of barrows within 7 and 10 to 12 h, respectively, of the first porcine ST (pST) injection and the response increased on the second and seventh day of treatment. In agreement with the present study, Doris et al. (1996) observed a 31% increase in plasma glycerol concentration growing sheep treated with ST for 7 d.

It is suggested by Boisclair et al. (1997) that the increase in plasma NEFA concentration with bST treatment of animals in positive energy balance is a result of mild disturbances or stress during blood collection. This is suggested because bST causes an increase in β-adrenergic receptor (βAR) number in rat adipocyte membranes (Watt et al., 1990) and therefore respond to catecholamines to a greater extent than non-treated animals. Houseknecht et al. (1995) determined that bST increased the maximum binding of a βAR agonist to the βAR without a change in the binding affinity. Boisclair et al. (1997) cautions that proper protocol is required to prevent inadvertent responses which may suggest lipolytic activity. It is true that the animals in the current study were disturbed during blood collection. They were removed from their pens, taken outside, worked through a typical beef cattle-handling facility and placed into a squeeze chute for jugular venipuncture.

Eisemann et al. (1986) demonstrated both an increase in irreversible loss and oxidation of NEFA with bST treatment in heifers. The data further suggested that NEFA are used as an energy source and perhaps this spares oxidation of other metabolites (e.g. amino acids) during bST treatment. It could also be theorized that the adipocytes are stimulated continuously due to the increased adrenergic receptors causing elevated plasma NEFA concentrations. Without measures of stress (e.g. cortisol) one can not determine if the animal experienced a mild disturbance. Plasma cortisol was not different in the study by Peters (1986), but NEFA concentrations were not elevated either.

Plasma NEFA and glycerol concentrations increase 743 and 46%, respectively, in steers under a prolonged fast (Rule et al., 1985). This is significantly greater then the increase In plasma NEFA observed in the present study. These changes were in response to decreased plasma glucose, insulin, and ST concentrations and were used for homeostatic control of plasma glucose, utilizing glycerol for gluconeogenesis (Rule et al., 1985). In the present study where plasma glucose concentrations were elevated, glycerol would not be needed for gluconeogenesis, but may be elevated due to increased lipolysis. This is in agreement with Sechen et al. (1990), where a 372% increase in plasma NEFA and 119% increased plasma glycerol concentration in bST-treated lactating dairy cattle were observed. Additionally, Peters et al. (1986) observed a 63% increase in basal plasma NEFA with feed restriction.

Plasma glucose was chronically increased from d 3 and thereafter in bST-treated steers. This increase in plasma glucose is supported by Boisclair et al. (1994) in bST-treated growing cattle and Pell et al. (1990) in ST-treated lambs where increases of 5 and 11% were observed, respectively. Dunshea et al. (1992a) observed an increase in plasma glucose and insulin within 2 and 4 h, respectively, after an initial injection of pST to barrows. Early et al. (1990a) and Enright et al. (1990) in steers, and Sechen et al. (1990) in lactating dairy cattle, did not observe an increase in plasma glucose with ST administration. Pell et al. (1990) stated, that the increase in plasma glucose could be due to an increased rate of gluconeogenesis, or a decrease in peripheral glucose utilization. Boisclair et al. (1994) demonstrated a decrease in hindlimb glucose uptake in growing steers administered bST. Additionally, Hart et al. (1984) demonstrated that bST had diabetogenic activity and decreased the insulin depression in plasma glucose during an insulin tolerance test and suggested that bST decreased glucose uptake by body tissues. Glucose uptake was decreased in pigs treated with pST (Dunshea et al., 1992c).

There is evidence that ST decreases insulin sensitivity. Hart et al. (1984) observed a reduction in the insulin-induced decrease of plasma glucose during an insulin tolerance test and Roupas et al. (1991) suggested that insulin is uncoupled from its second messengers in the presence of ST. If insulin sensitivity is reduced, that would explain the increase in plasma insulin observed in this study. Somatotropin induced increase in plasma insulin has been observed by Wallace and Bassett (1966), Johnsson et al. (1985), Eisemann et al. (1986), Pell et al. (1990) and Boisclair et al. (1994) in ruminants and by Hansen et al. (1997a) in pigs. Pell et al. (1990) suggests they have unpublished data which demonstrates an increase in gluconeogenic potential by hepatocytes isolated from ST-treated lambs and therefore, glucose production may be increased, but would require an adequate supply of gluconeogenic precursors, glycerol being one. Plasma glycerol concentrations were increased in the present study and Doris et al. (1996) in growing animals and may be the result of triacyglycerol breakdown as suggested by Pell et al. (1990). Wallace and Bassett (1966) believed that the increase in nitrogen retention with ST administration is dependent on the associated increase in plasma insulin. The increase in plasma insulin would drive more nutrients (AA, glucose) into cells and stimulate anabolism.

*Feedlot performance.* Just as in the previous study, bST increased ADG and BW early during treatment, but the increase was not maintained throughout the entire study. Early et al. (1990a) reported an increase in ADG during the first 8 d of a 112-d study, but Rumsey et al. (1996) and Preston et al. (1995) demonstrated increased ADG throughout their 56 and 84 to 119-d studies, respectively. In the current study, the dietary CP concentration was increased to 13.4% as compared to the 11.5% in the previous study (Chapter 2). There was not a sustained increase in ADG of bST steers with the increased dietary CP. Daily gains exhibited by both treatments in this study are similar to the previous study (Chapter 2), although adequate undegraded intake protein (518 g/d and 482 g/d for the control and bST-steers, respectively) was available to achieve ADG of 2.02 and 1.73 kg, respectively (NRC, 1996). Based on the NRC (1996) diet evaluator, energy would limit ADG to 1.68 and 1.5 kg for the control and bST-steers, respectively.

Dry matter intake was reduced in bST-treated steers. This is in agreement with Dalke et al. (1992), Moseley et al. (1992) and Preston et al. (1995) who reported a decrease in DMI of steers with increasing levels of bST administration. Early et al. (1990a) observed no effect of bST on intake and Rumsey et al. (1996) demonstrated an increase in DMI with bST treatment. The decrease in DMI suggests that as an animal mobilizes lipids and energy due to bST, these nutrients are directed away from lipogenesis, the animal compensates for the extra circulating nutrients by reducing its intake (McBride and Moseley, 1991). The effect may be dependent on BW and lipid content of the animal. In light-weight cattle which have less body-fat reserves, such as those used by Rumsey et al. (1996), the increased growth observed may stimulate intakes to supply the increased energy needs. Animals that have been on feed for some time (Preston et al., 1995; Moseley et al., 1992) have added body-fat reserves and the action of bST to enhance lipolysis increases circulating blood nutrients thereby decreasing DMI.

Although, ADG did not increase significantly and DMI decreased marginally, feed efficiency increased. This is supported Early et al. (1990a), Moseley et al. (1992), Preston et al. (1995), and Rumsey et al. (1996) who all observed increased feed efficiency with bST administration.

*Carcass measurements.* In the present study, HCW was not influenced by bST treatment. Hot carcass weight has been shown to decrease linearly with increasing bST doses from 0 to 300 µg bST/kg BW (Moseley et al., 1992), although Rumsey et al. (1996) observed a 5.5% increase in HCW with bST administration. The increase in NCW and the decrease in DP observed in the present study is consistent with previous research. The increase in NCW is supported by Early et al. (1990a) and the decrease in DP by Early et al. (1990a) and Moseley et al. (1992), but Preston et al. (1995) did not observe an effect of bST on DP. Early et al., (1990a) estimated that the increase in NCW was primarily due to an increase in the GIT, but this was not observed in the study by Rumsey et al. (1996).

Ribeye area when expressed on a HCW basis did increase in the present study and was similar to the response observed in the previous experiment (Table 2-8) in steers receiving bST during the latter part of the study as compared to control steers. This increase in REA is supported by Moseley et al. (1992) which observed a 4 to 8.7% linear and quadratic increase in REA with increasing bST doses (8.25, 16.5, 33, and 66 µg bST/kg BW), and a 7.2 and 6.6% increase in REA at doses of 100 and 300 µg bST/kg BW. An increase in REA with bST administration was not observed by Peters (1986) or Preston et al. (1995). The increase in REA is consistent with the increased protein composition and accretion of bST-treated steers. Rumsey et al. (1996) demonstrated a 22% increase in carcass protein accretion with bST administration in young steers and Early et al. (1990c) determined whole-body protein accretion was increased with bST administration by not of the carcass. Eisemann et al., (1989) demonstrated increased protein synthesis of the biceps femoris, longissimus dorsi, gastrocnemius and triceps brachii muscles. The increase in efficiency of protein accretion estimated in the present study is in agreement with Eisemann et al. (1986) who demonstrated a marked improvement in the efficiency of protein deposition (a decrease in the grams of protein synthesized / grams of protein deposited), and a 5.7% increase in whole-body protein synthesis. Additionally, these results would be consistent with the findings that ST reduces blood urea nitrogen suggesting reduced amino acid degradation and increased nitrogen retention and protein deposition (Wallace and Bassett, 1966; Eisemann et al., 1986b, and Sinnett-Smith et al., 1989)

All measures of carcass lipid content (backfat, KPH, marbling score, USDA quality grade, lipid composition and accretion rates) were decreased with bST administration. Peters (1986) observed a 24% reduction in backfat with bST administration following 29 d of treatment. Moseley et al. (1992) reported a 9 to 62% reduction in backfat and a 17 to 95% reduction in the percent of carcasses grading USDA Choice. The 95% reduction was in steers receiving 300 μg bST/kg BW, growth rate was reduced and these steers did not reach market weight. At 100 μg bST/kg BW, 70% fewer carcasses graded USDA Choice (Moseley et al., 1992). Preston et al. (1995) documented a linear decrease in backfat (15%), KPH fat (28%), marbling score (6%), and percent grading USDA choice (58%) with increased bST dosage. Early et al. (1990a) did not see a difference in backfat or Canadian carcass grade. As fat decreased, the percentage of lean tissue increased in the present study as shown by reduced yield grade. This agrees with Preston et al. (1995) in which bST reduced yield grade by 12.5%.

In the present study, carcass lipid composition and accretion were decreased to a greater extent in bST-treated steers than in steers receiving bST only during the latter part of the previous experiment (Chapter 2, 18 vs. 32%, and 39 vs. 70% reductions, respectively). The average bST dose was different between the two studies and may explain these differences. In the current study, 100 μg bST/kg BW was administered, but in the previous study a set quantity per 14 d was given and averaged 89 μg bST / kg BW for steers only receiving bST during the latter part of the study. This finding would be consistent with bST dose-response studies (Dalke et al., 1992 and Moseley et al., 1992). Total carcass lipid was decreased in steers treated with bST (Peters, 1986) and Rumsey et al. (1996) demonstrated a 23.5% decrease in lipid accretion after 56 d of bST administration. Early et al. (1990b) did show a statistically-significant reduction in carcass fat or lipid accretion with bST treatment, although, numerically this values decreased 11.5% and 11%, respectively.

*Lipogenesis*. All three measures of lipogenesis demonstrated a decrease over the period of the study. Pothoven et al. (1975) observed a 62% decrease in in vitro lipogenesis as crossbred steers increased in BW from 363 to 505 kg. The decrease in lipogenesis as BW increases is associated with an increase in adipocyte size and fewer cells per unit weight of tissue (Hood and Allen, 1973).

In the present study, after 40 d of treatment, both tritium incorporation into FA and FAS activity were reduced in bST-treated steers as compared to control steers. Somatotropin has been found to decrease fatty acid synthesis in AT treated in vitro with ST (Vernon, 1982; Sinnett-Smith and Woolliams, 1989). Walton and Etherton (1986) demonstrated that ST can antagonize insulin's stimulation of lipogenesis in cultured porcine AT. Kramer et al. (1993) observed a 35% decrease in fatty acid synthesis, as measured by tritium incorporation into FA, and a 56% decrease in malic enzyme activity in pigs treated with pST for 24 d. Additionally, Harris et al. (1993) reported a correlation between FAS and lipogenesis was r = .45, which is similar to the correlation between FAS activity and measures of lipogenesis in the present study. Harris et al. (1993) observed an 86% reduction in glucose incorporated in FA after barrows were treated 11 d and reduced FAS and ICD activities of 67 and 31%, respectively. Because AT enters a net degradative state after biopsy, in vitro measurements of lipogenesis may be underestimates (Kramer et al., 1993). Dunshea et al. (1992c) utilized an in vivo method to determine glucose utilization rates for lipogenesis and the concurrent effects of pST. Rates of glucose incorporated into lipids was reduced 76%. Specifically, glucose incorporated into triglyceride-FA was reduced 78% as compared to glucose incorporated into triglyceride-glycerol which was reduced 66%.

Vernon et al. (1991a) determined that ST decreased the activation of acetyl-CoA carboxylase (ACC) when AT from wethers was treated with ST in vitro. Magri et al. (1990) demonstrated a decrease in the lipogenic enzyme activities of FAS, glucose-6-phosphate dehydrogenase, 6-phosphogluconate dehydrogenase, and malic enzyme in AT of barrows treated for seven days with pST. Additionally, Magri et al. (1990) determined that glucose transport into adipocytes was reduced 62% with pST administration, but insulin binding to the adipocyte nor the insulin receptor's tyrosine kinase activity was affected. Donkin et al. (1996) found GLUT 4 mRNA abundance, the major insulin regulated glucose transporter in adipocytes, was not decreased with pST administration, but Kilgour et al. (1995) determined that a decreased in plasma ST concentration in the rat caused the GLUT 4 protein to translocate from the intracellular pool to the plasma membrane.

Roupas et al. (1991) discovered that ST interferes with the signal transmission of a G protein between the insulin receptor and phosphoinositol-phospholipase C, thereby, even though insulin binding is not inhibited (Magri et al., 1990) its signal is being interrupted. Borland et al. (1994) determined that a short-lived protein may also be needed for ST to inhibit lipogenesis in sheep AT. This was determined after actinomycin D, a protein synthesis inhibitor, blocked ST depression of lipogenesis in vitro. Ornithine carboxylase activity was shown to increase during ST treatment and coincided with the decrease in lipogenesis (Borland et al., 1994). Additionally, a polyamine may be needed for maximal ST expression (Borland et al., 1994). In addition to decreasing enzyme activation and interfering with signal transduction, Harris et al. (1993) and Donkin et al. (1996) have shown that ST can alter enzyme synthesis. Harris et al. (1993) demonstrated a 74% decrease in FAS mRNA with pST treatment for 11 d and Donkin et al. (1996) determined that FAS mRNA decreased in a linear fashion in porcine adipocytes with increased dosages of pST.

In the present study, ICD was numerically lower (16 to 26%) in AT of bST-treated steers as compared to control. In support of these findings, similar ICD activity was observed in lactating ewes (Vernon et al., 1991a) and lactating cows (Lanna et al., 1995). In a similar fashion, Ingle et al. (1973) observed a decreased in vitro lipogenesis, as measured by acetate incorporation into FA, and a significant reduction in acetyl CoA synthase (ACS) and ACC with fasting; but did not show a significant decrease in ICD (although, numerically activity decreased 15 to 30%). Additionally, Ingle et al. (1972) observed a tendency in ruminant AT for the dehydrogenase to have greater activity when rates of FA synthesis were greater.

*Lipolysis.* Basal-glycerol release was increased in AT from bST steers after 103 d of treatment. Stimulated-glycerol release was not affected by treatment or time on feed. This agrees with Jones and Marchello (1983) who demonstrated that basal and epinephrine-stimulated lipolysis did not change with the length of time on feed from 166 to 214 d. Pothoven et al. (1975) found no correlation between basal and stimulated lipolysis which appears to be the same as in the present study. Rule et al. (1992) observed a 134% increase in basal glycerol release per mg protein with increased BW of Holstein steers, from 277 to 528 kg. Greater lipolytic rates with changes in BW were observed in AT from perirenal (309%), omental (200%), and intermuscular (111%) depots than inner or outer backfat (Rule et al., 1992) without a change in stimulated lipolysis. Pothoven et al. (1975) observed an increase in basal-glycerol release as crossbred steers increased in weight from 363 to 505 kg, but a decrease in epinephrine-stimulated lipolysis. An increase in basal-glycerol release without an increase in epinephrine-stimulated lipolysis would suggest a change in enzyme activity without a change in enzyme quantity (Vernon, 1980). Egan et al. (1992) demonstrated that the lipolytic stimulation of adipocytes caused the translocation of hormone-sensitive lipase (HSL) from the cytosol to the lipid droplet resulting in an increase in lipolysis.

Hart et al. (1984) found similar lipolytic activity of AT incubated with rbST as measured by glycerol release. Doris et al. (1996) found basal-glycerol release in AT was increased 59% in vitro in sheep given ST for seven days. The AT from ST-treated sheep also responded to a greater extend to the β-agonist, isoproterenol, than AT from control sheep. Additionally, AT from ST-treated sheep responded less to the anti-lipolytic agent, $N^6$-phenylisoproyladenosine, an adenosine analog, than control AT (Doris et al., 1996). Like in the present study, Doris et al. (1996) did not find an increase in glycerol response to a catecholamine with ST administration. Vernon (1982), Hart et al. (1984), and Walton and Etherton (1986) did not observe an increase in glycerol release when sheep and swine AT, respectively, were treated in vitro with ST. Additionally, Kramer et al. (1993) and Sinnett-Smith and Woolliams (1989) observed similar glycerol release in AT from pigs and sheep treated with ST in vivo.

Dunshea et al. (1992a) suggested that the increase in lipolytic activity may in part be related to decreased insulin sensitivity, which would decrease the inhibition of lipolysis. Increased lipolytic activity may also be the result of a heightened sensitivity or responsiveness to lipolytic stimuli as suggested by Boisclair et al. (1997). Through calculations, grams of triglyceride mobilized per day, Dunshea et al. (1992b) determined a 50% increase in lipid mobilization with pST (56 to 109 g of triglyceride mobilized per day). Although when compared to the reduction in lipid accretion ( > 200 g/d), the increase in lipolysis would constitute approximately 25% of the reduction in daily lipid synthesis, the balance being reduced lipogenesis.

Measures of in vivo lipolytic activity were increased in bST steers after 40 d of treatment as seen by the increased response to the epinephrine challenge. This is in agreement with Peters (1986) who observed an increase in plasma NEFA response area to a single epinephrine challenge with ST administration. Although, Peters (1986) saw a greater response with feed restriction than with ST treatment. Likewise, Sechen et al. (1990), found that lactating cows receiving bST had greater response in circulating levels of NEFA at all doses of epinephrine. In the current study, plasma glycerol did not increase in response to the highest dose of epinephrine. In contrast, Sechen et al., (1990) observed an increased maximum response in plasma glycerol from epinephrine challenges. Adipose tissue has very low glycerol kinase activity, so alterations in glycerol response relates to lipolysis, whereas, NEFA alterations reflect mobilization (i.e. the difference between lipolysis and NEFA re-esterification, Sechen et al., 1990). The $ED_{50}$ for the NEFA response in the present study and in Sechen et al., (1990) was not altered by bST. Sechen et al. (1990) suggests that the absence of any changes in $ED_{50}$ make it unlikely that the elevated glycerol response was due to changes in epinephrine clearance rate or the number of epinephrine receptors, and further suggest that a change in a post-receptor mechanism enhanced lipolysis. Lanna et al. (1995) did not observe an increase in basal-glycerol release in vitro, but an increase in HSL activity of AT was observed with bST administration to lactating cows (Lanna et al., 1995 and Liesman et al., 1995).

Roupas et al. (1991) suggested that if ST inhibits a G inhibitory protein ($G_i$), then the G stimulatory protein axis may allow greater activation and subsequent stimulation of lipolysis. Doris et al. (1994) demonstrated in rats that ST alters the amount of $G_{i2}$ proteins in rat AT, which inhibit the cAMP-signaling systems which inhibit HSL. Less repression of HSL will allow greater stimulation of the enzymes involved in lipolysis. Although in a follow-up study in sheep, Doris et al. (1996) did not find altered quantities of the $G_i$ protein. Based on work by Doris et al. (1996) it can be hypothesized that ST alters the cAMP-based signaling systems of AT by several mechanisms. The first, by increasing the maximum rate of β-adrenergic-stimulated lipolysis, due to an increase in the number of βAR. Secondly, decrease the response of AT to lipolytic agents such as adenosine and prostaglandin $E_1$, and lastly, decreasing the production of the anti-lipolytic agent prostaglandin $E_2$ by the adipocyte. These factors would explain why Hansen et al. (1997b) observed an additive effect in the reduction of carcass lipid content when both pST and the β-agonist, salbutamol, were administered together.

## Implications

Bovine somatotropin is a potent modifier of growth in cattle that alters the composition of beef. It is clear that somatotropin increases carcass protein accretion, and efficiency, while drastically reducing carcass lipid accretion and content. The majority of the reduction in lipid accretion is a result of depressed lipogenesis through decreased glucose utilization and decreased activity and quantity of acetyl CoA carboxylase and fatty acid synthase. In conjunction, lipolysis is enhanced through suppression of antilipolytic factors such as adenosine, insulin, and prostaglandins. Although, the mechanism in which somatotropin stimulates lipolysis in growing animals is less clear.

# CONCLUSION

Based on the results from the previous discussed studies, the following conclusions can be drawn. Both studies showed somatotropin (ST) decreased dry matter intake (DMI) later in the feeding program and improved feed efficiency. Both affects would be beneficial to the economic feasibility of using ST. Although, due to the decrease in DMI, increased nutrient density may be necessary to obtain the full growth potential of ST. The increase in dietary CP content from 11.5% in Chapter 2 to 13.5% in Chapter 3 did not increase daily gains of either the control or ST-treated steers. Estimates of undegradeable intake protein supplied, would have allowed gains to be higher than observed. Houseknecht et al. (1992) suggest that due to limitations in amino acids supplied from microbial and ruminal escape protein in young-growing cattle, amino acid supply may limit nitrogen retention response to ST.

Before ST becomes commercially available, a better delivery system with a longer payout period needs to be developed to reduce the frequent injections used in this study. The author understands that a subdermal pump is in development that would allow longer treatment periods and the pump could be removed at harvest.

Contrary to the assumptions by Early et al. (1990a), giving ST to light-weight steers, for a longer period, did not increase the carcass components in relation to the noncarcass component of the animal. Noncarcass weight (NCW) was greater in ST-treated steers as compared to control steers in both studies, although, steers receiving ST only during the first part of the feeding program (bST-C, Chapter 2) had similar NCW as control steers at harvest.

Red meat yield was improved in both studies with the administration of ST. Somatotropin increased ribeye area, carcass protein composition, protein accretion and improved yield grade. As expected, ST reduced measures of carcass lipid content (backfat, kidney-pelvic-heart fat, marbling score, carcass lipid composition, and lipid accretion). Unfortunately, on an economic basis, the reduction in carcass value due to the decreased USDA quality grade was greater than the premiums associated with increasing red meat yield and decreasing yield grade.

At the start of this research there was a drive to decrease the fat content of beef to compete with the healthy image of poultry. Additionally, there has been a drive to increase the economic efficiency of bringing beef to the table. As mentioned in the Introduction, it costs about $2 billion to remove the fat from beef carcasses that producers spent $2.4 billion to put on (H.D. Ritchie, personal communication). The reduction in external fat would be a clear example where ST would be beneficial to the beef industry.

The resurgence of steak houses in the U.S. has poised another problem. Although the need to reduce external fat is apparent, consumers still demand a quality steak which requires a carcass to grade USDA choice or higher. Therefore, a genetic or a pharmacological method needs to be developed to minimize external fat but maintain marbling in the muscle. It does not appear that ST is the answer for this production segment. Somatotropin would be useful to produce cattle that, overall, have a reduced amount of carcass fat with increased red meat yield.

Consistent with previous research, the decrease in lipid accretion was primarily due to a decrease in lipogenesis with some added benefit from increased lipolysis. As discussed previously, ST administration decreases the activation state of lipogenic enzymes (Vernon et al., 1990a), decreases enzyme activity (Chapter 3), and reduces enzyme quantity (Harris et al., 1993; Donkin et al., 1996) contributing to the decrease in lipid accretion. Adipose tissue samples collected from the author's study are being used by another colleague to look at changes in lipogenic enzyme mRNA abundance.

In the author's study, there was a problem with limited adipose tissue during the third biopsy. Using the initial-harvest steers to get a baseline value would have been possible and would have eliminated one biopsy per animal. Consequently, the first and third biopsy would hot have been taken from the same location. Although, using the initial-harvest steers to establish the base line would have eliminated the opportunity for each animal to serve as its own control

The present study did observe an increase in lipolysis with ST administration as measured by in vitro glycerol release and in vivo with a series of epinephrine challenges. Consistent with the understanding of the control of hormone-sensitive lipase (HSL), the quantity of the enzyme did not change as evidence by the lack of response in the values for epinephrine-stimulated glycerol release. Therefore, the change in lipolysis would be due to change in HSL activity. A phosphorylation site on HSL has been identified for the β-adrenergic agonist, isoproterenol, and showed the associated increase in lipolysis (Anthonsen et al., 1998). No such site has yet to be demonstrated for ST, and would be an area for future research. Also, Egan et al. (1992) demonstrated that lipolytic stimulation of adipocytes caused HSL to translocate from the cytosol to the lipid droplet increasing lipolysis. This has not been shown, to date, with ST. Further research must be aware of the problems associated with excitability of the animals and the possible rise in plasma NEFA and glycerol due to excitability as compared with the effects of ST. In the present study, the author may have been overly ambitious to conduct the epinephrine challenges on ten steers at one time. By reducing the number of animals, the human participants would not need to be as hurried in the collection and possibly reduce the potential excitability of the steers, and improve the results.

Regarding both lipogenesis and lipolysis, changes in the number of cells per gram of adipose tissue over time and with ST administration should have been documented. This would have allowed the in vitro measures of lipid metabolism to be expressed on a per cell and a per gram of tissue basis.

As with any new technology, its acceptance by the consumer is required. Researchers and producers must be aware of effects the new technology has on tenderness, palatability and shelf-life of the resulting product. For example, the introduction of the callipyge gene in sheep, although it adds significant quantities of red meat to the carcass, the carcass is less tender and is unacceptable to the consumer. Somatotropin can fit into a beef production system that produces lean red meat from decreased lipogenesis and increased lipolysis, but further evaluation of the end product must be completed.

# APPENDICES

# APPENDIX A:

## Raw data and procedures from Chapter 2
## (Experiment BC9002)

Table A-1a. Initial harvest carcass characteristics for Experiment BC9002

| Steer No. | Harvest wt., kg | Hide wt., kg | Liver wt., g | Spleen wt., g | Heart wt., g | Kidney wt., g | | Semitendinosus muscle wt., g | REA, $cm^2$ | Back fat, mm | Hot carcass wt., kg | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Left | Right | | | | Right side | Left side |
| 6 | 216 | 14.9 | 3865 | 477 | 895 | 484 | 476 | 890 | 25.8 | 1.2 | 55.2 | 57.5 |
| 7 | 202 | 14.1 | 3750 | 420 | 102 | 340 | 342 | 793 | 36.8 | 1.2 | 55.8 | 57.7 |
| 67 | 191 | 13.2 | 3829 | 362 | 987 | 392 | 346 | 703 | 28.4 | 1.2 | 51.1 | 54.1 |
| 74 | 157 | 10.7 | 3044 | 349 | 809 | 323 | 309 | 581 | 25.8 | 1.2 | 41.0 | 43.4 |
| 92 | 225 | 15.5 | 3925 | 577 | 1063 | 406 | 394 | 904 | 28.4 | 1.2 | 60.9 | 64.1 |
| 150 | 193 | 13.2 | 3707 | 453 | 966 | 331 | 294 | 809 | 27.1 | 1.2 | 52.5 | 54.1 |
| 164 | 189 | 13.2 | 3420 | 441 | 976 | 314 | 327 | 805 | 25.8 | 1.2 | 49.4 | 53.0 |
| 202 | 184 | 14.1 | 3611 | 418 | 880 | 352 | 366 | 777 | 25.9 | 1.2 | 53.5 | 51.8 |

Table A-1b. Initial harvest carcass composition for Experiment BC9002

| Steer No. | Right side | | Soft tissue | | | | Carcass | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total bone, kg | Total soft tissue, kg | % of Side | Water, % | Protein, % | Ether extractable lipid, % | Bone, % | Water, % | Protein, % | Ether extractable lipid, % |
| 6 | 11.4 | 41.7 | 75.5 | 71.2 | 17.9 | 20.1 | 20.6 | 53.8 | 13.5 | 15.2 |
| 7 | 11.5 | 42.4 | 76.0 | 71.2 | 19.2 | 19.2 | 20.6 | 54.1 | 14.6 | 14.6 |
| 67 | 8.2 | 39.3 | 76.8 | 70.2 | 17.4 | 23.7 | 16.1 | 53.9 | 13.3 | 18.2 |
| 74 | 9.5 | 30.4 | 74.0 | 73.2 | 17.5 | 17.7 | 23.1 | 54.1 | 12.9 | 13.1 |
| 92 | 12.1 | 46.7 | 76.7 | 70.7 | 16.5 | 21.5 | 19.9 | 54.2 | 12.7 | 16.5 |
| 150 | 11.1 | 39.8 | 75.8 | 69.3 | 17.1 | 24.0 | 21.1 | 52.5 | 13.0 | 18.2 |
| 164 | 12.3 | 37.5 | 75.8 | 72.4 | 17.5 | 18.0 | 24.9 | 54.9 | 13.3 | 13.6 |
| 202 | 23.6 | 80.9 | 68.8 | 72.3 | 17.5 | 20.7 | 20.1 | 49.7 | 12.1 | 14.2 |

Table A-2. Record of removal of steers from Experiment BC9002 and disposal

| Steer no. | Date removed | Reason | Disposal | Date |
|---|---|---|---|---|
| 1 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 2 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 4 | 7/21/91 | Below 50% ADG | Killed | 3/16/92 |
| 5 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 6 | 4/23/91 | Initial Kill | Killed | 4/23/91 |
| 7 | 4/30/91 | Initial kill | Killed | 4/30/91 |
| 8 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 9 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 10 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 11 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 12 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 13 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 14 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 16 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 17 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 18 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 19 | 8/31/91 | Below 50% ADG | Killed | 11/11/91 |
| 20 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 21 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 25 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 27 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 29 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 31 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 32 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 34 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 37 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 38 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 39 | 11/9/91 | Injected before harvest | Killed | 3/16/92 |
| 40 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 42 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 43 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 44 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 45 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 46 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 47 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 49 | 5/25/91 | Below 50% ADG | Killed | 11/11/91 |
| 50 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 54 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 55 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 56 | 10/26/91 | Below 50% ADG | Killed | 4/13/92 |
| 57 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 58 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |

Table A-2. (cont'd)

| Steer no. | Date removed | Reason | Disposal | Date |
|---|---|---|---|---|
| 59 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 60 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 62 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 63 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 65 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 67 | 4/23/91 | Initial kill | Killed | 4/23/91 |
| 70 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 72 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 73 | 4/17/92 | Below 50% ADG | Killed | 4/27/92 |
| 74 | 4/23/91 | Initial kill | Killed | 4/23/91 |
| 75 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 76 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 77 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 78 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 79 | 10/21/91 | Died | Necropsy/Incinerated | |
| 80 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 83 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 84 | 10/21/91 | Died | Necropsy/Incinerated | |
| 85 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 86 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 87 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 88 | 10/26/91 | Below 50% ADG | Killed | 3/16/92 |
| 89 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 90 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 91 | 3/29/92 | Below 50% ADG | Killed | 5/11/92 |
| 92 | 4/30/91 | Initial kill | Killed | 4/30/91 |
| 94 | 12/21/91 | Below 50% ADG | Killed | 4/13/92 |
| 95 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 97 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 98 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 99 | 10/15/91 | Respiratory problems | Killed | 3/16/92 |
| 100 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 101 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 102 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 103 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 104 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 105 | 8/31/91 | Below 50% ADG | Killed | 11/11/91 |
| 106 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 107 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 108 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 109 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 110 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |

Table A-2. (cont'd)

| Steer no. | Date removed | Reason | Disposal | Date |
|---|---|---|---|---|
| 111 | 10/14/91 | Respiratory problems | Killed | 4/13/92 |
| 112 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 114 | 6/22/91 | Below 50% ADG | Died | 7/1/91 |
| 115 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 116 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 117 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 118 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 119 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 120 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 121 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 122 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 123 | 2/17/92 | Below 50% ADG | Killed | 3/16/92 |
| 124 | 11/23/91 | Below 50% ADG | Killed | 3/16/92 |
| 127 | 8/31/91 | One testicle/Not castrated | Killed | 11/11/91 |
| 128 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 129 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 130 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 133 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 135 | 8/31/91 | Below 50% ADG | Killed | 11/11/91 |
| 136 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 137 | 7/5/91 | Below 50% ADG | Killed | 11/11/91 |
| 139 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 140 | 8/3/91 | Below 50% ADG | Killed | 11/11/91 |
| 141 | 11/9/91 | Below 50% ADG | Killed | 3/16/92 |
| 142 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 143 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 144 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 147 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 148 | 4/26/91 | Poor health | Killed | 11/11/91 |
| 150 | 4/23/91 | Initial Kill | Killed | 4/23/91 |
| 151 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 153 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 155 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 157 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 157 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 158 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 159 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 161 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 163 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 164 | 4/30/91 | Initial kill | Killed | 4/30/91 |
| 165 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 166 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |

Table A-2. (cont'd)

| Steer no. | Date removed | Reason | Disposal | Date |
|---|---|---|---|---|
| 170 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 171 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 172 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 173 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 180 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 183 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 184 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 187 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 192 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 194 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 195 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 196 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 197 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 198 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 199 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 201 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 202 | 4/30/91 | Initial kill | Killed | 4/30/91 |
| 203 | 5/25/91 | Below 50% ADG | Died | 6/4/91 |
| 205 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 206 | 5/25/91 | Below 50% ADG | Killed | 11/11/91 |
| 208 | 6/22/91 | Below 50% ADG | Killed | 3/16/92 |
| 210 | 5/25/91 | Below 50% ADG | Died | 7/8/91 |
| 211 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 212 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 213 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 215 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 216 | 3/4/92 | Severe Inflammation of R. foot | Killed | 5/11/92 |
| 217 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 218 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 221 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 222 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 225 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 227 | 11/11/91 | Intermediate Harvest | Killed | 11/11/91 |
| 228 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |
| 231 | 11/9/91 | Below 50% ADG | Killed | 4/13/92 |
| 232 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 234 | 5/11/92 | Harvest #4 | Killed | 5/11/92 |
| 236 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 237 | 1/18/92 | Below 50% ADG | Killed | 4/27/92 |
| 238 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |
| 239 | 4/27/92 | Harvest #3 | Killed | 4/27/92 |
| 241 | 3/16/92 | Harvest #1 | Killed | 3/16/92 |

Table A-2. (cont'd)

| Steer no. | Date removed | Reason | Disposal | Date |
|---|---|---|---|---|
| 243 | 4/13/92 | Harvest #2 | Killed | 4/13/92 |

Table A-3. Steer weight for Experiment BC9002

| Steer no. | Pen | Block | Treatment | 2/23/91 Receiving wt., lb | 3/22/91 wt., lb | 4/19/91 Pre-trial wt., lb | 4/25/91 On trial #1 wt., lb | 4/27/91 On trial #2 wt., lb | Average Initial wt., lb | 05/10/91 Day 14 wt., lb | 05/24/91 Day 28 wt., lb | 06/07/91 Day 42 wt., lb | 06/21/91 Day 56 wt., lb | 07/05/91 Day 70 wt., lb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 13 | 4 | 1 C-C | 260 | 370 | 450 | 465 | 475 | 470 | 505 | 580 | 620 | 655 | 705 |
| 2 | 1 | 3 | 1 C-C | 235 | 335 | 415 | 440 | 445 | 443 | 460 | 525 | 555 | 610 | 640 |
| 4 | 2 | 3 | 4 bST-bST | 310 | 350 | 420 | 430 | 410 | 420 | 440 | 475 | 510 | 540 | 545 |
| 5 | 13 | 4 | 1 C-C | 290 | 390 | 430 | 460 | 465 | 463 | 520 | 555 | 605 | 670 | 705 |
| 8 | 8 | 2 | 3 C-bST | 250 | 330 | 370 | 385 | 390 | 388 | 430 | 470 | 520 | 580 | 615 |
| 9 | 9 | 1 | 4 bST-bST | 240 | 305 | 325 | 345 | 340 | 343 | 345 | 390 | 430 | 470 | 505 |
| 10 | 16 | 4 | 4 bST-bST | 265 | 365 | 435 | 475 | 465 | 470 | 510 | 565 | 600 | 660 | 690 |
| 11 | 6 | 2 | 1 C-C | 235 | 325 | 385 | 390 | 395 | 393 | 440 | 485 | 485 | 560 | 595 |
| 12 | 10 | 1 | 1 C-C | 230 | 245 | 290 | 300 | 300 | 300 | 330 | 375 | 405 | 450 | 490 |
| 13 | 14 | 4 | 2 bST-C | 275 | 365 | 465 | 500 | 485 | 493 | 580 | 605 | 660 | 760 | 810 |
| 14 | 7 | 2 | 2 bST-C | 255 | 320 | 375 | 385 | 395 | 390 | 410 | 465 | 495 | 545 | 585 |
| 16 | 6 | 2 | 1 C-C | 220 | 305 | 355 | 380 | 375 | 378 | 420 | 475 | 510 | 565 | 615 |
| 17 | 2 | 3 | 4 bST-bST | 240 | 330 | 405 | 430 | 430 | 430 | 460 | 520 | 580 | 600 | 665 |
| 18 | 7 | 2 | 2 bST-C | 260 | 310 | 390 | 405 | 416 | 411 | 435 | 505 | 545 | 595 | 645 |
| 19 | 12 | 1 | 3 C-bST | 220 | 275 | 310 | 325 | 330 | 328 | 350 | 400 | 425 | 470 | 500 |
| 20 | 14 | 4 | 2 bST-C | 280 | 375 | 455 | 470 | 475 | 473 | 515 | 570 | 610 | 680 | 710 |
| 21 | 14 | 4 | 2 bST-C | 275 | 375 | 430 | 455 | 455 | 455 | 525 | 560 | 615 | 660 | 690 |
| 25 | 10 | 1 | 1 C-C | 235 | 305 | 325 | 355 | 345 | 350 | 390 | 450 | 475 | 535 | 580 |
| 27 | 11 | 1 | 2 bST-C | 220 | 305 | 325 | 345 | 350 | 348 | 370 | 430 | 480 | 550 | 590 |
| 29 | 6 | 2 | 1 C-C | 225 | 320 | 355 | 380 | 380 | 380 | 405 | 440 | 505 | 555 | 595 |
| 31 | 7 | 2 | 2 bST-C | 270 | 365 | 405 | 410 | 420 | 415 | 470 | 535 | 595 | 630 | 695 |
| 32 | 11 | 1 | 2 bST-C | 225 | 300 | 370 | 310 | 385 | 348 | 400 | 460 | 500 | 550 | 600 |
| 34 | 3 | 3 | 3 C-bST | 245 | 330 | 400 | 415 | 420 | 418 | 440 | 465 | 510 | 560 | 600 |
| 37 | 5 | 2 | 4 bST-bST | 310 | 345 | 370 | 390 | 395 | 393 | 425 | 470 | 505 | 585 | 605 |

Table A-3. (cont'd)

| Steer no. | Pen | Block | Treatment | 2/23/91 Receiving wt., lb | 3/22/91 wt., lb | 4/19/91 Pre-trial wt., lb | 4/25/91 On trial #1 wt., lb | 4/27/91 On trial #2 wt., lb | Average Initial wt., lb | 05/10/91 Day 14 wt., lb | 05/24/91 Day 28 wt., lb | 06/07/91 Day 42 wt., lb | 06/21/91 Day 56 wt., lb | 07/05/91 Day 70 wt., lb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38 | 3 | 3 | 3 C-bST | 255 | 325 | 410 | 425 | 420 | 423 | 455 | 500 | 495 | 525 | 565 |
| 39 | 15 | 4 | 3 C-bST | 260 | 355 | 430 | 465 | 470 | 468 | 505 | 525 | 585 | 645 | 675 |
| 40 | 5 | 2 | 4 bST-bST | 260 | 305 | 350 | 375 | 380 | 378 | 405 | 455 | 495 | 575 | 625 |
| 42 | 13 | 4 | 1 C-C | 265 | 355 | 445 | 460 | 465 | 463 | 505 | 545 | 600 | 650 | 685 |
| 43 | 6 | 2 | 1 C-C | 245 | 300 | 375 | 400 | 400 | 400 | 410 | 445 | 480 | 540 | 585 |
| 44 | 4 | 3 | 2 bST-C | 250 | 335 | 415 | 440 | 420 | 430 | 465 | 500 | 565 | 610 | 665 |
| 45 | 1 | 3 | 1 C-C | 290 | 350 | 430 | 445 | 450 | 448 | 495 | 545 | 605 | 650 | 705 |
| 46 | 14 | 4 | 2 bST-C | 270 | 340 | 430 | 450 | 445 | 448 | 495 | 530 | 600 | 620 | 700 |
| 47 | 5 | 2 | 4 bST-bST | 280 | 290 | 380 | 400 | 400 | 400 | 445 | 485 | 540 | 590 | 635 |
| 49 | 6 | 2 | 1 C-C | 260 | 320 | 360 | 385 | 390 | 388 | 390 | 340 | | | |
| 50 | 15 | 4 | 3 C-bST | 280 | 345 | 440 | 465 | 465 | 465 | 505 | 550 | 605 | 680 | 725 |
| 54 | 14 | 4 | 2 bST-C | 286 | 370 | 435 | 455 | 450 | 453 | 520 | 540 | 615 | 680 | 730 |
| 55 | 11 | 1 | 2 bST-C | 220 | 255 | 295 | 315 | 315 | 315 | 365 | 415 | 465 | 520 | 560 |
| 56 | 4 | 3 | 2 bST-C | 245 | 330 | 420 | 440 | 430 | 435 | 490 | 525 | 610 | 660 | 715 |
| 57 | 7 | 2 | 2 bST-C | 225 | 285 | 365 | 385 | 400 | 393 | 410 | 480 | 530 | 570 | 625 |
| 58 | 7 | 2 | 2 bST-C | 245 | 315 | 325 | 385 | 390 | 388 | 385 | 460 | 515 | 565 | 620 |
| 59 | 12 | 1 | 3 C-bST | 215 | 280 | 310 | 340 | 340 | 340 | 385 | 435 | 460 | 520 | 565 |
| 60 | 5 | 2 | 4 bST-bST | 265 | 330 | 370 | 375 | 390 | 383 | 405 | 450 | 475 | 540 | 595 |
| 62 | 1 | 3 | 1 C-C | 255 | 340 | 395 | 420 | 420 | 420 | 460 | 490 | 550 | 595 | 630 |
| 63 | 12 | 1 | 3 C-bST | 220 | 265 | 345 | 355 | 350 | 353 | 405 | 460 | 495 | 560 | 595 |
| 65 | 3 | 3 | 3 C-bST | 235 | 330 | 385 | 410 | 405 | 408 | 405 | 475 | 520 | 575 | 620 |
| 70 | 1 | 3 | 1 C-C | 250 | 335 | 410 | 430 | 425 | 428 | 470 | 505 | 570 | 630 | 650 |
| 72 | 10 | 1 | 1 C-C | 210 | 260 | 320 | 350 | 345 | 348 | 375 | 455 | 490 | 560 | 605 |
| 73 | 10 | 1 | 1 C-C | 225 | 290 | 330 | 355 | 355 | 355 | 375 | 420 | 455 | 505 | 540 |
| 75 | 5 | 2 | 4 bST-bST | 235 | 305 | 375 | 400 | 395 | 398 | 435 | 470 | 505 | 575 | 630 |
| 76 | 8 | 2 | 3 C-bST | 240 | 315 | 355 | 380 | 370 | 375 | 400 | 440 | 490 | 550 | 585 |

Table A-3. (cont'd)

| Steer no. | Pen | Block | Treatment | 2/23/91 Receiving wt., lb | 3/22/91 wt., lb | 4/19/91 Pre-trial wt., lb | 4/25/91 On trial #1 wt., lb | 4/27/91 On trial #2 wt., lb | Average Initial wt., lb | 05/10/91 Day 14 wt., lb | 05/24/91 Day 28 wt., lb | 06/07/91 Day 42 wt., lb | 06/21/91 Day 56 wt., lb | 07/05/91 Day 70 wt., lb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | 16 | 4 | 4 bST-bST | 265 | 360 | 435 | 450 | 460 | 455 | 495 | 540 | 600 | 660 | 695 |
| 78 | 12 | 1 | 3 C-bST | 235 | 300 | 355 | 370 | 365 | 368 | 415 | 455 | 485 | 550 | 575 |
| 79 | 11 | 1 | 2 bST-C | 240 | 280 | 310 | 325 | 320 | 323 | 345 | 400 | 430 | 485 | 510 |
| 80 | 16 | 4 | 4 bST-bST | 270 | 370 | 400 | 450 | 445 | 448 | 475 | 515 | 575 | 635 | 690 |
| 83 | 16 | 4 | 4 bST-bST | 275 | 390 | 460 | 475 | 470 | 473 | 535 | 580 | 630 | 690 | 695 |
| 84 | 5 | 2 | 4 bST-bST | 260 | 345 | 370 | 385 | 395 | 390 | 415 | 465 | 475 | 540 | 585 |
| 85 | 1 | 3 | 1 C-C | 250 | 345 | 420 | 445 | 440 | 443 | 475 | 520 | 550 | 615 | 645 |
| 86 | 10 | 1 | 1 C-C | 245 | 300 | 335 | 355 | 365 | 360 | 375 | 420 | 465 | 515 | 565 |
| 87 | 2 | 3 | 4 bST-bST | 240 | 330 | 415 | 440 | 430 | 435 | 475 | 555 | 590 | 655 | 725 |
| 88 | 11 | 1 | 2 bST-C | 255 | 265 | 285 | 295 | 300 | 298 | 325 | 330 | 385 | 445 | 490 |
| 89 | 9 | 1 | 4 bST-bST | 240 | 305 | 330 | 345 | 345 | 345 | 380 | 405 | 450 | 495 | 525 |
| 90 | 2 | 3 | 4 bST-bST | 220 | 305 | 390 | 410 | 405 | 408 | 445 | 495 | 555 | 625 | 655 |
| 91 | 8 | 2 | 3 C-bST | 245 | 345 | 390 | 405 | 415 | 410 | 445 | 500 | 540 | 595 | 645 |
| 94 | 12 | 1 | 3 C-bST | 250 | 325 | 335 | 350 | 345 | 348 | 380 | 430 | 445 | 490 | 505 |
| 95 | 4 | 3 | 2 bST-C | 230 | 325 | 400 | 425 | 425 | 425 | 450 | 490 | 530 | 595 | 655 |
| 97 | 7 | 2 | 2 bST-C | 240 | 275 | 340 | 375 | 370 | 373 | 410 | 465 | 515 | 555 | 595 |
| 98 | 6 | 2 | 1 C-C | 215 | 315 | 385 | 405 | 410 | 408 | 460 | 505 | 560 | 615 | 655 |
| 99 | 9 | 1 | 4 bST-bST | 245 | 305 | 325 | 355 | 360 | 358 | 400 | 455 | 500 | 550 | 600 |
| 100 | 7 | 2 | 2 bST-C | 230 | 310 | 375 | 405 | 400 | 403 | 440 | 510 | 565 | 610 | 655 |
| 101 | 3 | 3 | 3 C-bST | 230 | 310 | 385 | 415 | 415 | 415 | 460 | 530 | 570 | 635 | 700 |
| 102 | 15 | 4 | 3 C-bST | 305 | 405 | 505 | 515 | 525 | 520 | 575 | 615 | 670 | 740 | 770 |
| 103 | 11 | 1 | 2 bST-C | 250 | 285 | 325 | 345 | 350 | 348 | 385 | 435 | 485 | 555 | 600 |
| 104 | 10 | 1 | 1 C-C | 245 | 325 | 345 | 370 | 360 | 365 | 400 | 440 | 475 | 545 | 550 |
| 105 | 13 | 4 | 1 C-C | 280 | 375 | 460 | 460 | 485 | 473 | 515 | 565 | 615 | 675 | 695 |
| 106 | 15 | 4 | 3 C-bST | 290 | 390 | 445 | 460 | 470 | 465 | 510 | 535 | 590 | 655 | 690 |
| 107 | 8 | 2 | 3 C-bST | 225 | 320 | 380 | 395 | 395 | 395 | 430 | 485 | 530 | 585 | 600 |

Table A-3. (cont'd)

| Steer no. | Pen | Block | Treatment | 2/23/91 Receiving wt., lb | 3/22/91 wt., lb | 4/19/91 Pre-trial wt., lb | 4/25/91 On trial #1 wt., lb | 4/27/91 On trial #2 wt., lb | Average Initial wt., lb | 05/10/91 Day 14 wt., lb | 05/24/91 Day 28 wt., lb | 06/07/91 Day 42 wt., lb | 06/21/91 Day 56 wt., lb | 07/05/91 Day 70 wt., lb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 108 | 5 | 2 | 4 bST-bST | 240 | 325 | 400 | 410 | 420 | 415 | 465 | 520 | 550 | 625 | 665 |
| 109 | 14 | 4 | 2 bST-C | 285 | 370 | 465 | 470 | 460 | 465 | 535 | 575 | 630 | 695 | 735 |
| 110 | 9 | 1 | 4 bST-bST | 240 | 285 | 330 | 350 | 350 | 350 | 370 | 425 | 460 | 510 | 555 |
| 111 | 9 | 1 | 4 bST-bST | 225 | 270 | 290 | 315 | 315 | 315 | 350 | 380 | 435 | 490 | 555 |
| 112 | 5 | 2 | 4 bST-bST | 230 | 315 | 375 | 395 | 395 | 395 | 445 | 480 | 460 | 535 | 585 |
| 114 | 11 | 1 | 2 bST-C | 255 | 315 | 345 | 365 | 370 | 368 | 395 | 470 | 515 | 435 | |
| 115 | 3 | 3 | 3 C-bST | 265 | 350 | 425 | 430 | 430 | 430 | 445 | 495 | 555 | 615 | 665 |
| 116 | 3 | 3 | 3 C-bST | 245 | 330 | 415 | 440 | 440 | 440 | 465 | 520 | 580 | 635 | 670 |
| 117 | 16 | 4 | 4 bST-bST | 260 | 345 | 440 | 470 | 465 | 468 | 505 | 535 | 595 | 645 | 685 |
| 118 | 8 | 2 | 3 C-bST | 255 | 300 | 365 | 395 | 400 | 398 | 435 | 485 | 530 | 600 | 620 |
| 119 | 1 | 3 | 1 C-C | 285 | 370 | 415 | 445 | 440 | 443 | 460 | 500 | 535 | 580 | 630 |
| 120 | 13 | 4 | 1 C-C | 295 | 375 | 450 | 470 | 475 | 473 | 535 | 560 | 625 | 685 | 715 |
| 121 | 5 | 2 | 4 bST-bST | 260 | 325 | 360 | 385 | 385 | 385 | 410 | 460 | 485 | 560 | 590 |
| 122 | 13 | 4 | 1 C-C | 280 | 370 | 455 | 485 | 485 | 485 | 525 | 585 | 635 | 665 | 690 |
| 123 | 7 | 2 | 2 bST-C | 235 | 310 | 345 | 375 | 370 | 373 | 420 | 465 | 505 | 560 | 605 |
| 124 | 8 | 2 | 3 C-bST | 255 | 315 | | 380 | 390 | 385 | 420 | 485 | 525 | 545 | 600 |
| 127 | 16 | 4 | 4 bST-bST | 300 | 390 | 455 | 475 | 470 | 473 | 510 | 565 | 630 | 670 | 720 |
| 128 | 3 | 3 | 3 C-bST | 240 | 330 | 405 | 430 | 420 | 425 | 445 | 510 | 560 | 620 | 660 |
| 129 | 16 | 4 | 4 bST-bST | 235 | 350 | 430 | 455 | 455 | 455 | 505 | 545 | 600 | 665 | 725 |
| 130 | 3 | 3 | 3 C-bST | 265 | 330 | 415 | 430 | 430 | 430 | 465 | 510 | 555 | 605 | 650 |
| 133 | 11 | 1 | 2 bST-C | 280 | 260 | 305 | 315 | 315 | 315 | 345 | 415 | 465 | 520 | 570 |
| 135 | 10 | 1 | 1 C-C | 260 | 320 | 345 | 365 | 375 | 370 | 400 | 440 | 465 | 510 | 545 |
| 136 | 6 | 2 | 1 C-C | 235 | 290 | 355 | 375 | 375 | 375 | 415 | 485 | 515 | 590 | 635 |
| 137 | 4 | 3 | 2 bST-C | 250 | 330 | 400 | 425 | 415 | 420 | 455 | 500 | 570 | 545 | 530 |
| 139 | 2 | 3 | 4 bST-bST | 240 | 325 | 390 | 420 | 405 | 413 | 445 | 495 | 555 | 605 | 630 |

Table A-3. (cont'd)

| Steer no. | Pen | Block | Treatment | 2/23/91 Receiving wt., lb | 3/22/91 wt., lb | 4/19/91 Pre-trial wt., lb | 4/25/91 On trial #1 wt., lb | 4/27/91 On trial #2 wt., lb | Average Initial wt., lb | 05/10/91 Day 14 wt., lb | 05/24/91 Day 28 wt., lb | 06/07/91 Day 42 wt., lb | 06/21/91 Day 56 wt., lb | 07/05/91 Day 70 wt., lb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 140 | 14 | 4 | 2 bST-C | 285 | 365 | 475 | 475 | 465 | 470 | 515 | 550 | 580 | 615 | 685 |
| 141 | 6 | 2 | 1 C-C | 230 | 330 | 375 | 380 | 380 | 380 | 415 | 445 | 490 | 530 | 570 |
| 142 | 12 | 1 | 3 C-bST | 265 | 280 | 325 | 315 | 310 | 313 | 365 | 395 | 425 | 485 | 505 |
| 143 | 15 | 4 | 3 C-bST | 285 | 390 | 470 | 475 | 475 | 475 | 535 | 570 | 610 | 680 | 705 |
| 144 | 3 | 3 | 3 C-bST | 280 | 335 | 395 | 430 | 425 | 428 | 450 | 505 | 560 | 615 | 660 |
| 147 | 1 | 3 | 1 C-C | 265 | 345 | 410 | 415 | 425 | 420 | 455 | 500 | 555 | 590 | 635 |
| 151 | 11 | 1 | 2 bST-C | 235 | 250 | 330 | 355 | 365 | 360 | 390 | 460 | 510 | 565 | 585 |
| 153 | 3 | 3 | 3 C-bST | 295 | 375 | 425 | 445 | 435 | 440 | 480 | 520 | 565 | 625 | 660 |
| 154 | 1 | 3 | 1 C-C | 280 | 365 | 390 | 420 | 410 | 415 | 440 | 480 | 520 | 590 | 625 |
| 155 | 9 | 1 | 4 bST-bST | 235 | 285 | 345 | 360 | 355 | 358 | 385 | 435 | 460 | 520 | 555 |
| 157 | 14 | 4 | 2 bST-C | 270 | 360 | 445 | 460 | 445 | 453 | 505 | 540 | 600 | 655 | 695 |
| 158 | 12 | 1 | 3 C-bST | 245 | 310 | 310 | 345 | 345 | 345 | 390 | 430 | 470 | 540 | 565 |
| 159 | 4 | 3 | 2 bST-C | 255 | 345 | 430 | 445 | 440 | 443 | 475 | 535 | 565 | 635 | 670 |
| 161 | 6 | 2 | 1 C-C | 220 | 280 | 365 | 385 | 385 | 385 | 430 | 500 | 535 | 585 | 630 |
| 163 | 8 | 2 | 3 C-bST | 270 | 315 | 375 | 405 | 405 | 405 | 440 | 500 | 535 | 600 | 645 |
| 165 | 11 | 1 | 2 bST-C | 225 | 295 | 360 | 370 | 370 | 370 | 390 | 460 | 500 | 555 | 590 |
| 166 | 8 | 2 | 3 C-bST | 250 | 320 | 400 | 405 | 420 | 413 | 435 | 500 | 550 | 605 | 640 |
| 170 | 8 | 2 | 3 C-bST | 245 | 300 | 410 | 405 | 410 | 408 | 445 | 495 | 550 | 620 | 640 |
| 171 | 12 | 1 | 3 C-bST | 245 | 260 | 300 | 320 | 315 | 318 | 350 | 400 | 425 | 445 | 520 |
| 172 | 9 | 1 | 4 bST-bST | 200 | 265 | 355 | 365 | 370 | 368 | 395 | 475 | 505 | 550 | 615 |
| 173 | 2 | 3 | 4 bST-bST | 275 | 355 | 395 | 410 | 395 | 403 | 385 | 450 | 500 | 545 | 565 |
| 180 | 9 | 1 | 4 bST-bST | 260 | 315 | 360 | 370 | 390 | 380 | 415 | 475 | 520 | 575 | 620 |
| 183 | 13 | 4 | 1 C-C | 290 | 385 | 455 | 475 | 480 | 478 | 535 | 570 | 635 | 700 | 710 |
| 184 | 15 | 4 | 3 C-bST | 285 | 370 | 440 | 470 | 470 | 470 | 500 | 545 | 590 | 660 | 695 |
| 187 | 14 | 4 | 2 bST-C | 300 | 375 | 450 | 475 | 475 | 475 | 550 | 585 | 635 | 700 | 745 |
| 192 | 16 | 4 | 4 bST-bST | 270 | 365 | 430 | 455 | 440 | 448 | 505 | 555 | 595 | 675 | 690 |

Table A-3. (cont'd)

| Steer no. | Pen | Block | Treatment | 2/23/91 Receiving wt., lb | 3/22/91 wt., lb | 4/19/91 Pre-trial wt., lb | 4/25/91 On trial #1 wt., lb | 4/27/91 On trial #2 wt., lb | Average Initial wt., lb | 05/10/91 Day 14 wt., lb | 05/24/91 Day 28 wt., lb | 06/07/91 Day 42 wt., lb | 06/21/91 Day 56 wt., lb | 07/05/91 Day 70 wt., lb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 194 | 12 | 1 | 3 C-bST | 260 | 305 | 315 | 340 | 325 | 333 | 370 | 415 | 445 | 505 | 540 |
| 195 | 4 | 3 | 2 bST-C | 280 | 340 | 415 | 435 | 425 | 430 | 470 | 520 | 580 | 640 | 670 |
| 196 | 4 | 3 | 2 bST-C | 275 | 345 | 395 | 430 | 405 | 418 | 460 | 515 | 575 | 600 | 655 |
| 197 | 15 | 4 | 3 C-bST | 275 | 335 | 430 | 460 | 460 | 460 | 525 | 560 | 610 | 670 | 705 |
| 198 | 13 | 4 | 1 C-C | 280 | 355 | 450 | 460 | 460 | 460 | 500 | 530 | 580 | 665 | 690 |
| 199 | 10 | 1 | 1 C-C | | 275 | 340 | 355 | 360 | 358 | 385 | 450 | 505 | 565 | 610 |
| 201 | 10 | 1 | 1 C-C | 230 | 280 | 300 | 315 | 310 | 313 | 340 | 405 | 440 | 510 | 540 |
| 203 | 1 | 3 | 1 C-C | 265 | 280 | 400 | 425 | 430 | 428 | 435 | 415 | | | |
| 205 | 4 | 3 | 2 bST-C | 260 | 340 | 395 | 425 | 415 | 420 | 455 | 515 | 575 | 625 | 630 |
| 206 | 9 | 1 | 4 bST-bST | 245 | 325 | 315 | 320 | 315 | 318 | 315 | 310 | | | |
| 208 | 5 | 2 | 4 bST-bST | 220 | 325 | 365 | 380 | 390 | 385 | 430 | 465 | 455 | 475 | |
| 210 | 8 | 2 | 3 C-bST | 270 | 340 | 380 | 385 | 385 | 385 | 390 | 365 | | | |
| 211 | 4 | 3 | 2 bST-C | 265 | 355 | 390 | 415 | 410 | 413 | 445 | 505 | 595 | 655 | 710 |
| 212 | 6 | 2 | 1 C-C | 260 | 310 | 380 | 390 | 385 | 388 | 385 | 455 | 510 | 530 | 595 |
| 213 | 2 | 3 | 4 bST-bST | 270 | 345 | 410 | 445 | 435 | 440 | 455 | 530 | 580 | 645 | 675 |
| 215 | 15 | 4 | 3 C-bST | 290 | 365 | 460 | 450 | 460 | 455 | 505 | 535 | 580 | 630 | 680 |
| 216 | 2 | 3 | 4 bST-bST | 265 | 305 | 405 | 435 | 425 | 430 | 470 | 525 | 595 | 650 | 715 |
| 217 | 16 | 4 | 4 bST-bST | 315 | 385 | 450 | 470 | 470 | 470 | 505 | 560 | 610 | 650 | 675 |
| 218 | 2 | 3 | 4 bST-bST | 260 | 365 | 405 | 435 | 425 | 430 | 450 | 515 | 560 | 605 | 660 |
| 221 | 10 | 1 | 1 C-C | 295 | 325 | 335 | 345 | 350 | 348 | 385 | 435 | 485 | 545 | 605 |
| 222 | 14 | 4 | 2 bST-C | 290 | 355 | 445 | 465 | 450 | 458 | 495 | 525 | 600 | 640 | 670 |
| 225 | 16 | 4 | 4 bST-bST | 255 | 335 | 420 | 455 | 455 | 455 | 480 | 535 | 590 | 660 | 720 |
| 227 | 13 | 4 | 1 C-C | 290 | 370 | 440 | 470 | 465 | 468 | 460 | 490 | 560 | 615 | 645 |
| 228 | 2 | 3 | 4 bST-bST | 275 | 340 | 390 | 410 | 415 | 413 | 465 | 515 | 570 | 635 | 680 |
| 231 | 1 | 3 | 1 C-C | 275 | 325 | 415 | 445 | 445 | 445 | 485 | 525 | 575 | 630 | 665 |
| 232 | 13 | 4 | 1 C-C | 300 | 355 | 435 | 460 | 455 | 458 | 510 | 535 | 560 | 605 | 635 |

Table A-3. (cont'd)

| Steer no. | Pen | Block | Treatment | 2/23/91 Receiving wt., lb | 3/22/91 wt., lb | 4/19/91 Pre-trial wt., lb | 4/25/91 On trial #1 wt., lb | 4/27/91 On trial #2 wt., lb | Average Initial wt., lb | 05/10/91 Day 14 wt., lb | 05/24/91 Day 28 wt., lb | 06/07/91 Day 42 wt., lb | 06/21/91 Day 56 wt., lb | 07/05/91 Day 70 wt., lb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 234 | 9 | 1 | 4 bST-bST | 285 | 315 | 340 | 350 | 350 | 350 | 395 | 425 | 470 | 520 | 540 |
| 236 | 7 | 2 | 2 bST-C | 265 | 330 | 365 | 390 | 400 | 395 | 450 | 505 | 555 | 605 | 650 |
| 237 | 12 | 1 | 3 C-bST | 280 | 340 | 360 | 375 | 370 | 373 | 390 | 450 | 490 | 555 | 590 |
| 238 | 15 | 4 | 3 C-bST | 275 | 375 | 460 | 470 | 460 | 465 | 515 | 555 | 630 | 690 | 725 |
| 239 | 7 | 2 | 2 bST-C | 290 | 340 | 380 | 395 | 405 | 400 | 430 | 465 | 530 | 565 | 620 |
| 241 | 15 | 4 | 3 C-bST | 295 | 355 | 435 | 465 | 465 | 465 | 520 | 565 | 615 | 675 | 695 |
| 243 | 4 | 3 | 2 bST-C | 260 | 340 | 405 | 410 | 400 | 405 | 425 | 470 | 520 | 580 | 635 |

Table A-3. (cont'd)

| Steer no. | 07/19/91 Day 84 wt., lb | 08/02/91 Day 98 wt., lb | 08/16/91 Day 112 wt., lb | 08/30/91 Day 126 wt., lb | 09/13/91 Day 140 wt., lb | 09/27/91 Day 154 wt., lb | 10/11/91 Day 168 wt., lb | 10/25/91 Day 181 wt., lb | 10/27/91 Day 183 wt., lb | Average Day 182 wt., lb | 11/08/91 Day 196 wt., lb | Intermediate harvest wt., lb | | 11/22/91 Day 210 wt., lb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 11/10/91 | 11/11/91 | |
| 1 | 755 | 785 | 825 | 845 | 910 | 935 | 960 | 985 | 980 | 982.5 | 1015 | | | 1075 |
| 2 | 675 | 705 | 760 | 795 | 845 | 875 | 915 | 945 | 940 | 942.5 | 980 | | | 1040 |
| 4 | 560 | | | | | | | | | | | | | |
| 5 | 720 | 810 | 835 | 855 | 920 | 965 | 1015 | 1025 | 995 | 1010 | 1030 | | | 1100 |
| 8 | 675 | 700 | 730 | 765 | 800 | 830 | 880 | 905 | 895 | 900 | 935 | 945 | 945 | |
| 9 | 550 | 595 | 620 | 675 | 710 | 755 | 780 | 800 | 790 | 795 | 835 | | | 850 |
| 10 | 735 | 770 | 815 | 860 | 930 | 955 | 1005 | 1040 | 1025 | 1032.5 | 1045 | 1055 | 1055 | |
| 11 | 650 | 675 | 695 | 735 | 785 | 815 | 835 | 885 | 880 | 882.5 | 930 | 940 | 940 | |
| 12 | 525 | 560 | 605 | 630 | 665 | 680 | 725 | 765 | 760 | 762.5 | 785 | | | 805 |
| 13 | 850 | 890 | 955 | 930 | 995 | 1030 | 1055 | 1110 | 1095 | 1102.5 | 1170 | | | 1190 |
| 14 | 630 | 650 | 690 | 725 | 770 | 820 | 860 | 880 | 885 | 882.5 | 900 | 905 | 905 | |
| 16 | 645 | 655 | 710 | 745 | 795 | 835 | 800 | 900 | 905 | 902.5 | 925 | | | 970 |
| 17 | 715 | 740 | 790 | 835 | 890 | 915 | 965 | 990 | 1000 | 995 | 1030 | | | 1075 |
| 18 | 695 | 710 | 755 | 805 | 835 | 895 | 925 | 965 | 955 | 960 | 980 | | | 1045 |
| 19 | 540 | 595 | 605 | 610 | | | | | | | | | | |
| 20 | 755 | 765 | 825 | 865 | 905 | 950 | 970 | 995 | 985 | 990 | 1015 | | | 1095 |
| 21 | 745 | 760 | 765 | 825 | 880 | 900 | 935 | 955 | 950 | 952.5 | 970 | | | 1030 |
| 25 | 620 | 655 | 695 | 730 | 775 | 840 | 855 | 900 | 885 | 892.5 | 945 | | | 970 |
| 27 | 610 | 685 | 710 | 750 | 785 | 810 | 865 | 915 | 895 | 905 | 940 | 925 | 945 | |
| 29 | 660 | 690 | 705 | 740 | 790 | 845 | 875 | 890 | 890 | 890 | 920 | | | 945 |
| 31 | 745 | 765 | 835 | 870 | 900 | 930 | 970 | 1010 | 980 | 995 | 985 | | | 1020 |
| 32 | 625 | 645 | 685 | 730 | 780 | 815 | 880 | 910 | 900 | 905 | 890 | 910 | 910 | |
| 34 | 640 | 655 | 705 | 720 | 755 | 790 | 825 | 845 | 845 | 845 | 860 | | | 905 |
| 37 | 650 | 700 | 725 | 775 | 835 | 895 | 925 | 950 | 960 | 955 | 970 | | | 1010 |
| 38 | 610 | 640 | 675 | 715 | 745 | 790 | 825 | 855 | 845 | 850 | 890 | | | 935 |

Table A-3. (cont'd)

| Steer no. | 07/19/91 Day 84 wt., lb | 08/02/91 Day 98 wt., lb | 08/16/91 Day 112 wt., lb | 08/30/91 Day 126 wt., lb | 09/13/91 Day 140 wt., lb | 09/27/91 Day 154 wt., lb | 10/11/91 Day 168 wt., lb | 10/25/91 Day 181 wt., lb | 10/27/91 Day 183 wt., lb | Average Day 182 wt., lb | 11/08/91 Day 196 wt., lb | Intermediate harvest wt., lb 11/10/91 | Intermediate harvest wt., lb 11/11/91 | 11/22/91 Day 210 wt., lb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 39 | 700 | 725 | 765 | 770 | 835 | 865 | 905 | 930 | 995 | 962.5 | 990 | 990 | | |
| 40 | 665 | 705 | 755 | 785 | 820 | 875 | 905 | 955 | 940 | 947.5 | 940 | 950 | 960 | |
| 42 | 755 | 760 | 805 | 830 | 885 | 925 | 955 | 995 | 995 | 995 | 1030 | | | 1095 |
| 43 | 615 | 670 | 700 | 730 | 760 | 830 | 850 | 895 | 885 | 890 | 910 | | | 965 |
| 44 | 710 | 735 | 775 | 805 | 865 | 885 | 930 | 970 | 970 | 970 | 985 | | | 1045 |
| 45 | 750 | 770 | 800 | 840 | 880 | 910 | 975 | 995 | 990 | 992.5 | 1000 | 1020 | 1010 | |
| 46 | 735 | 740 | 790 | 815 | 870 | 900 | 950 | 995 | 980 | 987.5 | 1020 | | | 1080 |
| 47 | 680 | 720 | 765 | 820 | 870 | 910 | 920 | 970 | 955 | 962.5 | 1000 | | | 1045 |
| 49 | | | | | | | | | | | | | | |
| 50 | 785 | 810 | 845 | 865 | 915 | 960 | 995 | 1035 | 1025 | 1030 | 1055 | | | 1145 |
| 54 | 790 | 830 | 885 | 935 | 1010 | 1035 | 1095 | 1130 | 1110 | 1120 | 1179 | | | 1205 |
| 55 | 605 | 670 | 705 | 745 | 795 | 825 | 870 | 920 | 905 | 912.5 | 945 | | | 975 |
| 56 | 775 | 825 | 865 | 920 | 985 | 1010 | 1080 | 985 | 980 | 982.5 | | | | |
| 57 | 665 | 705 | 730 | 775 | 810 | 860 | 900 | 935 | 925 | 930 | 965 | | | 1010 |
| 58 | 645 | 690 | 740 | 775 | 810 | 860 | 900 | 940 | 920 | 930 | 975 | | | 1010 |
| 59 | 620 | 660 | 685 | 725 | 770 | 775 | 840 | 885 | 865 | 875 | 930 | | | 990 |
| 60 | 640 | 680 | 730 | 775 | 820 | 875 | 905 | 925 | 915 | 920 | 995 | 980 | 960 | |
| 62 | 670 | 695 | 730 | 770 | 795 | 830 | 885 | 885 | 875 | 880 | 940 | | | 945 |
| 63 | 645 | 690 | 735 | 755 | 810 | 850 | 885 | 910 | 900 | 905 | 975 | | | 990 |
| 65 | 660 | 690 | 705 | 730 | 785 | 810 | 825 | 855 | 845 | 850 | 875 | | | 915 |
| 70 | 705 | 735 | 785 | 805 | 860 | 885 | 930 | 925 | 930 | 927.5 | 950 | | | 1015 |
| 72 | 665 | 710 | 750 | 775 | 830 | 865 | 910 | 915 | 915 | 915 | 965 | 955 | 955 | |
| 73 | 590 | 620 | 660 | 685 | 740 | 770 | 815 | 840 | 820 | 830 | 860 | | | 885 |
| 75 | 675 | 700 | 750 | 790 | 870 | 885 | 915 | 950 | 930 | 940 | 965 | | | 1005 |
| 76 | 645 | 690 | 715 | 760 | 800 | 840 | 870 | 930 | 905 | 917.5 | 945 | | | 960 |

Table A-3. (cont'd)

| Steer no. | 07/19/91 Day 84 wt., lb | 08/02/91 Day 98 wt., lb | 08/16/91 Day 112 wt., lb | 08/30/91 Day 126 wt., lb | 09/13/91 Day 140 wt., lb | 09/27/91 Day 154 wt., lb | 10/11/91 Day 168 wt., lb | 10/25/91 Day 181 wt., lb | 10/27/91 Day 183 wt., lb | Average Day 182 wt., lb | 11/08/91 Day 196 wt., lb | Intermediate harvest wt., lb 11/10/91 | 11/11/91 | 11/22/91 Day 210 wt., lb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | 745 | 765 | 825 | 855 | 920 | 950 | 995 | 1035 | 1045 | 1040 | 1070 | | | 1130 |
| 78 | 640 | 670 | 695 | 730 | 755 | 780 | 830 | 860 | 860 | 860 | 885 | 885 | 880 | |
| 79 | 535 | 575 | 620 | 660 | 725 | 750 | 765 | | | | | | | |
| 80 | 735 | 765 | 805 | 850 | 930 | 975 | 1030 | 1085 | 1080 | 1082.5 | 1135 | | | 1150 |
| 83 | 770 | 795 | 835 | 875 | 935 | 975 | 1010 | 1055 | 1030 | 1042.5 | 1085 | | | 1110 |
| 84 | 600 | 640 | 665 | 705 | 710 | 735 | 765 | | | | | | | |
| 85 | 695 | 720 | 765 | 790 | 840 | 865 | 920 | 950 | 940 | 945 | 980 | 1010 | 1005 | |
| 86 | 615 | 650 | 610 | 725 | 765 | 810 | 840 | 875 | 865 | 870 | 910 | | | 935 |
| 87 | 770 | 800 | 840 | 890 | 940 | 975 | 1005 | 1065 | 1050 | 1057.5 | 1100 | | | 1150 |
| 88 | 540 | 585 | 620 | 675 | 750 | 765 | 730 | 740 | 725 | 732.5 | | | | |
| 89 | 595 | 635 | 700 | 730 | 755 | 820 | 810 | 880 | 875 | 877.5 | 925 | | | 900 |
| 90 | 705 | 735 | 765 | 820 | 850 | 900 | 955 | 990 | 980 | 985 | 1015 | | | 1045 |
| 91 | 690 | 695 | 760 | 800 | 815 | 890 | 920 | 965 | 950 | 957.5 | 995 | | | 1055 |
| 94 | 560 | 585 | 600 | 620 | 675 | 710 | 745 | 780 | 770 | 775 | 815 | | | 855 |
| 95 | 695 | 735 | 770 | 825 | 865 | 915 | 955 | 990 | 970 | 980 | 990 | 990 | 990 | |
| 97 | 645 | 685 | 740 | 780 | 790 | 855 | 890 | 940 | 915 | 927.5 | 945 | | | 1015 |
| 98 | 695 | 740 | 750 | 810 | 845 | 900 | 965 | 965 | 960 | 962.5 | 1005 | 1000 | 1010 | |
| 99 | 640 | 675 | 720 | 770 | 790 | 785 | 800 | | | | | | | |
| 100 | 690 | 715 | 760 | 795 | 850 | 905 | 935 | 940 | 935 | 937.5 | 980 | 995 | 990 | |
| 101 | 730 | 780 | 810 | 820 | 880 | 915 | 950 | 985 | 985 | 985 | 1030 | | | 1100 |
| 102 | 805 | 835 | 880 | 920 | 975 | 1020 | 1080 | 1105 | 1105 | 1105 | 1150 | | | 1195 |
| 103 | 670 | 715 | 745 | 800 | 870 | 905 | 955 | 1000 | 975 | 987.5 | 1030 | | | 1080 |
| 104 | 620 | 645 | 695 | 710 | 765 | 815 | 840 | 905 | 890 | 897.5 | 935 | | | 950 |
| 105 | 750 | 765 | 745 | 750 | | | | | | | | | | |
| 106 | 720 | 775 | 790 | 820 | 885 | 900 | 940 | 985 | 985 | 985 | 1010 | 1010 | 1010 | |

Table A-3. (cont'd)

| Steer no. | 07/19/91 Day 84 wt., lb | 08/02/91 Day 98 wt., lb | 08/16/91 Day 112 wt., lb | 08/30/91 Day 126 wt., lb | 09/13/91 Day 140 wt., lb | 09/27/91 Day 154 wt., lb | 10/11/91 Day 168 wt., lb | 10/25/91 Day 181 wt., lb | 10/27/91 Day 183 wt., lb | Average Day 182 wt., lb | 11/08/91 Day 196 wt., lb | Intermediate harvest wt., lb | | 11/22/91 Day 210 wt., lb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 11/10/91 | 11/11/91 | |
| 107 | 655 | 690 | 725 | 770 | 805 | 835 | 875 | 905 | 905 | 905 | 945 | | | 960 |
| 108 | 700 | 735 | 780 | 840 | 895 | 925 | 960 | 995 | 985 | 990 | 1015 | | | 1045 |
| 109 | 795 | 830 | 860 | 895 | 970 | 1005 | 1045 | 1095 | 1075 | 1085 | 1110 | | | 1155 |
| 110 | 610 | 645 | 680 | 705 | 740 | 805 | 810 | 845 | 840 | 842.5 | 890 | 880 | 875 | |
| 111 | 610 | 630 | 690 | 725 | 765 | 805 | 805 | | | | | | | |
| 112 | 620 | 660 | 715 | 770 | 805 | 855 | 900 | 935 | 920 | 927.5 | 965 | | | 990 |
| 114 | | | | | | | | | | | | | | |
| 115 | 705 | 750 | 780 | 810 | 840 | 870 | 905 | 940 | 935 | 937.5 | 980 | | | 1045 |
| 116 | 710 | 745 | 780 | 795 | 865 | 910 | 935 | 985 | 970 | 977.5 | 1020 | | | 1075 |
| 117 | 735 | 775 | 785 | 845 | 905 | 925 | 975 | 1035 | 1015 | 1025 | 1070 | | | 1100 |
| 118 | 675 | 715 | 745 | 770 | 830 | 865 | 900 | 930 | 930 | 930 | 975 | 970 | 980 | |
| 119 | 650 | 685 | 715 | 745 | 785 | 825 | 840 | 880 | 880 | 880 | 915 | | | 950 |
| 120 | 775 | 815 | 860 | 870 | 920 | 985 | 1040 | 1040 | 1045 | 1042.5 | 1095 | 1080 | 1075 | |
| 121 | 615 | 655 | 700 | 755 | 745 | 820 | 860 | 920 | 900 | 910 | 945 | | | 995 |
| 122 | 745 | 760 | 775 | 795 | 835 | 865 | 890 | 890 | 885 | 887.5 | 940 | | | 965 |
| 123 | 650 | 670 | 720 | 760 | 785 | 835 | 855 | 920 | 905 | 912.5 | 940 | | | 1005 |
| 124 | 650 | 695 | 720 | 750 | 725 | 815 | 835 | 875 | 860 | 867.5 | 860 | | | 865 |
| 127 | 780 | 800 | 850 | | | | | | | | | | | |
| 128 | 715 | 735 | 770 | 775 | 835 | 850 | 880 | 920 | 910 | 915 | 935 | 945 | 935 | |
| 129 | 770 | 795 | 845 | 835 | 915 | 960 | 1010 | 1075 | 1070 | 1072.5 | 1125 | 1125 | 1120 | |
| 130 | 700 | 740 | 775 | 800 | 845 | 875 | 905 | 960 | 945 | 952.5 | 990 | | | 1025 |
| 133 | 615 | 660 | 710 | 750 | 815 | 845 | 895 | 950 | 930 | 940 | 975 | | | 1025 |
| 135 | 560 | 595 | 570 | 565 | | | | | | | | | | |
| 136 | 695 | 720 | 775 | 805 | 805 | 850 | 880 | 930 | 910 | 920 | 940 | | | 990 |
| 137 | | | | | | | | | | | | | | |

Table A-3. (cont'd)

| Steer no. | 07/19/91 Day 84 wt., lb | 08/02/91 Day 98 wt., lb | 08/16/91 Day 112 wt., lb | 08/30/91 Day 126 wt., lb | 09/13/91 Day 140 wt., lb | 09/27/91 Day 154 wt., lb | 10/11/91 Day 168 wt., lb | 10/25/91 Day 181 wt., lb | 10/27/91 Day 183 wt., lb | Average Day 182 wt., lb | 11/08/91 Day 196 wt., lb | Intermediate harvest wt., lb | | 11/22/91 Day 210 wt., lb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 11/10/91 | 11/11/91 | |
| 139 | 670 | 720 | 745 | 775 | 830 | 865 | 925 | 950 | 965 | 957.5 | 1000 | | | 1060 |
| 140 | 620 | 630 | | | | | | | | | | | | |
| 141 | 605 | 640 | 645 | 670 | 710 | 755 | 870 | 830 | 830 | 830 | 845 | | | |
| 142 | 570 | 595 | 630 | 670 | 655 | 675 | 705 | 725 | 710 | 717.5 | 725 | | | 775 |
| 143 | 745 | 795 | 820 | 845 | 895 | 920 | 970 | 990 | 990 | 990 | 1025 | | | 1080 |
| 144 | 705 | 745 | 785 | 815 | 855 | 915 | 935 | 975 | 965 | 970 | 1025 | | | 1075 |
| 147 | 680 | 695 | 755 | 805 | 825 | 860 | 895 | 930 | 930 | 930 | 955 | | | 1010 |
| 151 | 635 | 675 | 730 | 785 | 815 | 880 | 920 | 970 | 950 | 960 | 955 | | | 1030 |
| 153 | 700 | 760 | 770 | 790 | 845 | 890 | 935 | 960 | 955 | 957.5 | 985 | 985 | 990 | |
| 154 | 665 | 705 | 755 | 785 | 820 | 845 | 895 | 910 | 910 | 910 | 945 | | | 1000 |
| 155 | 595 | 620 | 675 | 705 | 740 | 780 | 815 | 860 | 850 | 855 | 905 | | | 945 |
| 157 | 745 | 795 | 835 | 830 | 925 | 955 | 990 | 1005 | 985 | 995 | 1025 | 1030 | 1025 | |
| 158 | 620 | 655 | 670 | 720 | 770 | 795 | 835 | 850 | 845 | 847.5 | 895 | | | 950 |
| 159 | 705 | 740 | 775 | 790 | 830 | 865 | 925 | 975 | 975 | 975 | 1025 | | | 1045 |
| 161 | 675 | 725 | 750 | 800 | 840 | 900 | 960 | 990 | 975 | 982.5 | 1040 | | | 1085 |
| 163 | 700 | 725 | 765 | 805 | 835 | 875 | 905 | 940 | 930 | 935 | 985 | | | 1050 |
| 165 | 630 | 640 | 695 | 730 | 780 | 795 | 850 | 895 | 870 | 882.5 | 900 | | | 980 |
| 166 | 690 | 725 | 770 | 820 | 840 | 895 | 910 | 945 | 935 | 940 | 980 | | | 1005 |
| 170 | 705 | 730 | 770 | 795 | 820 | 895 | 915 | 970 | 970 | 970 | 995 | | | 1025 |
| 171 | 590 | 620 | 640 | 680 | 725 | 770 | 800 | 855 | 850 | 852.5 | 885 | 880 | 890 | |
| 172 | 655 | 700 | 755 | 775 | 810 | 840 | 905 | 950 | 945 | 947.5 | 990 | 990 | 965 | |
| 173 | 610 | 670 | 685 | 750 | 820 | 830 | 880 | 930 | 925 | 927.5 | 935 | 920 | 930 | |
| 180 | 690 | 725 | 760 | 795 | 840 | 890 | 940 | 985 | 970 | 977.5 | 1030 | | | 1065 |
| 183 | 775 | 800 | 860 | 880 | 945 | 990 | 1000 | 1045 | 1035 | 1040 | 1065 | | | 1135 |
| 184 | 725 | 780 | 810 | 835 | 905 | 925 | 980 | 1010 | 1020 | 1015 | 1040 | | | 1080 |

Table A-3. (cont'd)

| Steer no. | 07/19/91 Day 84 wt., lb | 08/02/91 Day 98 wt., lb | 08/16/91 Day 112 wt., lb | 08/30/91 Day 126 wt., lb | 09/13/91 Day 140 wt., lb | 09/27/91 Day 154 wt., lb | 10/11/91 Day 168 wt., lb | 10/25/91 Day 181 wt., lb | 10/27/91 Day 183 wt., lb | Average Day 182 wt., lb | 11/08/91 Day 196 wt., lb | Intermediate harvest wt., lb 11/10/91 | Intermediate harvest wt., lb 11/11/91 | 11/22/91 Day 210 wt., lb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 187 | 790 | 820 | 875 | 900 | 965 | 1000 | 1055 | 1105 | 1085 | 1095 | 1125 | 1120 | 1115 | |
| 192 | 750 | 805 | 830 | 880 | 955 | 990 | 1055 | 1110 | 1105 | 1107.5 | 1135 | | | 1180 |
| 194 | 595 | 630 | 665 | 690 | 725 | 770 | 800 | 815 | 795 | 805 | 845 | | | 890 |
| 195 | 725 | 735 | 790 | 835 | 865 | 905 | 940 | 990 | 980 | 985 | 1000 | | | 1045 |
| 196 | 690 | 730 | 765 | 800 | 830 | 875 | 915 | 950 | 945 | 947.5 | 980 | | | 1020 |
| 197 | 735 | 770 | 800 | 845 | 865 | 945 | 995 | 1025 | 1030 | 1027.5 | 1075 | | | 1155 |
| 198 | 745 | 795 | 830 | 850 | 915 | 920 | 985 | 1015 | 1020 | 1017.5 | 1065 | | | 1120 |
| 199 | 660 | 720 | 715 | 765 | 815 | 835 | 860 | 900 | 895 | 897.5 | 925 | | | 960 |
| 201 | 600 | 620 | 680 | 715 | 755 | 785 | 815 | 865 | 860 | 862.5 | 895 | 900 | 895 | |
| 203 | | | | | | | | | | | | | | |
| 205 | 695 | 740 | 740 | 780 | 795 | 855 | 895 | 925 | 915 | 920 | 960 | | | 1010 |
| 206 | | | | | | | | | | | | | | |
| 208 | | | | | | | | | | | | | | |
| 210 | | | | | | | | | | | | | | |
| 211 | 760 | 800 | 840 | 890 | 945 | 960 | 1040 | 1075 | 1045 | 1060 | 1075 | 1060 | 1055 | |
| 212 | 630 | 660 | 690 | 710 | 750 | 775 | 805 | 845 | 835 | 840 | 865 | | | 890 |
| 213 | 715 | 750 | 785 | 830 | 870 | 910 | 955 | 985 | 980 | 982.5 | 1000 | 995 | 995 | |
| 215 | 700 | 740 | 765 | 770 | 835 | 850 | 885 | 905 | 895 | 900 | 980 | | | 1025 |
| 216 | 755 | 785 | 825 | 865 | 910 | 905 | 965 | 1010 | 1000 | 1005 | 1015 | | | 1105 |
| 217 | 745 | 770 | 800 | 825 | 910 | 930 | 1005 | 1025 | 1030 | 1027.5 | 1060 | | | 1105 |
| 218 | 685 | 735 | 775 | 810 | 860 | 900 | 965 | 1020 | 1005 | 1012.5 | 1020 | | | 1060 |
| 221 | 660 | 690 | 765 | 795 | 845 | 875 | 905 | 945 | 940 | 942.5 | 990 | | | 1000 |
| 222 | 725 | 780 | 810 | 835 | 915 | 940 | 970 | 1015 | 995 | 1005 | 1050 | | | 1110 |
| 225 | 765 | 805 | 840 | 875 | 965 | 1010 | 1055 | 1095 | 1095 | 1095 | 1135 | | | 1210 |

Table A-3. (cont'd)

| Steer no. | 07/19/91 Day 84 wt., lb | 08/02/91 Day 98 wt., lb | 08/16/91 Day 112 wt., lb | 08/30/91 Day 126 wt., lb | 09/13/91 Day 140 wt., lb | 09/27/91 Day 154 wt., lb | 10/11/91 Day 168 wt., lb | 10/25/91 Day 181 wt., lb | 10/27/91 Day 183 wt., lb | Average Day 182 wt., lb | 11/08/91 Day 196 wt., lb | Intermediate harvest wt., lb 11/10/91 | Intermediate harvest wt., lb 11/11/91 | 11/22/91 Day 210 wt., lb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 227 | 690 | 730 | 755 | 775 | 830 | 845 | 875 | 915 | 895 | 905 | 935 | 940 | 920 | |
| 228 | 745 | 755 | 790 | 850 | 900 | 915 | 965 | 1005 | 1015 | 1010 | 1040 | | | 1110 |
| 231 | 705 | 740 | 765 | 790 | 830 | 880 | 935 | 950 | 935 | 942.5 | 955 | | | |
| 232 | 665 | 705 | 745 | 765 | 800 | 835 | 890 | 920 | 920 | 920 | 955 | | | 1025 |
| 234 | 565 | 625 | 670 | 695 | 735 | 785 | 820 | 845 | 835 | 840 | 885 | | | 930 |
| 236 | 680 | 725 | 780 | 780 | 805 | 855 | 890 | 930 | 920 | 925 | 980 | | | 1030 |
| 237 | 640 | 660 | 710 | 750 | 815 | 855 | 890 | 910 | 905 | 907.5 | 945 | | | 995 |
| 238 | 775 | 795 | 835 | 865 | 930 | 955 | 1020 | 1035 | 1030 | 1032.5 | 1070 | | | 1130 |
| 239 | 665 | 695 | 730 | 775 | 815 | 835 | 880 | 915 | 905 | 910 | 935 | | | 975 |
| 241 | 745 | 780 | 810 | 855 | 895 | 920 | 975 | 1005 | 1005 | 1005 | 1030 | | | 1090 |
| 243 | 690 | 740 | 780 | 820 | 890 | 935 | 990 | 1040 | 1025 | 1032.5 | 1075 | | | 1110 |

Table A-3. (cont'd)

| Steer no. | 12/06/91 Day 224 wt., lb | 12/20/91 Day 238 wt., lb | 01/03/92 Day 252 wt., lb | 01/17/92 Day 266 wt., lb | 01/31/92 Day 280 wt., lb | 02/14/92 Day 294 wt., lb | 02/28/92 Day 308 wt., lb | 03/13/92 Day 322 wt., lb | 03/27/92 Day 336 wt., lb | 04/10/92 Day 350 wt., lb | 04/24/92 Day 364 wt., lb | Days on Trial | Final wt., lb #1 | Final wt., lb #2 | Final wt., lb Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1085 | 1095 | 1120 | 1170 | 1190 | 1220 | 1215 | | | | | 322 | 1185 | 1175 | 1180 |
| 2 | 1065 | 1090 | 1125 | 1170 | 1200 | 1260 | 1290 | 1315 | 1345 | | | 350 | 1400 | 1385 | 1392.5 |
| 4 | | | | | | | | | | | | | | | |
| 5 | 1135 | 1140 | 1155 | 1230 | 1250 | 1315 | 1335 | | | | | 322 | 1325 | 1315 | 1320 |
| 8 | | | | | | | | | | | | | | | |
| 9 | 895 | 930 | 980 | 1010 | 1055 | 1090 | 1120 | 1155 | 1200 | 1230 | 1235 | 377 | 1295 | 1265 | 1280 |
| 10 | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | |
| 12 | 850 | 895 | 925 | 955 | 985 | 1030 | 1050 | 1080 | 1085 | 1105 | 1105 | 377 | 1150 | 1150 | 1150 |
| 13 | 1210 | 1245 | 1230 | 1310 | 1330 | 1370 | 1390 | | | | | 322 | 1450 | 1430 | 1440 |
| 14 | | | | | | | | | | | | | | | |
| 16 | 990 | 1015 | 1030 | 1090 | 1125 | 1170 | 1200 | 1225 | 1260 | 1290 | | 364 | 1315 | 1320 | 1317.5 |
| 17 | 1120 | 1125 | 1150 | 1230 | 1260 | 1310 | 1355 | 1380 | 1385 | | | 350 | 1385 | 1380 | 1382.5 |
| 18 | 1090 | 1090 | 1125 | 1150 | 1180 | 1195 | 1210 | 1245 | 1270 | 1280 | | 364 | 1300 | 1290 | 1295 |
| 19 | | | | | | | | | | | | | | | |
| 20 | 1085 | 1115 | 1130 | 1180 | 1215 | 1250 | 1305 | | | | | 322 | 1330 | 1300 | 1315 |
| 21 | 1050 | 1080 | 1050 | 1130 | 1135 | 1190 | 1213 | | | | | 322 | 1250 | 1230 | 1240 |
| 25 | 1005 | 1050 | 1075 | 1115 | 1125 | 1175 | 1220 | 1240 | 1270 | 1300 | 1320 | 377 | 1380 | 1365 | 1372.5 |
| 27 | | | | | | | | | | | | | | | |
| 29 | 985 | 1045 | 1040 | 1110 | 1145 | 1175 | 1225 | 1245 | 1305 | 1275 | | 364 | 1300 | 1295 | 1297.5 |
| 31 | 1030 | 1085 | 1100 | 1120 | 1140 | 1165 | 1205 | 1250 | 1280 | 1285 | | 364 | 1310 | 1290 | 1300 |
| 32 | | | | | | | | | | | | | | | |
| 34 | 940 | 970 | 1000 | 1040 | 1070 | 1100 | 1115 | 1150 | 1155 | | | 350 | 1195 | 1185 | 1190 |
| 37 | 1065 | 1100 | 1052 | 1140 | 1200 | 1225 | 1230 | 1280 | 1275 | 1305 | | 364 | 1320 | 1325 | 1322.5 |
| 38 | 975 | 1005 | 1040 | 1070 | 1130 | 1155 | 1195 | 1245 | 1250 | | | 350 | 1285 | 1265 | 1275 |

Table A-3. (cont'd)

| Steer no. | 12/06/91 Day 224 wt., lb | 12/20/91 Day 238 wt., lb | 01/03/92 Day 252 wt., lb | 01/17/92 Day 266 wt., lb | 01/31/92 Day 280 wt., lb | 02/14/92 Day 294 wt., lb | 02/28/92 Day 308 wt., lb | 03/13/92 Day 322 wt., lb | 03/27/92 Day 336 wt., lb | 04/10/92 Day 350 wt., lb | 04/24/92 Day 364 wt., lb | Days on Trial | Final wt., lb | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | #1 | #2 | Avg. |
| 39 | | | | | | | | | | | | | | | |
| 40 | | | | | | | | | | | | | | | |
| 42 | 1130 | 1135 | 1200 | 1255 | 1285 | 1325 | 1350 | | | | | 322 | 1360 | 1355 | 1357.5 |
| 43 | 1010 | 1050 | 1060 | 1110 | 1155 | 1180 | 1240 | 1250 | 1280 | 1310 | | 364 | 1325 | 1330 | 1327.5 |
| 44 | 1085 | 1110 | 1165 | 1180 | 1240 | 1275 | 1315 | 1340 | 1335 | | | 350 | 1360 | 1345 | 1352.5 |
| 45 | | | | | | | | | | | | | | | |
| 46 | 1095 | 1115 | 1115 | 1150 | 1200 | 1205 | 1240 | | | | | 322 | 1265 | 1255 | 1260 |
| 47 | 1090 | 1110 | 1130 | 1200 | 1240 | 1280 | 1320 | 1365 | 1400 | 1400 | | 364 | 1425 | 1400 | 1412.5 |
| 49 | | | | | | | | | | | | | | | |
| 50 | 1145 | 1180 | 1220 | 1280 | 1320 | 1395 | 1430 | | | | | 322 | 1455 | 1410 | 1432.5 |
| 54 | 1235 | 1265 | 1285 | 1350 | 1355 | 1395 | 1425 | | | | | 322 | 1475 | 1450 | 1462.5 |
| 55 | 995 | 1045 | 1070 | 1125 | 1125 | 1185 | 1230 | 1265 | 1290 | 1305 | 1325 | 377 | 1390 | 1375 | 1382.5 |
| 56 | | | | | | | | | | | | | | | |
| 57 | 1040 | 1065 | 1095 | 1135 | 1150 | 1185 | 1200 | 1260 | 1265 | 1265 | | 364 | 1290 | 1300 | 1295 |
| 58 | 1025 | 1060 | 1100 | 1135 | 1160 | 1190 | 1205 | 1245 | 1265 | 1280 | | 364 | 1295 | 1295 | 1295 |
| 59 | 1010 | 1050 | 1105 | 1155 | 1210 | 1260 | 1300 | 1335 | 1380 | 1410 | 1425 | 377 | 1450 | 1435 | 1442.5 |
| 60 | | | | | | | | | | | | | | | |
| 62 | 1010 | 1015 | 1040 | 1080 | 1100 | 1140 | 1175 | 1220 | 1210 | | | 350 | 1240 | 1235 | 1237.5 |
| 63 | 1035 | 1080 | 1095 | 1150 | 1155 | 1190 | 1235 | 1275 | 1305 | 1325 | 1355 | 377 | 1455 | 1415 | 1435 |
| 65 | 955 | 990 | 1000 | 1050 | 1075 | 1115 | 1150 | 1185 | 1190 | | | 350 | 1235 | 1215 | 1225 |
| 70 | 1055 | 1080 | 1130 | 1160 | 1200 | 1240 | 1290 | 1305 | 1325 | | | 350 | 1340 | 1340 | 1340 |
| 72 | | | | | | | | | | | | | | | |
| 73 | 920 | 950 | 985 | 1035 | 1060 | 1095 | 1125 | 1145 | 1100 | 1080 | | | | | |
| 75 | 1040 | 1060 | 1090 | 1135 | 1190 | 1215 | 1240 | 1280 | 1315 | 1315 | | 364 | 1310 | 1315 | 1312.5 |
| 76 | 1015 | 1055 | 1095 | 1140 | 1165 | 1215 | 1275 | 1290 | 1325 | 1360 | | 364 | 1365 | 1360 | 1362.5 |

Table A-3. (cont'd)

| Steer no. | 12/06/91 Day 224 wt., lb | 12/20/91 Day 238 wt., lb | 01/03/92 Day 252 wt., lb | 01/17/92 Day 266 wt., lb | 01/31/92 Day 280 wt., lb | 02/14/92 Day 294 wt., lb | 02/28/92 Day 308 wt., lb | 03/13/92 Day 322 wt., lb | 03/27/92 Day 336 wt., lb | 04/10/92 Day 350 wt., lb | 04/24/92 Day 364 wt., lb | Days on Trial | Final wt., lb #1 | Final wt., lb #2 | Final wt., lb Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | 1170 | 1180 | 1225 | 1270 | 1290 | 1330 | 1350 | | | | | 322 | 1400 | 1365 | 1382.5 |
| 78 | | | | | | | | | | | | | | | |
| 79 | | | | | | | | | | | | | | | |
| 80 | 1215 | 1225 | 1275 | 1320 | 1305 | 1380 | 1395 | | | | | 322 | 1440 | 1405 | 1422.5 |
| 83 | 1195 | 1215 | 1235 | 1270 | 1295 | 1340 | 1370 | | | | | 322 | 1375 | 1345 | 1360 |
| 84 | | | | | | | | | | | | | | | |
| 85 | | | | | | | | | | | | | | | |
| 86 | 970 | 1020 | 1050 | 1100 | 1105 | 1145 | 1190 | 1220 | 1240 | 1285 | 1305 | 377 | 1365 | 1345 | 1355 |
| 87 | 1190 | 1190 | 1205 | 1230 | 1295 | 1360 | 1370 | 1400 | 1410 | | | 350 | 1410 | 1405 | 1407.5 |
| 88 | | | | | | | | | | | | | | | |
| 89 | 975 | 1015 | 1070 | 1100 | 1125 | 1170 | 1225 | 1250 | 1255 | 1290 | 1310 | 377 | 1340 | 1300 | 1320 |
| 90 | 1080 | 1110 | 1135 | 1150 | 1200 | 1290 | 1315 | 1330 | 1360 | | | 350 | 1320 | 1310 | 1315 |
| 91 | 1085 | 1110 | 1165 | 1240 | 1250 | 1310 | 1345 | 1340 | 1330 | | | | | | |
| 94 | 860 | 860 | | | | | | | | | | | | | |
| 95 | | | | | | | | | | | | | | | |
| 97 | 1035 | 1070 | 1080 | 1090 | 1125 | 1130 | 1145 | 1200 | 1235 | 1250 | | 364 | 1290 | 1265 | 1277.5 |
| 98 | | | | | | | | | | | | | | | |
| 99 | | | | | | | | | | | | | | | |
| 100 | | | | | | | | | | | | | | | |
| 101 | 1150 | 1195 | 1230 | 1270 | 1315 | 1355 | 1365 | 1415 | 1400 | | | 350 | 1400 | 1400 | 1400 |
| 102 | 1240 | 1275 | 1310 | 1360 | 1432 | 1470 | 1480 | | | | | 322 | 1505 | 1475 | 1490 |
| 103 | 1100 | 1110 | 1150 | 1215 | 1225 | 1265 | 1305 | 1350 | 1355 | 1390 | 1430 | 377 | 1495 | 1455 | 1475 |
| 104 | 1000 | 1020 | 1065 | 1115 | 1145 | 1180 | 1220 | 1270 | 1280 | 1330 | 1325 | 377 | 1370 | 1345 | 1357.5 |
| 105 | | | | | | | | | | | | | | | |
| 106 | | | | | | | | | | | | | | | |

Table A-3. (cont'd)

| Steer no. | 12/06/91 Day 224 wt., lb | 12/20/91 Day 238 wt., lb | 01/03/92 Day 252 wt., lb | 01/17/92 Day 266 wt., lb | 01/31/92 Day 280 wt., lb | 02/14/92 Day 294 wt., lb | 02/28/92 Day 308 wt., lb | 03/13/92 Day 322 wt., lb | 03/27/92 Day 336 wt., lb | 04/10/92 Day 350 wt., lb | 04/24/92 Day 364 wt., lb | Days on Trial | Final wt., lb #1 | Final wt., lb #2 | Final wt., lb Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 107 | 975 | 1005 | 1040 | 1065 | 1105 | 1160 | 1215 | 1250 | 1270 | 1285 | | 364 | 1315 | 1295 | 1305 |
| 108 | 1105 | 1115 | 1150 | 1180 | 1210 | 1220 | 1250 | 1320 | 1340 | 1375 | | 364 | 1395 | 1370 | 1382.5 |
| 109 | 1180 | 1205 | 1225 | 1270 | 1290 | 1315 | 1325 | | | | | 322 | 1380 | 1365 | 1372.5 |
| 110 | | | | | | | | | | | | | | | |
| 111 | | | | | | | | | | | | | | | |
| 112 | 1045 | 1070 | 1110 | 1180 | 1225 | 1260 | 1290 | 1350 | 1355 | 1395 | | 364 | 1395 | 1375 | 1385 |
| 114 | | | | | | | | | | | | | | | |
| 115 | 1070 | 1110 | 1135 | 1170 | 1225 | 1255 | 1295 | 1345 | 1320 | | | 350 | 1360 | 1350 | 1355 |
| 116 | 1105 | 1155 | 1170 | 1225 | 1275 | 1320 | 1365 | 1395 | 1410 | | | 350 | 1460 | 1425 | 1442.5 |
| 117 | 1145 | 1170 | 1220 | 1270 | 1290 | 1350 | 1350 | | | | | 322 | 1360 | 1340 | 1350 |
| 118 | | | | | | | | | | | | | | | |
| 119 | 970 | 1000 | 1035 | 1065 | 1110 | 1150 | 1175 | 1195 | 1220 | | | 350 | 1250 | 1240 | 1245 |
| 120 | | | | | | | | | | | | | | | |
| 121 | 1040 | 1020 | 1095 | 1160 | 1175 | 1215 | 1200 | 1270 | 1295 | 1295 | | 364 | 1295 | 1295 | 1295 |
| 122 | 995 | 1010 | 1040 | 1075 | 1100 | 1120 | 1115 | | | | | 322 | 1160 | 1160 | 1160 |
| 123 | 1020 | 1035 | 1095 | 1145 | 1155 | 1125 | | | | | | | | | |
| 124 | | | | | | | | | | | | | | | |
| 127 | | | | | | | | | | | | | | | |
| 128 | | | | | | | | | | | | | | | |
| 129 | | | | | | | | | | | | | | | |
| 130 | 1090 | 1120 | 1145 | 1230 | 1225 | 1265 | 1295 | 1335 | 1350 | | | 350 | 1395 | 1375 | 1385 |
| 133 | 1015 | 1050 | 1055 | 1130 | 1145 | 1175 | 1240 | 1270 | 1310 | 1315 | 1310 | 377 | 1360 | 1355 | 1357.5 |
| 135 | | | | | | | | | | | | | | | |
| 136 | 1020 | 1095 | 1110 | 1160 | 1215 | 1245 | 1290 | 1300 | 1325 | 1350 | | 364 | 1355 | 1370 | 1362.5 |
| 137 | | | | | | | | | | | | | | | |

Table A-3. (cont'd)

| Steer no. | 12/06/91 Day 224 wt., lb | 12/20/91 Day 238 wt., lb | 01/03/92 Day 252 wt., lb | 01/17/92 Day 266 wt., lb | 01/31/92 Day 280 wt., lb | 02/14/92 Day 294 wt., lb | 02/28/92 Day 308 wt., lb | 03/13/92 Day 322 wt., lb | 03/27/92 Day 336 wt., lb | 04/10/92 Day 350 wt., lb | 04/24/92 Day 364 wt., lb | Days on Trial | Final wt., lb | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | #1 | #2 | Avg. |
| 139 | 1100 | 1105 | 1150 | 1190 | 1245 | 1280 | 1290 | 1340 | 1380 | | | 350 | 1380 | 1380 | 1380 |
| 140 | | | | | | | | | | | | | | | |
| 141 | | | | | | | | | | | | | | | |
| 142 | 810 | 845 | 905 | 960 | 1030 | 1055 | 1120 | 1160 | 1170 | 1230 | 1265 | 377 | 1330 | 1330 | 1330 |
| 143 | 1100 | 1105 | 1130 | 1210 | 1250 | 1310 | 1335 | | | | | 322 | 1360 | 1330 | 1345 |
| 144 | 1105 | 1135 | 1165 | 1210 | 1205 | 1240 | 1230 | 1290 | 1275 | | | 350 | 1315 | 1300 | 1307.5 |
| 147 | 1040 | 1055 | 1090 | 1085 | 1175 | 1205 | 1245 | 1265 | 1285 | | | 350 | 1295 | 1300 | 1297.5 |
| 151 | 1055 | 1075 | 1115 | 1180 | 1195 | 1255 | 1305 | 1340 | 1315 | 1360 | 1415 | 377 | 1435 | 1425 | 1430 |
| 153 | | | | | | | | | | | | | | | |
| 154 | 1030 | 1070 | 1105 | 1185 | 1205 | 1245 | 1280 | 1310 | 1335 | | | 350 | 1360 | 1360 | 1360 |
| 155 | 970 | 1010 | 1045 | 1070 | 1105 | 1155 | 1195 | 1195 | 1225 | 1235 | 1275 | 377 | 1310 | 1295 | 1302.5 |
| 157 | | | | | | | | | | | | | | | |
| 158 | 970 | 995 | 1025 | 1085 | 1125 | 1175 | 1200 | 1245 | 1245 | 1290 | 1320 | 377 | 1355 | 1345 | 1350 |
| 159 | 1085 | 1120 | 1150 | 1195 | 1240 | 1275 | 1315 | 1350 | 1340 | | | 350 | 1355 | 1350 | 1352.5 |
| 161 | 1120 | 1170 | 1170 | 1260 | 1310 | 1360 | 1400 | 1430 | 1480 | 1470 | | 364 | 1495 | 1500 | 1497.5 |
| 163 | 1065 | 1085 | 1125 | 1190 | 1225 | 1245 | 1270 | 1310 | 1285 | 1290 | | 364 | 1295 | 1270 | 1282.5 |
| 165 | 1000 | 1030 | 1075 | 1110 | 1120 | 1170 | 1225 | 1235 | 1220 | 1255 | 1280 | 377 | 1325 | 1315 | 1320 |
| 166 | 1035 | 1080 | 1100 | 1155 | 1195 | 1250 | 1295 | 1330 | 1370 | 1400 | | 364 | 1400 | 1390 | 1395 |
| 170 | 1070 | 1100 | 1150 | 1190 | 1220 | 1225 | 1260 | 1275 | 1265 | 1285 | | 364 | 1260 | 1270 | 1265 |
| 171 | | | | | | | | | | | | | | | |
| 172 | | | | | | | | | | | | | | | |
| 173 | | | | | | | | | | | | | | | |
| 180 | 1120 | 1180 | 1225 | 1290 | 1320 | 1365 | 1410 | 1450 | 1460 | 1490 | 1520 | 377 | 1585 | 1535 | 1560 |
| 183 | 1160 | 1170 | 1195 | 1260 | 1280 | 1340 | 1340 | | | | | 322 | 1390 | 1380 | 1385 |
| 184 | 1095 | 1115 | 1145 | 1185 | 1235 | 1265 | 1300 | | | | | 322 | 1320 | 1280 | 1300 |

Table A-3. (cont'd)

| Steer no. | 12/06/91 Day 224 wt., lb | 12/20/91 Day 238 wt., lb | 01/03/92 Day 252 wt., lb | 01/17/92 Day 266 wt., lb | 01/31/92 Day 280 wt., lb | 02/14/92 Day 294 wt., lb | 02/28/92 Day 308 wt., lb | 03/13/92 Day 322 wt., lb | 03/27/92 Day 336 wt., lb | 04/10/92 Day 350 wt., lb | 04/24/92 Day 364 wt., lb | Days on Trial | Final wt., lb #1 | Final wt., lb #2 | Final wt., lb Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 187 | | | | | | | | | | | | | | | |
| 192 | 1245 | 1255 | 1300 | 1375 | 1390 | 1445 | 1450 | | | | | 322 | 1430 | 1395 | 1412.5 |
| 194 | 900 | 910 | 935 | 980 | 990 | 1020 | 1050 | 1100 | 1120 | 1150 | 1180 | 377 | 1215 | 1195 | 1205 |
| 195 | 1090 | 1120 | 1155 | 1195 | 1225 | 1270 | 1310 | 1345 | 1340 | | | 350 | 1380 | 1370 | 1375 |
| 196 | 1095 | 1075 | 1100 | 1130 | 1180 | 1205 | 1240 | 1265 | 1280 | | | 350 | 1310 | 1310 | 1310 |
| 197 | 1165 | 1175 | 1190 | 1260 | 1265 | 1320 | 1350 | | | | | 322 | 1365 | 1340 | 1352.5 |
| 198 | 1155 | 1150 | 1210 | 1260 | 1280 | 1280 | 1345 | | | | | 322 | 1385 | 1370 | 1377.5 |
| 199 | 985 | 1030 | 1075 | 1120 | 1155 | 1195 | 1230 | 1277 | 1270 | 1305 | 1320 | 377 | 1365 | 1350 | 1357.5 |
| 201 | | | | | | | | | | | | | | | |
| 203 | | | | | | | | | | | | | | | |
| 205 | 1035 | 1035 | 1095 | 1125 | 1155 | 1205 | 1215 | 1260 | 1270 | | | 350 | 1295 | 1300 | 1297.5 |
| 206 | | | | | | | | | | | | | | | |
| 208 | | | | | | | | | | | | | | | |
| 210 | | | | | | | | | | | | | | | |
| 211 | | | | | | | | | | | | | | | |
| 212 | 920 | 960 | 970 | 1015 | 1060 | 1095 | 1120 | 1135 | 1160 | 1205 | | 364 | 1215 | 1225 | 1220 |
| 213 | | | | | | | | | | | | | | | |
| 215 | 1040 | 1075 | 1100 | 1155 | 1180 | 1245 | 1255 | | | | | 322 | 1285 | 1260 | 1272.5 |
| 216 | 1105 | 1130 | 1200 | 1190 | 1225 | 1285 | 1300 | | | | | | | | |
| 217 | 1160 | 1175 | 1210 | 1250 | 1250 | 1330 | 1340 | | | | | 322 | 1340 | 1315 | 1327.5 |
| 218 | 1090 | 1075 | 1110 | 1160 | 1195 | 1235 | 1265 | 1270 | 1275 | | | 350 | 1275 | 1245 | 1260 |
| 221 | 1030 | 1065 | 1110 | 1170 | 1200 | 1225 | 1290 | 1310 | 1335 | 1390 | 1400 | 377 | 1470 | 1450 | 1460 |
| 222 | 1110 | 1155 | 1130 | 1180 | 1185 | 1250 | 1265 | | | | | 322 | 1295 | 1280 | 1287.5 |
| 225 | 1280 | 1325 | 1350 | 1395 | 1410 | 1460 | 1505 | | | | | 322 | 1515 | 1480 | 1497.5 |
| 227 | | | | | | | | | | | | | | | |

Table A-3. (cont'd)

| Steer no. | 12/06/91 Day 224 wt., lb | 12/20/91 Day 238 wt., lb | 01/03/92 Day 252 wt., lb | 01/17/92 Day 266 wt., lb | 01/31/92 Day 280 wt., lb | 02/14/92 Day 294 wt., lb | 02/28/92 Day 308 wt., lb | 03/13/92 Day 322 wt., lb | 03/27/92 Day 336 wt., lb | 04/10/92 Day 350 wt., lb | 04/24/92 Day 364 wt., lb | Days on Trial | Final wt., lb | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | #1 | #2 | Avg. |
| 228 | 1150 | 1185 | 1230 | 1325 | 1355 | 1405 | 1435 | 1485 | 1490 | | | 350 | 1505 | 1500 | 1502.5 |
| 231 | | | | | | | | | | | | | | | |
| 232 | 1045 | 1045 | 1080 | 1125 | 1125 | 1180 | 1170 | | | | | 322 | 1215 | 1210 | 1212.5 |
| 234 | 955 | 1005 | 1040 | 1075 | 1105 | 1160 | 1175 | 1230 | 1280 | 1315 | 1335 | 377 | 1370 | 1340 | 1355 |
| 236 | 1075 | 1090 | 1120 | 1160 | 1200 | 1225 | 1270 | 1305 | 1305 | 1325 | | 364 | 1370 | 1345 | 1357.5 |
| 237 | 975 | 1020 | 1030 | 1050 | | | | | | | | | | | |
| 238 | 1150 | 1195 | 1225 | 1280 | 1315 | 1360 | 1380 | | | | | 322 | 1405 | 1365 | 1385 |
| 239 | 980 | 1030 | 1035 | 1100 | 1120 | 1160 | 1175 | 1210 | 1235 | 1230 | | 364 | 1245 | 1230 | 1237.5 |
| 241 | 1130 | 1130 | 1155 | 1215 | 1250 | 1285 | 1320 | | | | | 322 | 1345 | 1315 | 1330 |
| 243 | 1135 | 1170 | 1215 | 1260 | 1325 | 1360 | 1410 | 1440 | 1445 | | | 350 | 1480 | 1470 | 1475 |

## Table A-4a. Weekly pen dry matter intake for pens 1 to 4 for Experiment BC9002

| Period | Pen 1 | | | | | Pen 2 | | | | | Pen 3 | | | | | Pen 4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of steers | Corn, lb | Pellet, lb | WB, lb[a] | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb |
| day 1 to 7 | 10.0 | 684 | 104 | 80.0 | 9.78 | 10.0 | 685 | 105 | 81.4 | 9.80 | 10.0 | 685 | 105 | 83.2 | 9.80 | 10.0 | 739 | 113 | 60.7 | 10.62 |
| day 8 to 14 | 10.0 | 749 | 114 | NR[b] | ND[c] | 10.0 | 685 | 105 | NR | ND | 10.0 | 673 | 103 | NR | ND | 10.0 | 738 | 113 | NR | ND |
| day 15 to 21 | 10.0 | 717 | 110 | 109.4 | 10.22 | 10.0 | 803 | 123 | 131.8 | 11.42 | 10.0 | 803 | 123 | 128.7 | 11.43 | 10.0 | 760 | 117 | 157.3 | 10.76 |
| day 22 to 28 | 10.0 | 803 | 123 | 101.5 | 11.48 | 10.0 | 901 | 139 | 94.6 | 12.92 | 10.0 | 857 | 132 | 72.4 | 12.32 | 10.0 | 802 | 123 | 50.5 | 11.55 |
| day 29 to 35 | 9.1 | 856 | 111 | 123.6 | 13.10 | 10.0 | 834 | 110 | 58.5 | 11.78 | 10.0 | 834 | 109 | 154.9 | 11.63 | 10.0 | 922 | 110 | 135.9 | 12.79 |
| day 36 to 42 | 9.0 | 945 | 109 | 28.0 | 14.68 | 10.0 | 990 | 113 | 0 | 13.87 | 10.0 | 924 | 105 | 0 | 12.94 | 10.0 | 1012 | 116 | 16 | 14.16 |
| day 43 to 49 | 9.0 | 900 | 103 | 69.8 | 13.91 | 10.0 | 1004 | 122.2 | 62.6 | 14.07 | 10.0 | 1035 | 119 | 26.2 | 14.47 | 10.0 | 1136 | 117.2 | 21.3 | 15.73 |
| day 50 to 56 | 9.0 | 901 | 102 | 1.0 | 14.01 | 10.0 | 967 | 111 | 1.5 | 13.55 | 10.0 | 944 | 108 | 15.4 | 13.21 | 10.0 | 862 | 98.8 | 15.9 | 12.06 |
| day 57 to 63 | 9.0 | 897 | 101 | 5.0 | 13.93 | 10.0 | 1052 | 116 | 3.9 | 14.68 | 10.0 | 1031 | 113 | 19.4 | 14.36 | 10.0 | 964 | 108.5 | 3.1 | 13.48 |
| day 64 to 70 | 9.0 | 1056 | 115 | 45.0 | 16.29 | 10.0 | 1191 | 128 | 41 | 16.53 | 10.0 | 1146 | 123 | 37 | 15.91 | 10.0 | 1124 | 121 | 62 | 15.57 |
| day 71 to 77 | 9.0 | 921 | 101 | 32.1 | 14.23 | 10.0 | 1056 | 113 | 16.7 | 14.67 | 10.0 | 1056 | 113 | 2.3 | 14.69 | 9.0 | 921 | 99 | 49.7 | 14.18 |
| day 78 to 84 | 9.0 | 1168 | 126 | 90.9 | 17.95 | 10.0 | 1260 | 133 | 79.1 | 17.41 | 10.0 | 1191 | 127 | 61.3 | 16.49 | 9.0 | 1214 | 129 | 41.4 | 18.70 |
| day 85 to 91 | 9.0 | 933 | 86 | 24.7 | 14.20 | 9.3 | 1045 | 98 | 79.6 | 15.37 | 10.0 | 1052 | 97 | 23.9 | 14.41 | 9.0 | 999 | 94 | 8.5 | 15.25 |
| day 92 to 98 | 9.0 | 1120 | 98 | 42.1 | 16.96 | 9.0 | 1166 | 102 | 44.3 | 17.65 | 10.0 | 1189 | 104 | 2.7 | 16.24 | 9.0 | 1166 | 102 | 23.1 | 17.68 |
| day 99 to 105 | 9.0 | 1074 | 94 | 88.4 | 16.20 | 9.0 | 982 | 86 | 1.3 | 14.91 | 10.0 | 1166 | 102 | 0.9 | 15.93 | 9.0 | 1120 | 98 | 33.2 | 16.97 |
| day 106 to 112 | 9.0 | 1212 | 106 | 165.3 | 18.21 | 9.0 | 1189 | 104 | 110.1 | 17.92 | 10.0 | 1281 | 112 | 140 | 17.36 | 9.0 | 1212 | 106 | 157.1 | 18.22 |
| day 113 to 119 | 9.0 | 1182 | 98 | 214.6 | 17.63 | 9.0 | 1104 | 90 | 49.8 | 16.61 | 10.0 | 1159 | 96 | 121.4 | 15.65 | 9.0 | 1136 | 94 | 134.2 | 17.02 |
| day 120 to 126 | 9.0 | 1093 | 84 | 181.6 | 16.24 | 9.0 | 1093 | 84 | 93.8 | 16.33 | 10.0 | 1093 | 84 | 82.1 | 14.71 | 9.0 | 1093 | 84 | 100.8 | 16.32 |
| day 127 to 133 | 9.0 | 1217 | 97 | 52.0 | 18.29 | 9.0 | 1217 | 97 | 51 | 18.29 | 10.0 | 1256 | 98 | 69 | 16.94 | 9.0 | 932 | 75 | 0 | 14.05 |
| day 134 to 140 | 9.0 | 1185 | 93 | 45.2 | 17.79 | 9.0 | 1162 | 92 | 25 | 17.48 | 10.0 | 1208 | 96 | 13.4 | 16.37 | 9.0 | 1208 | 96 | 84.8 | 18.11 |
| day 141 to 147 | 9.0 | 1223 | 91 | 46.5 | 18.29 | 9.0 | 1157 | 87 | 62.5 | 17.30 | 10.0 | 1087 | 82 | 2 | 14.68 | 9.0 | 1064 | 80 | 74 | 15.89 |
| day 148 to 154 | 9.0 | 1043 | 78 | 0.0 | 15.64 | 9.0 | 1043 | 78 | 0 | 15.64 | 10.0 | 1206 | 90 | 1 | 16.28 | 9.0 | 1041 | 77 | 0 | 15.60 |
| day 155 to 161 | 9.0 | 1167 | 88 | 0.0 | 17.52 | 9.0 | 1321 | 99 | 6.5 | 19.81 | 10.0 | 1414 | 106 | 87.9 | 19.02 | 9.0 | 1191 | 90 | 93.3 | 17.78 |
| day 162 to 168 | 9.0 | 1112 | 83 | 26.6 | 16.65 | 9.0 | 1111 | 82 | 4.9 | 16.64 | 10.0 | 1113 | 83 | 0 | 15.02 | 9.0 | 1160 | 89 | 13.8 | 17.42 |

Table A-4a -(cont'd)

| Period | Pen 1 | | | | | Pen 2 | | | | | Pen 3 | | | | | Pen 4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb |
| day 169 to 175 | 9.0 | 1129 | 74 | 23.4 | 16.76 | 9.0 | 1129 | 74 | 10 | 16.78 | 10.0 | 1107 | 73 | 20.9 | 14.80 | 9.0 | 1106 | 72 | 49.6 | 16.39 |
| day 176 to 182 | 9.0 | 1194 | 76 | 80.6 | 17.65 | 9.0 | 1285 | 82 | 93.2 | 18.99 | 10.0 | 1227 | 78 | 54.9 | 16.34 | 9.0 | 1071 | 68.2 | 74.2 | 15.83 |
| day 183 to 189 | 9.0 | 1077 | 69 | 0.0 | 15.99 | 9.0 | 1147 | 73 | 2.4 | 17.02 | 10.0 | 1216 | 77.5 | 0 | 16.24 | 8.1 | 1029 | 66.5 | 12.3 | 16.88 |
| day 190 to 196 | 9.0 | 1124 | 73 | 113.3 | 16.60 | 9.0 | 1112 | 69.5 | 61.5 | 16.43 | 10.0 | 1172 | 74 | 183.2 | 15.50 | 8.0 | 1041 | 65.5 | 83.3 | 17.29 |
| day 197 to 203 | 7.3 | 1090 | 71 | 30.0 | 19.98 | 7.9 | 929 | 60 | 20 | 15.78 | 8.9 | 1029 | 66 | 13 | 15.51 | 6.9 | 913 | 59 | 97 | 17.68 |
| day 204 to 210 | 6.0 | 821 | 50 | 46.5 | 18.16 | 7.0 | 1013 | 63 | 38.5 | 19.26 | 8.0 | 1013 | 63 | 46.5 | 16.84 | 6.0 | 989 | 61 | 34.5 | 21.93 |
| day 211 to 217 | 6.0 | 924 | 55 | 61.5 | 20.41 | 7.0 | 1162 | 69 | 86.5 | 21.99 | 8.0 | 1030 | 61.5 | 75 | 17.06 | 6.0 | 841 | 49.5 | 0 | 18.63 |
| day 218 to 224 | 6.0 | 912 | 55 | 15.5 | 20.21 | 7.0 | 1089 | 64 | 0 | 20.68 | 8.0 | 973 | 59 | 26 | 16.17 | 6.0 | 995 | 59 | 62.5 | 21.98 |
| day 225 to 231 | 6.0 | 822 | 49 | 6.0 | 18.21 | 7.0 | 932 | 55.5 | 8.5 | 17.70 | 8.0 | 837 | 50.5 | 0 | 13.92 | 6.0 | 884 | 53.5 | 11 | 19.60 |
| day 232 to 238 | 6.0 | 767 | 45.5 | 0.0 | 16.99 | 7.0 | 795 | 47 | 0.5 | 15.10 | 8.0 | 1100 | 65 | 32 | 18.25 | 6.0 | 889 | 52 | 0 | 19.69 |
| day 239 to 245 | 6.0 | 790 | 47 | 60.0 | 17.44 | 7.0 | 920 | 54 | 0 | 17.47 | 8.0 | 965 | 58.5 | 4 | 16.06 | 6.0 | 814 | 49 | 0 | 18.05 |
| day 246 to 252 | 6.0 | 883 | 53 | 0.0 | 19.58 | 7.0 | 962 | 57 | 16 | 18.26 | 8.0 | 1024 | 61 | 24 | 17.00 | 6.0 | 883 | 52 | 0 | 19.56 |
| day 253 to 259 | 6.0 | 939 | 57 | 33.5 | 20.80 | 7.0 | 1019 | 61 | 9.5 | 19.36 | 8.0 | 1009 | 60 | 18.5 | 16.76 | 6.0 | 997 | 59 | 82 | 21.99 |
| day 260 to 266 | 6.0 | 879 | 55 | 50.0 | 19.48 | 7.0 | 1022 | 61 | 0 | 19.42 | 8.0 | 1072 | 64 | 3.3 | 17.82 | 6.0 | 961 | 58 | 47.2 | 21.26 |
| day 267 to 273 | 6.0 | 851 | 51 | 0.0 | 18.87 | 7.0 | 1044 | 63.5 | 2.5 | 19.86 | 8.0 | 1023 | 60 | 3.5 | 16.99 | 6.0 | 1000 | 61 | 2 | 22.20 |
| day 274 to 280 | 6.0 | 997 | 60 | 117.5 | 21.97 | 7.0 | 1119 | 68 | 43 | 21.24 | 8.0 | 1119 | 68 | 66 | 18.57 | 6.0 | 997 | 60 | 28 | 22.08 |
| day 281 to 287 | 6.0 | 768 | 48.5 | 3.5 | 17.08 | 7.0 | 1013 | 65.5 | 19.7 | 19.32 | 8.0 | 780 | 49.5 | 0 | 13.01 | 6.0 | 780 | 49.5 | 0 | 17.35 |
| day 288 to 294 | 6.0 | 969 | 62.5 | 55.0 | 21.51 | 7.0 | 1111 | 71.5 | 47.5 | 21.16 | 8.0 | 1125 | 72 | 17.5 | 18.77 | 6.0 | 1029 | 66 | 10.5 | 22.90 |
| day 295 to 301 | 6.0 | 814 | 49.5 | 0.0 | 18.06 | 7.0 | 1056 | 66.5 | 0 | 20.13 | 8.0 | 910 | 56.5 | 0 | 15.17 | 6.0 | 814 | 49.5 | 0 | 18.06 |
| day 302 to 308 | 6.0 | 947 | 60.3 | 53.0 | 21.01 | 7.0 | 1043 | 57.5 | 7 | 19.73 | 8.0 | 1067 | 69.5 | 0 | 17.84 | 6.0 | 1113 | 72 | 111 | 24.65 |
| day 309 to 315 | 6.0 | 823 | 51.8 | 44.3 | 18.24 | 6.7 | 998 | 63 | 49.5 | 19.78 | 8.0 | 998 | 63 | 6.5 | 16.64 | 6.0 | 870 | 55.5 | 10.5 | 19.35 |
| day 316 to 322 | 6.0 | 971 | 63 | 47.5 | 21.57 | 6.0 | 949 | 60 | 1.5 | 21.11 | 8.0 | 1161 | 73 | 16 | 19.35 | 6.0 | 983 | 63 | 39 | 21.84 |
| day 323 to 329 | 6.0 | 922 | 58 | 55.0 | 20.43 | 6.0 | 987 | 62 | 97 | 21.83 | 8.0 | 1086 | 69 | 92 | 18.04 | 6.0 | 865 | 54 | 0 | 19.23 |
| day 330 to 336 | 6.0 | 901 | 57 | 103.7 | 19.91 | 6.0 | 942 | 60 | 74 | 20.87 | 8.0 | 1030 | 66 | 91.5 | 17.11 | 6.0 | 901 | 57 | 76.2 | 19.95 |
| day 337 to 343 | 6.0 | 765 | 51 | 58.0 | 16.99 | 6.0 | 818 | 55 | 26 | 18.23 | 8.0 | 933 | 63 | 0 | 15.63 | 6.0 | 818 | 55 | 64 | 18.18 |

Table A-4a -(cont'd)

| Period | Pen 1 | | | | | Pen 2 | | | | | Pen 3 | | | | | Pen 4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb |
| day 344 to 350 | 6.0 | 745 | 52 | 0.0 | 16.67 | 6.0 | 745 | 52 | 0 | 16.67 | 8.0 | 1234 | 84 | 79.7 | 20.61 | 6.0 | 739 | 53 | 0 | 16.57 |

[a]Weigh-back.

[b]Not recorded.

[c]Not determined, missing weighback, the average of the two adjacent weeks was used as the DMI for this week.

Table A-4b. Weekly pen dry matter intake for pens 5 to 8 for Experiment BC9002

| Period | Pen 5 | | | | | Pen 6 | | | | | Pen 7 | | | | | Pen 8 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of steers | Corn, lb | Pellet, lb | WB, lb[a] | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb |
| day 1 to 7 | 10.0 | 642 | 97 | 93.8 | 9.14 | 10.0 | 684 | 104 | 112.8 | 9.72 | 10.0 | 771 | 119 | 145.2 | 10.95 | 10.0 | 695 | 108 | 93.8 | 9.94 |
| day 8 to 14 | 10.0 | 716 | 110 | NR[b] | ND[c] | 10.0 | 705 | 107 | NR | ND | 10.0 | 673 | 106 | NR | ND | 10.0 | 704 | 106 | NR | ND |
| day 15 to 21 | 10.0 | 695 | 107 | 134.3 | 9.86 | 10.0 | 716 | 109 | 141.4 | 10.14 | 10.0 | 717 | 110 | 120.3 | 10.20 | 10.0 | 825 | 127 | 240.3 | 11.56 |
| day 22 to 28 | 10.0 | 706 | 108 | 4 | 10.23 | 10.0 | 683 | 108 | 33.3 | 9.89 | 10.0 | 705 | 111 | 0 | 10.27 | 10.0 | 641 | 97 | 0 | 9.28 |
| day 29 to 35 | 10.0 | 790 | 103 | 118.4 | 11.05 | 9.1 | 749 | 86 | 46.8 | 11.41 | 10.0 | 790 | 103 | 20 | 11.20 | 9.1 | 790 | 103 | 95.1 | 12.13 |
| day 36 to 42 | 10.0 | 721 | 83 | 0 | 10.11 | 9.0 | 766 | 88 | 23 | 11.89 | 10.0 | 924 | 107 | 8 | 12.95 | 9.0 | 878 | 101 | 0 | 13.67 |
| day 43 to 49 | 10.0 | 900 | 103 | 65.4 | 12.52 | 9.0 | 855 | 98 | 7.8 | 13.30 | 10.0 | 990 | 114 | 37.4 | 13.83 | 9.0 | 923 | 107 | 6.2 | 14.38 |
| day 50 to 56 | 10.0 | 944 | 108 | 12.1 | 13.21 | 9.0 | 832 | 95 | 38.7 | 12.89 | 10.0 | 856 | 98 | 0 | 11.99 | 9.0 | 856 | 97 | 15.2 | 13.29 |
| day 57 to 63 | 9.1 | 784 | 88 | 2.9 | 11.98 | 9.0 | 851 | 94 | 2.9 | 13.19 | 10.0 | 941 | 105 | 5.4 | 13.14 | 9.0 | 783 | 86 | 0 | 12.14 |
| day 64 to 70 | 9.0 | 1012 | 109 | 71 | 15.56 | 9.0 | 1034 | 111 | 59 | 15.91 | 10.0 | 1146 | 123 | 20 | 15.93 | 9.0 | 1033 | 112 | 38 | 15.94 |
| day 71 to 77 | 9.0 | 831 | 89 | 46.5 | 12.78 | 9.0 | 853 | 93 | 24.1 | 13.18 | 10.0 | 967 | 107 | 4.7 | 13.49 | 9.0 | 966 | 106 | 19.4 | 14.95 |
| day 78 to 84 | 9.0 | 989 | 107 | 6 | 15.30 | 9.0 | 1078 | 116 | 57.6 | 16.60 | 10.0 | 1146 | 123 | 60.7 | 15.88 | 9.0 | 1054 | 114 | 19.3 | 16.29 |
| day 85 to 91 | 9.0 | 899 | 83 | 33.8 | 13.67 | 9.0 | 955 | 89 | 25.8 | 14.54 | 10.0 | 1024 | 95 | 18.9 | 14.04 | 9.0 | 953 | 90 | 1.9 | 14.56 |
| day 92 to 98 | 9.0 | 1005 | 88 | 1.6 | 15.26 | 9.0 | 1097 | 96 | 3.1 | 16.65 | 10.0 | 1143 | 100 | 49.4 | 15.57 | 9.0 | 1051 | 92 | 3.3 | 15.95 |
| day 99 to 105 | 9.0 | 1051 | 92 | 38.1 | 15.91 | 9.0 | 1120 | 98 | 61.7 | 16.93 | 10.0 | 1143 | 100 | 28.2 | 15.59 | 9.0 | 1051 | 92 | 18.1 | 15.94 |
| day 106 to 112 | 9.0 | 1235 | 108 | 161.2 | 18.56 | 9.0 | 1189 | 104 | 229.4 | 17.79 | 10.0 | 1258 | 109 | 128.2 | 17.04 | 9.0 | 1166 | 102 | 111.6 | 17.57 |
| day 113 to 119 | 9.0 | 1159 | 96 | 32.5 | 17.48 | 9.0 | 1113 | 92 | 34 | 16.78 | 10.0 | 1159 | 96 | 27.5 | 15.74 | 9.0 | 1127 | 92 | 16 | 17.00 |
| day 120 to 126 | 9.0 | 955 | 74 | 118.6 | 14.24 | 9.0 | 1001 | 78 | 76.7 | 14.98 | 10.0 | 955 | 74 | 16.3 | 12.91 | 9.0 | 1001 | 78 | 37.9 | 15.02 |
| day 127 to 133 | 9.0 | 987 | 77 | 26 | 14.82 | 9.0 | 1139 | 90 | 77 | 17.07 | 10.0 | 1116 | 88 | 53 | 15.07 | 9.0 | 1033 | 81 | 97 | 15.45 |
| day 134 to 140 | 9.0 | 1024 | 81 | 21.2 | 15.40 | 9.0 | 1070 | 84 | 13.8 | 16.09 | 10.0 | 1024 | 81 | 2.1 | 13.88 | 9.0 | 909 | 72 | 0 | 13.69 |
| day 141 to 147 | 9.0 | 899 | 68 | 21 | 13.47 | 9.0 | 970 | 74 | 0.5 | 14.57 | 10.0 | 1131 | 85 | 21.5 | 15.25 | 9.0 | 1038 | 79 | 85 | 15.50 |
| day 148 to 154 | 9.0 | 1065 | 80 | 22.8 | 15.96 | 9.0 | 1135 | 85 | 34.8 | 16.99 | 10.0 | 1136 | 86 | 11.3 | 15.34 | 9.0 | 1136 | 86 | 23 | 17.03 |
| day 155 to 161 | 9.0 | 911 | 69 | 3.2 | 13.67 | 9.0 | 934 | 70 | 0 | 14.01 | 10.0 | 1122 | 85 | 17.2 | 15.14 | 9.0 | 1130 | 85 | 0 | 16.96 |
| day 162 to 168 | 9.0 | 971 | 73 | 2.2 | 14.57 | 9.0 | 1114 | 83 | 2.6 | 16.70 | 10.0 | 1068 | 81 | 5.6 | 14.43 | 9.0 | 1068 | 81 | 0 | 16.03 |
| day 169 to 175 | 9.0 | 990 | 64 | 3.1 | 14.70 | 9.0 | 1247 | 81 | 69.7 | 18.47 | 10.0 | 1014 | 66 | 2.2 | 13.56 | 9.0 | 1086 | 70.5 | 7 | 16.13 |

Table A-4b. (cont'd)

| Period | Pen 5 | | | | | Pen 6 | | | | | Pen 7 | | | | | Pen 8 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb |
| day 176 to 182 | 8.0 | 983 | 63 | 60.7 | 16.36 | 9.0 | 1232 | 79.7 | 58.1 | 18.25 | 10.0 | 1006 | 65 | 87.6 | 13.38 | 9.0 | 1157 | 73 | 92 | 17.08 |
| day 183 to 189 | 8.0 | 937 | 60 | 23.5 | 15.62 | 9.0 | 1120 | 72.25 | 15.5 | 16.62 | 10.0 | 1123 | 71.5 | 14.5 | 14.99 | 9.0 | 1054 | 67 | 20.4 | 15.62 |
| day 190 to 196 | 8.0 | 892 | 56 | 48.4 | 14.83 | 9.0 | 1147 | 74.5 | 151.1 | 16.91 | 10.0 | 1215 | 79 | 118.2 | 16.16 | 9.0 | 986 | 64.5 | 67.4 | 14.60 |
| day 197 to 203 | 6.9 | 913 | 59 | 121 | 17.66 | 7.3 | 960 | 62 | 62.5 | 17.54 | 8.9 | 1121 | 72 | 0 | 16.91 | 7.9 | 868 | 55 | 14.5 | 14.73 |
| day 204 to 210 | 6.0 | 749 | 46 | 35 | 16.59 | 6.0 | 751 | 46 | 17.5 | 16.65 | 8.0 | 1174 | 70 | 66 | 19.46 | 6.9 | 810 | 49 | 101 | 15.61 |
| day 211 to 217 | 6.0 | 686 | 42 | 0 | 15.23 | 6.0 | 841 | 50 | 26 | 18.61 | 8.0 | 984 | 60 | 0 | 16.38 | 6.0 | 634 | 37.5 | 66.5 | 13.96 |
| day 218 to 224 | 6.0 | 782 | 47 | 42.5 | 17.29 | 6.0 | 758 | 45 | 0 | 16.80 | 8.0 | 1162 | 68 | 0 | 19.30 | 6.0 | 697 | 42 | 0 | 15.46 |
| day 225 to 231 | 6.0 | 744 | 44.5 | 5.5 | 16.49 | 6.0 | 859 | 49.5 | 6 | 19.00 | 8.0 | 1100 | 65 | 1 | 18.28 | 6.0 | 730 | 43 | 6.5 | 16.16 |
| day 232 to 238 | 6.0 | 747 | 44 | 0 | 16.54 | 6.0 | 889 | 52 | 5.5 | 19.68 | 8.0 | 1093 | 65 | 0 | 18.17 | 6.0 | 717 | 42 | 0 | 15.87 |
| day 239 to 245 | 6.0 | 712 | 41 | 5 | 15.74 | 6.0 | 723 | 42 | 2 | 16.00 | 8.0 | 1016 | 60 | 0 | 16.88 | 6.0 | 587 | 33 | 0 | 12.96 |
| day 246 to 252 | 6.0 | 714 | 41.5 | 0 | 15.80 | 6.0 | 714 | 41.5 | 6 | 15.79 | 8.0 | 993 | 59 | 7 | 16.50 | 6.0 | 750 | 44 | 2 | 16.60 |
| day 253 to 259 | 6.0 | 765 | 47 | 8.5 | 16.97 | 6.0 | 916 | 56 | 58 | 20.26 | 8.0 | 1009 | 60 | 2 | 16.77 | 6.0 | 755 | 47 | 2 | 16.77 |
| day 260 to 266 | 6.0 | 863 | 53 | 29 | 19.13 | 6.0 | 923 | 56 | 80 | 20.38 | 8.0 | 1118 | 66 | 4.2 | 18.58 | 6.0 | 863 | 53 | 57 | 19.09 |
| day 267 to 273 | 6.0 | 805 | 49 | 0 | 17.86 | 6.0 | 873 | 53 | 16 | 19.35 | 8.0 | 1185 | 70 | 3 | 19.69 | 6.0 | 825 | 49.5 | 16.5 | 18.27 |
| day 274 to 280 | 6.0 | 863 | 52.5 | 34.5 | 19.11 | 6.0 | 1001 | 61 | 63.5 | 22.14 | 8.0 | 1190 | 71 | 64.5 | 19.73 | 6.0 | 828 | 52 | 11 | 18.40 |
| day 281 to 287 | 6.0 | 627 | 39.5 | 0 | 13.94 | 6.0 | 929 | 58.5 | 20.7 | 20.63 | 8.0 | 1001 | 64.5 | 0 | 16.72 | 6.0 | 815 | 52 | 0 | 18.14 |
| day 288 to 294 | 6.0 | 826 | 53.5 | 0 | 18.40 | 6.0 | 909 | 59 | 0 | 20.25 | 8.0 | 1065 | 69 | 5 | 17.79 | 6.0 | 874 | 56.5 | 52 | 19.40 |
| day 295 to 301 | 6.0 | 814 | 49.5 | 14.5 | 18.05 | 6.0 | 777 | 49.5 | 0 | 17.29 | 7.4 | 945 | 60.5 | 12.5 | 16.98 | 6.0 | 777 | 49.5 | 4.75 | 17.28 |
| day 302 to 308 | 6.0 | 767 | 48.5 | 5 | 17.05 | 6.0 | 957 | 60.5 | 69 | 21.20 | 7.0 | 980 | 63 | 0 | 18.71 | 6.0 | 957 | 61.5 | 71 | 21.22 |
| day 309 to 315 | 6.0 | 919 | 57.5 | 82 | 20.33 | 6.0 | 854 | 54.5 | 30 | 18.97 | 7.0 | 991 | 62 | 40.5 | 18.84 | 6.0 | 801 | 50.5 | 13.75 | 17.80 |
| day 316 to 322 | 6.0 | 907 | 59 | 44.5 | 20.15 | 6.0 | 830 | 54 | 4 | 18.49 | 7.0 | 1103 | 69 | 83 | 20.93 | 6.0 | 889 | 58 | 44 | 19.76 |
| day 323 to 329 | 6.0 | 821 | 52 | 1 | 18.26 | 6.0 | 862 | 55 | 7 | 19.18 | 7.0 | 943 | 60 | 35 | 17.95 | 6.0 | 904 | 57 | 76 | 20.01 |
| day 330 to 336 | 6.0 | 813 | 51 | 0 | 18.07 | 6.0 | 899 | 57 | 7.2 | 19.99 | 7.0 | 1143 | 72 | 106 | 21.68 | 6.0 | 805 | 50 | 0 | 17.89 |
| day 337 to 343 | 6.0 | 724 | 49 | 9.2 | 16.16 | 6.0 | 795 | 53 | 5.8 | 17.73 | 7.0 | 885 | 59 | 5.6 | 16.92 | 5.3 | 794 | 54 | 140.1 | 19.92 |
| day 344 to 350 | 6.0 | 705 | 48 | 5.1 | 15.75 | 6.0 | 721 | 50 | 3 | 16.13 | 7.0 | 836 | 57 | 2 | 16.01 | 5.0 | 697 | 48 | 38.2 | 18.64 |

Table A-4b. (cont'd)

| Period | Pen 5 | | | | | Pen 6 | | | | | Pen 7 | | | | | Pen 8 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb |
| day 351 to 357 | 6.0 | 884 | 60 | 66 | 19.66 | 6.0 | 837 | 58 | 90 | 18.60 | 7.0 | 977 | 66 | 49 | 18.65 | 5.0 | 705 | 48 | 71 | 18.79 |
| day 358 to 364 | 6.0 | 822 | 55 | 0.94 | 18.35 | 6.0 | 822 | 55 | 8.6 | 18.34 | 7.0 | 885 | 60 | 4 | 16.94 | 5.0 | 729 | 50 | 38.6 | 19.49 |

[a]Weighback.

[b]Not recorded.

[c]Not determined, missing weighback, the average of the two adjacent weeks was used as the DMI for this week.

Table A-4c. Weekly pen dry matter intake for pens 9 to 12 for Experiment BC9002

| Period | Pen 9 | | | | | Pen10 | | | | | Pen 11 | | | | | Pen 12 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of steers | Corn, lb | Pellet, lb | WB, lb[a] | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb |
| day 1 to 7 | 10.0 | 647 | 99.0 | 134.8 | 9.15 | 10.0 | 640 | 97.0 | 90.2 | 9.12 | 10.0 | 673 | 102.0 | 87.1 | 9.60 | 10.0 | 598 | 91.0 | 114.0 | 8.47 |
| day 8 to 14 | 10.0 | 674 | 102.0 | 15.1[b] | ND[c] | 10.0 | 640 | 97.0 | NR[d] | ND | 10.0 | 549.5 | 84.5 | NR | ND | 10.0 | 597 | 91.0 | NR | ND |
| day 15 to 21 | 10.0 | 587 | 90.0 | 96.3 | 8.35 | 10.0 | 673 | 103.0 | 133.7 | 9.53 | 10.0 | 630 | 97.0 | 96.7 | 8.98 | 10.0 | 651 | 100.0 | 82.8 | 9.30 |
| day 22 to 28 | 10.0 | 640 | 97.0 | 39.5 | 9.20 | 10.0 | 662 | 101.0 | 9.7 | 9.58 | 10.0 | 749 | 115.0 | 110.1 | 10.68 | 10.0 | 663 | 102.0 | 83.0 | 9.48 |
| day 29 to 35 | 9.1 | 724 | 95.0 | 102.3 | 11.10 | 10.0 | 790 | 103.0 | 73.0 | 11.12 | 10.0 | 790 | 103.0 | 86.7 | 11.10 | 10.0 | 790 | 103.0 | 140.2 | 11.02 |
| day 36 to 42 | 9.0 | 766 | 87.0 | 8.0 | 11.90 | 10.0 | 811 | 94.0 | 0.0 | 11.38 | 10.0 | 924 | 107.0 | 49.0 | 12.90 | 10.0 | 767 | 88.0 | 0.0 | 10.75 |
| day 43 to 49 | 9.0 | 811 | 93.0 | 14.3 | 12.60 | 10.0 | 923 | 105.0 | 27.2 | 12.89 | 9.4 | 788 | 89.0 | 3.8 | 11.69 | 10.0 | 878 | 101.0 | 45.6 | 12.25 |
| day 50 to 56 | 9.0 | 720 | 83.0 | 0.0 | 11.21 | 10.0 | 900 | 104.0 | 37.0 | 12.57 | 9.0 | 788 | 89.0 | 38.9 | 12.19 | 10.0 | 834 | 95.0 | 12.3 | 11.66 |
| day 57 to 63 | 9.0 | 738 | 81.0 | 51.2 | 11.36 | 10.0 | 919 | 103.0 | 27.1 | 12.81 | 9.0 | 739 | 82.0 | 0.0 | 11.46 | 10.0 | 940 | 103.0 | 51.9 | 13.04 |
| day 64 to 70 | 9.0 | 875 | 95.0 | 5.0 | 13.54 | 10.0 | 1011 | 111.0 | 13.0 | 14.09 | 9.0 | 898 | 98.0 | 44.0 | 13.85 | 10.0 | 875 | 95.0 | 0.5 | 12.19 |
| day 71 to 77 | 9.0 | 876 | 96.0 | 20.4 | 13.55 | 10.0 | 966 | 106.0 | 21.0 | 13.45 | 9.0 | 808 | 87.0 | 58.7 | 12.42 | 10.0 | 987 | 107.0 | 19.8 | 13.73 |
| day 78 to 84 | 9.0 | 988 | 106.0 | 40.0 | 15.22 | 10.0 | 1169 | 125.0 | 66.1 | 16.18 | 9.0 | 898 | 98.0 | 0.9 | 13.91 | 10.0 | 1033 | 111.0 | 4.0 | 14.38 |
| day 85 to 91 | 9.0 | 962 | 87.0 | 42.6 | 14.59 | 10.0 | 1001 | 94.0 | 34.2 | 13.72 | 9.0 | 942 | 89.0 | 27.6 | 14.36 | 10.0 | 955 | 89.0 | 28.8 | 13.09 |
| day 92 to 98 | 9.0 | 982 | 86.0 | 13.2 | 14.89 | 10.0 | 1051 | 92.0 | 2.6 | 14.36 | 9.0 | 936 | 82.0 | 1.9 | 14.21 | 10.0 | 1005 | 88.0 | 36.2 | 13.69 |
| day 99 to 105 | 9.0 | 1005 | 88.0 | 45.3 | 15.21 | 10.0 | 1212 | 106.0 | 52.1 | 16.51 | 9.0 | 913 | 80.0 | 31.4 | 13.82 | 10.0 | 959 | 84.0 | 30.8 | 13.07 |
| day 106 to 112 | 9.0 | 1143 | 100.0 | 105.4 | 17.23 | 10.0 | 1166 | 102.0 | 94.8 | 15.83 | 9.0 | 1074 | 94.0 | 125.6 | 16.16 | 10.0 | 1120 | 98.0 | 121.1 | 15.18 |
| day 113 to 119 | 9.0 | 1067 | 88.0 | 23.0 | 16.10 | 10.0 | 1113 | 92.0 | 37.0 | 15.10 | 9.0 | 975 | 80.0 | 23.0 | 14.70 | 10.0 | 1090 | 90.0 | 91.0 | 14.73 |
| day 120 to 126 | 9.0 | 863 | 70.0 | 35.3 | 12.98 | 10.0 | 1001 | 78.0 | 10.3 | 13.54 | 9.0 | 955 | 74.0 | 64.0 | 14.29 | 10.0 | 955 | 74.0 | 73.2 | 12.86 |
| day 127 to 133 | 9.0 | 978 | 78.0 | 32.0 | 14.70 | 9.1 | 1116 | 88.0 | 22.0 | 16.52 | 9.0 | 1001 | 78.0 | 9.0 | 15.05 | 9.1 | 978 | 77.0 | 27.0 | 14.47 |
| day 134 to 140 | 9.0 | 955 | 75.0 | 12.1 | 14.36 | 9.0 | 1162 | 90.0 | 50.9 | 17.42 | 9.0 | 1116 | 88.0 | 34.2 | 16.77 | 9.0 | 932 | 73.0 | 8.9 | 14.02 |
| day 141 to 147 | 9.0 | 938 | 71.0 | 25.3 | 14.05 | 9.0 | 923 | 70.0 | 2.8 | 13.85 | 9.0 | 1063 | 80.0 | 15.0 | 15.94 | 9.0 | 875 | 67.0 | 17.3 | 13.13 |
| day 148 to 154 | 9.0 | 1000 | 74.5 | 15.8 | 14.98 | 9.0 | 1042 | 78.0 | 17.1 | 15.61 | 9.0 | 935 | 70.0 | 9.1 | 14.01 | 9.0 | 948 | 71.0 | 0.0 | 14.22 |
| day 155 to 161 | 9.0 | 934 | 70.0 | 17.4 | 13.99 | 9.0 | 1098 | 83.0 | 80.1 | 16.40 | 9.0 | 1098 | 83.0 | 78.0 | 16.40 | 9.0 | 1004 | 75.0 | 104.3 | 14.95 |
| day 162 to 168 | 9.0 | 950 | 71.0 | 16.0 | 14.23 | 9.0 | 967 | 76.0 | 2.9 | 14.55 | 9.0 | 916 | 72.0 | 6.1 | 13.78 | 9.0 | 995 | 75.0 | 23.0 | 14.91 |
| day 169 to 175 | 8.0 | 693 | 44.0 | 0.0 | 11.56 | 9.0 | 897 | 58.0 | 0.0 | 13.32 | 9.0 | 897 | 58.0 | 11.2 | 13.31 | 9.0 | 886 | 57.0 | 7.3 | 13.15 |

Table A-4c. (cont'd)

| Period | Pen 9 | | | | | Pen10 | | | | | Pen 11 | | | | | Pen 12 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb |
| day 176 to 182 | 7.0 | 939 | 58.0 | 128.2 | 17.74 | 9.0 | 1181 | 75.0 | 79.3 | 17.46 | 8.0 | 948 | 59.5 | 20.5 | 15.79 | 9.0 | 1006 | 65.5 | 48.7 | 14.91 |
| day 183 to 189 | 7.0 | 891 | 57.0 | 36.0 | 16.96 | 9.0 | 1216 | 77.5 | 17.6 | 18.03 | 7.1 | 891 | 57.0 | 7.9 | 16.65 | 9.0 | 983 | 63.5 | 43.4 | 14.56 |
| day 190 to 196 | 7.0 | 841 | 53.3 | 40.7 | 15.99 | 9.0 | 1033 | 65.5 | 9.7 | 15.32 | 7.0 | 893 | 57.5 | 24.1 | 17.02 | 9.0 | 880 | 54.5 | 47.7 | 12.99 |
| day 197 to 203 | 5.9 | 673 | 43.0 | 102.0 | 15.21 | 7.9 | 913 | 59.0 | 28.0 | 15.50 | 5.9 | 776 | 49.0 | 30.5 | 17.64 | 7.9 | 798 | 51.0 | 63.0 | 13.50 |
| day 204 to 210 | 5.0 | 617 | 37.0 | 71.5 | 16.31 | 7.0 | 797 | 49.0 | 0.0 | 15.17 | 5.0 | 723 | 44.5 | 15.0 | 19.24 | 7.0 | 741 | 45.2 | 53.5 | 14.04 |
| day 211 to 217 | 5.0 | 622 | 36.5 | 53.0 | 16.45 | 7.0 | 896 | 53.5 | 2.5 | 17.02 | 5.0 | 622 | 36.5 | 2.5 | 16.52 | 7.0 | 481 | 28.5 | 0.0 | 9.13 |
| day 218 to 224 | 5.0 | 734 | 44.0 | 67.0 | 19.43 | 7.0 | 970 | 57.5 | 4.0 | 18.42 | 5.0 | 793 | 46.0 | 26.0 | 21.02 | 7.0 | 804 | 48.0 | 7.0 | 15.27 |
| day 225 to 231 | 5.0 | 645 | 37.5 | 25.5 | 17.09 | 7.0 | 948 | 55.5 | 0.0 | 17.99 | 5.0 | 726 | 42.0 | 0.0 | 19.27 | 7.0 | 704 | 40.0 | 8.0 | 13.33 |
| day 232 to 238 | 5.0 | 663 | 39.0 | 21.5 | 17.59 | 7.0 | 943 | 55.0 | 0.0 | 17.90 | 5.0 | 713 | 40.0 | 4.5 | 18.89 | 7.0 | 777 | 44.0 | 2.0 | 14.72 |
| day 239 to 245 | 5.0 | 585 | 32.5 | 0.0 | 15.49 | 7.0 | 842 | 50.0 | 0.0 | 15.99 | 5.0 | 674 | 39.5 | 0.0 | 17.91 | 6.1 | 607 | 36.0 | 2.0 | 13.13 |
| day 246 to 252 | 5.0 | 660 | 38.5 | 20.0 | 17.50 | 7.0 | 976 | 59.0 | 0.0 | 18.56 | 5.0 | 671 | 39.0 | 0.0 | 17.82 | 6.0 | 629 | 36.5 | 0.0 | 13.92 |
| day 253 to 259 | 5.0 | 696 | 42.5 | 83.0 | 18.41 | 7.0 | 997 | 59.0 | 69.0 | 18.87 | 5.0 | 744 | 46.5 | 18.0 | 19.82 | 6.0 | 792 | 49.0 | 59.5 | 17.52 |
| day 260 to 266 | 5.0 | 723 | 44.0 | 36.0 | 19.20 | 7.0 | 980 | 58.0 | 49.5 | 18.56 | 5.0 | 815 | 50.5 | 47.6 | 21.66 | 6.0 | 791 | 49.5 | 103.3 | 17.45 |
| day 267 to 273 | 5.0 | 682 | 42.0 | 0.0 | 18.17 | 7.0 | 970 | 59.0 | 20.0 | 18.43 | 5.0 | 750 | 45.5 | 2.0 | 19.96 | 5.1 | 698 | 42.0 | 122.5 | 17.88 |
| day 274 to 280 | 5.0 | 792 | 49.5 | 116.5 | 20.95 | 7.0 | 875 | 54.0 | 0.0 | 16.66 | 5.0 | 738 | 45.0 | 36.0 | 19.60 | 5.0 | 643 | 38.5 | 95.0 | 16.96 |
| day 281 to 287 | 5.0 | 615 | 39.0 | 0.0 | 16.41 | 7.0 | 1001 | 64.5 | 6.9 | 19.10 | 5.0 | 687 | 43.5 | 0.0 | 18.34 | 5.0 | 583 | 36.5 | 7.5 | 15.53 |
| day 288 to 294 | 5.0 | 886 | 57.5 | 114.5 | 23.51 | 7.0 | 1004 | 64.0 | 3.0 | 19.15 | 5.0 | 777 | 49.5 | 6.0 | 20.74 | 5.0 | 682 | 44.0 | 76.5 | 18.10 |
| day 295 to 301 | 5.0 | 729 | 44.0 | 24.3 | 19.37 | 7.0 | 826 | 50.5 | 5.5 | 15.71 | 5.0 | 742 | 45.5 | 0.0 | 19.77 | 5.0 | 672 | 42.0 | 7.0 | 17.91 |
| day 302 to 308 | 5.0 | 752 | 48.0 | 24.5 | 20.04 | 7.0 | 1042 | 67.0 | 46.0 | 19.84 | 5.0 | 787 | 50.0 | 29.0 | 20.97 | 5.0 | 648 | 41.0 | 9.5 | 17.28 |
| day 309 to 315 | 5.0 | 676 | 44.5 | 43.5 | 18.02 | 7.0 | 896 | 56.5 | 21.0 | 17.06 | 5.0 | 724 | 46.5 | 20.0 | 19.31 | 5.0 | 653 | 42.5 | 19.0 | 17.43 |
| day 316 to 322 | 5.0 | 760 | 49.0 | 65.0 | 20.21 | 7.0 | 1062 | 67.0 | 84.0 | 20.16 | 5.0 | 665 | 43.0 | 6.0 | 17.76 | 5.0 | 668 | 43.0 | 11.5 | 17.83 |
| day 323 to 329 | 5.0 | 666 | 42.0 | 17.0 | 17.74 | 7.0 | 901 | 56.0 | 10.0 | 17.15 | 5.0 | 708 | 46.0 | 1.0 | 18.92 | 5.0 | 666 | 42.0 | 34.0 | 17.72 |
| day 330 to 336 | 5.0 | 744 | 48.0 | 66.5 | 19.78 | 7.0 | 919 | 58.0 | 11.9 | 17.51 | 5.0 | 724 | 46.0 | 46.8 | 19.26 | 5.0 | 767 | 50.0 | 47.3 | 20.44 |
| day 337 to 343 | 5.0 | 771 | 52.0 | 91.0 | 20.51 | 7.0 | 771 | 52.0 | 64.0 | 14.68 | 5.0 | 748 | 51.0 | 55.0 | 19.97 | 5.0 | 653 | 42.0 | 4.2 | 17.44 |
| day 344 to 350 | 5.0 | 610 | 42.0 | 0.0 | 16.36 | 7.0 | 857 | 57.0 | 0.0 | 16.39 | 5.0 | 627 | 42.0 | 0.0 | 16.79 | 5.0 | 604 | 40.0 | 0.0 | 16.16 |

Table A-4c. (cont'd)

| Period | Pen 9 | | | | | Pen10 | | | | | Pen 11 | | | | | Pen 12 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb |
| day 351 to 357 | 5.0 | 674 | 45.0 | 127.8 | 17.84 | 7.0 | 1023 | 70.0 | 148.3 | 19.43 | 5.0 | 703 | 49.0 | 95.4 | 18.72 | 5.0 | 743 | 50.0 | 102.0 | 19.74 |
| day 358 to 364 | 5.0 | 682 | 47.0 | 2.9 | 18.30 | 6.0 | 705 | 48.0 | 2.6 | 15.75 | 5.0 | 635 | 44.0 | 31.7 | 16.99 | 5.0 | 595 | 41.0 | 55.1 | 15.87 |
| day 365 to 371 | 5.0 | 728 | 50.0 | 43.7 | 19.46 | 6.0 | 814 | 56.0 | 29.8 | 18.16 | 5.0 | 674 | 47.0 | 14.1 | 18.08 | 5.0 | 720 | 49.0 | 8.5 | 19.29 |
| day 372 to 378 | 5.0 | 728 | 51.0 | 5.9 | 19.55 | 6.0 | 814 | 57.0 | 18.6 | 18.20 | 5.0 | 718 | 50.0 | 52.3 | 19.19 | 5.0 | 718 | 50.0 | 66.8 | 19.17 |

[a]Weighback.
[b]Weighback from sick pen.
[c]Not determined, missing weighback, the average of the two adjacent weeks was used as the DMI for this week.
[d]Not recorded.

Table A-4d. Weekly pen dry matter intake for pens 13 to 16 for Experiment BC9002

| Period | Pen 13 | | | | | Pen14 | | | | | Pen 15 | | | | | Pen 16 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of steers | Corn, lb | Pellet, lb | WB, lb[a] | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb |
| day 1 to 7 | 10.0 | 804 | 124 | 78.1 | 11.54 | 10.0 | 889 | 136 | 112.3 | 12.71 | 10.0 | 793 | 122 | 86.6 | 11.36 | 10.0 | 771 | 119 | 75 | 117 |
| day 8 to 14 | 10.0 | 836 | 129 | NR[b] | ND[c] | 10.0 | 878 | 134 | NR | ND | 10.0 | 900 | 138 | NR | ND | 10.0 | 858 | 132 | NR | ND |
| day 15 to 21 | 10.0 | 825 | 127 | 152.9 | 11.72 | 10.0 | 901 | 138 | 146.8 | 12.82 | 10.0 | 922 | 141 | 126.4 | 13.16 | 10.0 | 835 | 127 | 102.7 | 11.93 |
| day 22 to 28 | 10.0 | 900 | 139 | 48.3 | 12.99 | 10.0 | 814 | 126 | 2.3 | 11.82 | 10.0 | 836 | 130 | 1.8 | 12.15 | 10.0 | 879 | 136 | 7.4 | 12.76 |
| day 29 to 35 | 10.0 | 877 | 112 | 90.4 | 12.30 | 10.0 | 856 | 112 | 61.9 | 12.08 | 10.0 | 834 | 109 | 43.5 | 11.79 | 10.0 | 856 | 112 | 60.3 | 12.08 |
| day 36 to 42 | 10.0 | 1079 | 125 | 40 | 15.08 | 10.0 | 1035 | 119 | 2.0 | 14.51 | 10.0 | 1035 | 119 | 3.0 | 14.51 | 10.0 | 1012 | 115 | 0 | 14.17 |
| day 43 to 49 | 10.0 | 1056 | 122 | 26.4 | 14.78 | 10.0 | 1013 | 117 | 10.1 | 14.19 | 10.0 | 1102 | 128 | 0 | 15.47 | 10.0 | 1147 | 133 | 0 | 16.09 |
| day 50 to 56 | 10.0 | 1057 | 123 | 13 | 14.82 | 10.0 | 1146 | 132 | 47.9 | 16.01 | 10.0 | 1057 | 122 | 35.5 | 14.78 | 10.0 | 967 | 111 | 3.8 | 13.55 |
| day 57 to 63 | 10.0 | 1144 | 125 | 22.4 | 15.93 | 10.0 | 1053 | 115 | 10.7 | 14.67 | 10.0 | 1053 | 115 | 42.6 | 14.63 | 10.0 | 1053 | 115 | 28.5 | 14.65 |
| day 64 to 70 | 10.0 | 1124 | 120 | 21 | 15.61 | 10.0 | 1146 | 124 | 8 | 15.96 | 10.0 | 1146 | 124 | 16 | 15.95 | 10.0 | 1190 | 128 | 0 | 16.57 |
| day 71 to 77 | 10.0 | 1145 | 124 | 32.1 | 15.91 | 10.0 | 1057 | 115 | 22.1 | 14.71 | 10.0 | 1147 | 123 | 6.6 | 15.96 | 10.0 | 1190 | 128 | 4.5 | 16.56 |
| day 78 to 84 | 10.0 | 1213 | 130 | 0 | 16.88 | 10.0 | 1260 | 133 | 33.5 | 17.47 | 10.0 | 1235 | 133 | 28.4 | 17.16 | 10.0 | 1326 | 143 | 23.2 | 18.44 |
| day 85 to 91 | 10.0 | 1159 | 109 | 4.2 | 15.93 | 10.0 | 976 | 92 | 3.8 | 13.42 | 10.0 | 1069 | 100 | 11.2 | 14.68 | 10.0 | 1068 | 100 | 2.8 | 14.67 |
| day 92 to 98 | 10.0 | 1281 | 112 | 75.4 | 17.43 | 10.0 | 1189 | 104 | 8.9 | 16.24 | 10.0 | 1120 | 98 | 7.7 | 15.30 | 10.0 | 1212 | 106 | 11.7 | 16.55 |
| day 99 to 105 | 10.0 | 1304 | 114 | 8.7 | 17.81 | 9.1 | 1074 | 94 | 76.9 | 15.96 | 10.0 | 1074 | 94 | 9.6 | 14.66 | 10.0 | 1120 | 98 | 1.1 | 15.30 |
| day 106 to 112 | 10.0 | 1363 | 120.2 | 97.3 | 18.54 | 9.0 | 1350 | 121 | 182.3 | 20.32 | 10.0 | 1258 | 110 | 129.6 | 17.05 | 10.0 | 1452 | 129 | 161.4 | 19.70 |
| day 113 to 119 | 10.0 | 1265 | 107.2 | 41.5 | 17.20 | 8.4 | 1201 | 103 | 157.3 | 19.25 | 10.0 | 1274 | 106 | 27.5 | 17.31 | 10.0 | 1410 | 123 | 3 | 19.26 |
| day 120 to 126 | 10.0 | 1062.8 | 86.4 | 11.9 | 14.42 | 8.0 | 1051.2 | 84.8 | 91.7 | 17.73 | 10.0 | 1070.0 | 84.0 | 53.8 | 14.44 | 10.0 | 1206.2 | 96.4 | 75.4 | 16.29 |
| day 127 to 133 | 9.1 | 1116.0 | 88.0 | 22.0 | 16.52 | 9.0 | 1116.0 | 88.0 | 22.0 | 16.78 | 10.0 | 1047.0 | 82.0 | 2.0 | 14.18 | 9.1 | 1116.0 | 88.0 | 4.0 | 16.54 |
| day 134 to 140 | 9.0 | 1208.0 | 96.0 | 17.6 | 18.18 | 9.0 | 1116.0 | 88.0 | 6.8 | 16.80 | 10.0 | 1208.0 | 96.0 | 22.1 | 16.36 | 9.0 | 1231.0 | 97.0 | 34.6 | 18.50 |
| day 141 to 147 | 9.0 | 1087.0 | 82.0 | 31.0 | 16.28 | 9.0 | 923.0 | 70.0 | 20.3 | 13.84 | 10.0 | 1087.0 | 82.0 | 2.9 | 14.68 | 9.0 | 1134.0 | 85.0 | 2.0 | 17.01 |
| day 148 to 154 | 9.0 | 1160.0 | 87.0 | 0.0 | 17.40 | 9.0 | 1090.0 | 82.0 | 0.0 | 16.36 | 10.0 | 1183.0 | 88.0 | 0.0 | 15.96 | 9.0 | 1183.0 | 88.0 | 0.0 | 17.74 |
| day 155 to 161 | 9.0 | 1191.0 | 90.0 | 18.5 | 17.86 | 9.0 | 1144.0 | 86.0 | 20.8 | 17.14 | 10.0 | 1214.0 | 92.0 | 35.5 | 16.37 | 9.0 | 1238.0 | 94.0 | 21.8 | 18.57 |
| day 162 to 168 | 9.0 | 1182.0 | 88.0 | 4.9 | 17.72 | 9.0 | 1134.0 | 84.0 | 0.0 | 17.00 | 10.0 | 1205.0 | 89.0 | 9.6 | 16.24 | 9.0 | 1182.0 | 88.0 | 0.3 | 17.72 |
| day 169 to 175 | 9.0 | 1015.0 | 66.5 | 37.8 | 15.05 | 9.0 | 1129.0 | 74.0 | 14.9 | 16.77 | 10.0 | 1105.0 | 73.0 | 2.1 | 14.79 | 9.0 | 1200.0 | 78.0 | 0.0 | 17.83 |

Table A-4d. (cont'd)

| Period | Pen 13 | | | | | Pen14 | | | | | Pen 15 | | | | | Pen 16 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb | No. of steers | Corn, lb | Pellet, lb | WB, lb | Daily DMI, lb |
| day 176 to 182 | 9.0 | 1100.0 | 70.0 | 34.9 | 16.29 | 9.0 | 1111.0 | 70.0 | 38.5 | 16.44 | 10.0 | 1227.0 | 78.0 | 63.2 | 16.34 | 9.0 | 1261.0 | 81.0 | 65.4 | 18.67 |
| day 183 to 189 | 9.0 | 1204.0 | 77.0 | 1.7 | 17.87 | 9.0 | 1169.0 | 74.5 | 6.6 | 17.34 | 10.0 | 1214.0 | 77.0 | 12.5 | 16.20 | 9.0 | 1297.0 | 83.0 | 5.5 | 19.25 |
| day 190 to 196 | 9.0 | 1124.0 | 73.0 | 47.3 | 16.66 | 9.0 | 1332.0 | 84.0 | 2.7 | 19.75 | 10.0 | 1125.0 | 71.0 | 27.2 | 15.00 | 9.0 | 1241.0 | 78.5 | 0.5 | 18.41 |
| day 197 to 203 | 7.9 | 971.0 | 62.0 | 50.0 | 16.46 | 7.9 | 1030.0 | 66.0 | 89.0 | 17.43 | 8.9 | 936.0 | 60.0 | 22.5 | 14.10 | 7.9 | 1075.0 | 69.0 | 29.5 | 18.25 |
| day 204 to 210 | 7.0 | 1033.0 | 62.0 | 30.0 | 19.61 | 7.0 | 1058.0 | 65.0 | 21.5 | 20.12 | 8.0 | 939.0 | 55.0 | 0.0 | 15.60 | 7.0 | 841.0 | 51.0 | 0.0 | 15.99 |
| day 211 to 217 | 7.0 | 1113.0 | 66.0 | 175.5 | 20.96 | 7.0 | 1019.0 | 61.0 | 20.0 | 19.35 | 8.0 | 841.0 | 50.5 | 0.0 | 13.99 | 7.0 | 958.0 | 56.5 | 4.5 | 18.19 |
| day 218 to 224 | 7.0 | 1099.0 | 65.0 | 4.5 | 20.87 | 7.0 | 1068.0 | 65.0 | 0.0 | 20.32 | 8.0 | 1090.0 | 65.0 | 38.0 | 18.09 | 7.0 | 1114.0 | 66.0 | 21.0 | 21.14 |
| day 225 to 231 | 7.0 | 982.0 | 59.0 | 85.0 | 18.58 | 7.0 | 1076.0 | 65.0 | 18.5 | 20.44 | 8.0 | 807.0 | 47.0 | 0.0 | 13.40 | 7.0 | 807.0 | 47.0 | 1.0 | 15.31 |
| day 232 to 238 | 7.0 | 887.0 | 51.0 | 1.5 | 16.82 | 7.0 | 1006.0 | 60.0 | 16.5 | 19.10 | 8.0 | 911.0 | 52.0 | 0.5 | 15.11 | 7.0 | 955.0 | 56.0 | 0.5 | 18.13 |
| day 239 to 245 | 7.0 | 910.0 | 54.0 | 0.0 | 17.29 | 7.0 | 962.0 | 57.5 | 0.0 | 18.28 | 8.0 | 887.0 | 53.0 | 2.0 | 14.75 | 7.0 | 1023.0 | 62.0 | 0.0 | 19.46 |
| day 246 to 252 | 7.0 | 943.0 | 56.0 | 5.0 | 17.91 | 7.0 | 793.0 | 47.5 | 0.0 | 15.07 | 8.0 | 873.0 | 51.0 | 0.0 | 14.50 | 7.0 | 908.0 | 54.0 | 0.0 | 17.25 |
| day 253 to 259 | 7.0 | 1009.0 | 60.0 | 49.0 | 19.12 | 7.0 | 939.0 | 57.0 | 10.5 | 17.85 | 8.0 | 916.0 | 55.5 | 6.5 | 15.24 | 7.0 | 986.0 | 58.5 | 8.0 | 18.72 |
| day 260 to 266 | 7.0 | 1071.0 | 64.0 | 70.5 | 20.28 | 7.0 | 1094.0 | 65.0 | 59.7 | 20.72 | 8.0 | 1112.0 | 66.0 | 24.8 | 18.46 | 7.0 | 1118.0 | 67.0 | 5.0 | 21.25 |
| day 267 to 273 | 7.0 | 1068.0 | 65.0 | 30.5 | 20.29 | 7.0 | 946.0 | 57.0 | 8.5 | 17.98 | 8.0 | 999.0 | 60.0 | 3.0 | 16.61 | 7.0 | 1045.0 | 62.0 | 0.0 | 19.85 |
| day 274 to 280 | 7.0 | 900.0 | 55.0 | 2.5 | 17.12 | 7.0 | 1064.0 | 64.0 | 0.0 | 20.23 | 8.0 | 1024.0 | 62.0 | 10.5 | 17.03 | 7.0 | 968.0 | 60.0 | 0.0 | 18.44 |
| day 281 to 287 | 7.0 | 1001.0 | 64.5 | 22.0 | 19.09 | 7.0 | 791.0 | 50.0 | 0.0 | 15.08 | 8.0 | 1059.0 | 68.0 | 59.5 | 17.63 | 7.0 | 1119.0 | 71.5 | 35.5 | 21.31 |
| day 288 to 294 | 7.0 | 1075.0 | 68.5 | 60.0 | 20.44 | 7.0 | 1054.0 | 67.5 | 6.0 | 20.11 | 8.0 | 1076.0 | 69.0 | 0.0 | 17.97 | 7.0 | 991.0 | 64.5 | 2.0 | 18.93 |
| day 295 to 301 | 7.0 | 858.0 | 53.5 | 5.0 | 16.34 | 7.0 | 814.0 | 49.5 | 6.0 | 15.48 | 8.0 | 886.0 | 57.0 | 44.0 | 14.75 | 7.0 | 1125.0 | 72.0 | 89.0 | 21.37 |
| day 302 to 308 | 7.0 | 993.0 | 64.5 | 121.7 | 18.83 | 7.0 | 1087.0 | 69.5 | 101.1 | 20.63 | 8.0 | 1079.0 | 70.5 | 80.5 | 17.96 | 7.0 | 1225.0 | 79.8 | 76.8 | 23.32 |
| day 309 to 315 | 7.0 | 882.0 | 56.0 | 118.0 | 16.69 | 7.0 | 1038.0 | 65.5 | 93.0 | 19.69 | 8.0 | 959.0 | 60.0 | 16.0 | 15.98 | 7.0 | 829.0 | 52.5 | 0.0 | 15.81 |
| day 316 to 322 | 7.0 | 968.0 | 62.0 | 82.6 | 18.38 | 7.0 | 1130.0 | 70.0 | 113.1 | 21.40 | 8.0 | 1270.0 | 80.0 | 182.3 | 21.02 | 7.0 | 1279.0 | 81.0 | 176.7 | 24.20 |
| day 323 to 329 | 7.0 | 432.0 | 28.0 | 0.0 | 8.24 | 7.0 | 432.0 | 28.0 | 0.0 | 8.24 | 8.0 | 432.0 | 28.0 | 0.0 | 7.21 | 7.0 | 432.0 | 28.0 | 0.0 | 8.24 |

[a]Weighback.

[b]Not recorded.

[c]Not determined, missing weighback, the average of the two adjacent weeks was used as the DMI for this week.

Table A-5. Carcass characteristics of steers from Experiment BC9002

| Steer no. | Date harvested | Slaughter wt., kg | HCW, kg | REA, $cm^2$ | Backfat, mm | KPH, % | Marbling score [a] | Quality grade [b] | Calculated yield grade [c] |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 03/16/92 | 535 | 313.1 | 62.6 | 2.45 | 2.0 | 690 | 19 | 2.67 |
| 2 | 04/13/92 | 632 | 367.8 | 78.4 | 8.58 | 3.0 | 540 | 18 | 3.17 |
| 5 | 03/16/92 | 599 | 336.0 | 71.0 | 6.13 | 2.5 | 630 | 19 | 2.92 |
| 8 | 11/11/91 | 424 | 246.7 | 58.1 | 3.68 | 3.5 | 460 | 17 | 2.75 |
| 9 | 05/11/92 | 581 | 336.9 | 74.2 | 3.68 | 1.5 | 480 | 17 | 2.32 |
| 10 | 11/11/91 | 479 | 269.0 | 71.0 | 2.45 | 2.5 | 430 | 16 | 1.97 |
| 11 | 11/11/91 | 426 | 234.6 | 67.1 | 2.45 | 2.5 | 430 | 16 | 1.88 |
| 12 | 05/11/92 | 522 | 316.3 | 74.8 | 9.80 | 3.5 | 950 | 22 | 3.14 |
| 13 | 03/16/92 | 653 | 375.4 | 81.3 | 14.70 | 2.5 | 540 | 18 | 3.61 |
| 14 | 11/11/91 | 411 | 226.4 | 63.2 | 2.45 | 2.0 | 310 | 14 | 1.90 |
| 16 | 04/27/92 | 598 | 361.0 | 85.8 | 4.90 | 3.0 | 510 | 18 | 2.37 |
| 17 | 04/13/92 | 627 | 353.7 | 81.6 | 3.06 | 2.0 | 380 | 15 | 2.13 |
| 18 | 04/27/92 | 587 | 357.3 | 80.6 | 2.45 | 2.5 | 460 | 17 | 2.24 |
| 20 | 03/16/92 | 596 | 347.3 | 83.5 | 7.96 | 3.0 | 540 | 18 | 2.68 |
| 21 | 03/16/92 | 562 | 309.1 | 67.1 | 6.13 | 3.0 | 570 | 18 | 2.99 |
| 25 | 05/11/92 | 623 | 371.8 | 69.7 | 6.74 | 3.5 | 880 | 21 | 3.55 |
| 27 | 11/11/91 | 424 | 235.4 | 67.7 | 2.45 | 3.0 | 460 | 17 | 1.95 |
| 29 | 04/27/92 | 589 | 352.5 | 80.6 | 4.90 | 2.0 | 480 | 17 | 2.35 |
| 31 | 04/27/92 | 590 | 352.5 | 64.5 | 4.90 | 3.0 | 500 | 18 | 3.35 |
| 32 | 11/11/91 | 413 | 232.0 | 60.6 | 2.45 | 2.0 | 420 | 16 | 2.07 |
| 34 | 04/13/92 | 540 | 324.6 | 74.8 | 9.80 | 2.5 | 520 | 18 | 3.01 |
| 37 | 04/27/92 | 600 | 353.6 | 76.1 | 2.45 | 1.5 | 440 | 16 | 2.24 |
| 38 | 04/13/92 | 578 | 335.2 | 95.5 | 3.68 | 1.5 | 390 | 15 | 1.25 |
| 40 | 11/11/91 | 433 | 245.8 | 69.0 | 2.45 | 2.5 | 340 | 15 | 1.87 |
| 42 | 03/16/92 | 616 | 381.9 | 91.6 | 3.68 | 2.5 | 770 | 20 | 2.03 |
| 43 | 04/27/92 | 602 | 358.0 | 77.4 | 4.90 | 3.5 | 530 | 18 | 2.86 |
| 44 | 04/13/92 | 613 | 364.9 | 83.5 | 4.90 | 3.5 | 550 | 18 | 2.61 |
| 45 | 11/11/91 | 460 | 254.7 | 60.6 | 3.68 | 3.5 | 500 | 18 | 2.69 |
| 46 | 03/16/92 | 572 | 349.3 | 78.0 | 6.13 | 3.0 | 440 | 16 | 2.78 |
| 47 | 04/27/92 | 641 | 387.3 | 89.0 | 4.90 | 2.0 | 440 | 16 | 2.23 |
| 50 | 03/16/92 | 650 | 377.4 | 79.7 | 8.58 | 2.0 | 490 | 17 | 2.98 |
| 54 | 03/16/92 | 663 | 389.0 | 79.0 | 10.41 | 2.5 | 530 | 18 | 3.40 |
| 55 | 05/11/92 | 627 | 374.8 | 80.6 | 3.68 | 3.0 | 550 | 18 | 2.62 |
| 57 | 04/27/92 | 587 | 357.0 | 79.7 | 7.35 | 3.5 | 620 | 19 | 2.99 |
| 58 | 04/27/92 | 587 | 360.9 | 68.4 | 5.39 | 3.0 | 460 | 17 | 3.28 |
| 59 | 05/11/92 | 654 | 382.8 | 86.4 | 7.96 | 2.0 | 510 | 18 | 2.63 |
| 60 | 11/11/91 | 440 | 234.9 | 56.8 | 3.68 | 2.0 | 350 | 15 | 2.42 |
| 62 | 04/13/92 | 561 | 328.0 | 82.6 | 9.80 | 3.5 | 550 | 18 | 2.85 |
| 63 | 05/11/92 | 651 | 367.2 | 77.4 | 7.35 | 2.5 | 510 | 18 | 2.99 |
| 65 | 04/13/92 | 556 | 316.9 | 82.6 | 2.45 | 2.0 | 520 | 18 | 1.71 |
| 70 | 04/13/92 | 608 | 356.0 | 78.0 | 4.90 | 3.5 | 610 | 19 | 2.81 |

Table A-5. (cont'd)

| Steer no. | Date harvested | Harvest wt., kg | HCW, kg | REA, $cm^2$ | Backfat, mm | KPH, % | Marbling score | Quality grade | Calculated yield grade |
|---|---|---|---|---|---|---|---|---|---|
| 72 | 11/11/91 | 433 | 244.9 | 67.1 | 2.45 | 2.0 | 410 | 16 | 1.86 |
| 75 | 04/27/92 | 595 | 342.8 | 76.8 | 3.68 | 2.0 | 420 | 16 | 2.34 |
| 76 | 04/27/92 | 618 | 357.4 | 76.8 | 2.45 | 2.0 | 500 | 18 | 2.34 |
| 77 | 03/16/92 | 627 | 364.2 | 72.2 | 4.29 | 3.0 | 500 | 18 | 3.00 |
| 78 | 11/11/91 | 400 | 227.4 | 59.3 | 4.90 | 4.5 | 560 | 18 | 2.85 |
| 80 | 03/16/92 | 645 | 356.0 | 73.2 | 4.90 | 1.5 | 480 | 20 | 2.65 |
| 83 | 03/16/92 | 617 | 370.7 | 86.1 | 4.90 | 2.0 | 450 | 17 | 2.23 |
| 85 | 11/11/91 | 457 | 265.7 | 71.0 | 6.13 | 3.5 | 610 | 20 | 2.52 |
| 86 | 05/11/92 | 615 | 358.0 | 80.0 | 6.13 | 3.0 | 560 | 18 | 2.76 |
| 87 | 04/13/92 | 638 | 385.4 | 91.6 | 4.90 | 1.5 | 460 | 17 | 1.98 |
| 89 | 05/11/92 | 599 | 340.1 | 75.5 | 9.19 | 1.5 | 460 | 17 | 2.84 |
| 90 | 04/13/92 | 596 | 343.4 | 74.2 | 3.68 | 2.0 | 430 | 16 | 2.47 |
| 95 | 11/11/91 | 449 | 250.9 | 62.6 | 2.45 | 3.5 | 510 | 18 | 2.44 |
| 97 | 04/27/92 | 579 | 343.9 | 74.8 | 3.68 | 3.0 | 500 | 18 | 2.64 |
| 98 | 11/11/91 | 456 | 245.6 | 67.1 | 2.45 | 3.0 | 440 | 16 | 2.07 |
| 100 | 11/11/91 | 450 | 250.7 | 72.2 | 3.68 | 3.0 | 520 | 18 | 1.98 |
| 101 | 04/13/92 | 635 | 382.3 | 86.1 | 10.41 | 2.0 | 420 | 16 | 2.89 |
| 102 | 03/16/92 | 676 | 392.2 | 78.7 | 6.13 | 3.5 | 620 | 19 | 3.21 |
| 103 | 05/11/92 | 669 | 395.3 | 78.7 | 6.74 | 3.0 | 550 | 18 | 3.20 |
| 104 | 05/11/92 | 616 | 372.3 | 69.0 | 11.64 | 5.0 | 570 | 18 | 4.38 |
| 106 | 11/11/91 | 458 | 251.0 | 59.3 | 4.90 | 3.0 | 530 | 18 | 2.75 |
| 107 | 04/27/92 | 592 | 336.6 | 65.1 | 4.41 | 1.5 | 470 | 17 | 2.84 |
| 108 | 04/27/92 | 627 | 375.9 | 79.3 | 2.94 | 1.5 | 430 | 16 | 2.31 |
| 109 | 03/16/92 | 623 | 370.7 | 78.7 | 10.41 | 3.5 | 730 | 20 | 3.46 |
| 110 | 11/11/91 | 398 | 222.9 | 67.7 | 2.45 | 2.5 | 390 | 15 | 1.74 |
| 112 | 04/27/92 | 628 | 366.2 | 80.6 | 4.41 | 2.0 | 600 | 19 | 2.42 |
| 115 | 04/13/92 | 615 | 366.7 | 87.1 | 3.68 | 2.0 | 540 | 18 | 2.03 |
| 116 | 04/13/92 | 654 | 387.4 | 94.2 | 4.90 | 1.5 | 520 | 18 | 1.87 |
| 117 | 03/16/92 | 612 | 340.7 | 66.4 | 4.29 | 1.0 | 510 | 18 | 2.70 |
| 118 | 11/11/91 | 442 | 247.0 | 67.7 | 2.45 | 3.0 | 450 | 17 | 2.05 |
| 119 | 04/13/92 | 565 | 334.8 | 73.5 | 6.13 | 4.0 | 930 | 22 | 3.08 |
| 120 | 11/11/91 | 489 | 289.2 | 68.4 | 3.68 | 4.5 | 460 | 17 | 2.79 |
| 121 | 04/27/92 | 587 | 350.1 | 89.7 | 7.35 | 2.0 | 360 | 15 | 2.13 |
| 122 | 03/16/92 | 526 | 343.5 | 66.4 | 4.90 | 3.5 | 740 | 20 | 3.28 |
| 128 | 11/11/91 | 426 | 250.2 | 66.4 | 4.90 | 3.5 | 450 | 17 | 2.49 |
| 129 | 11/11/91 | 509 | 281.1 | 65.8 | 2.45 | 2.5 | 430 | 16 | 2.33 |
| 130 | 04/13/92 | 628 | 358.3 | 87.7 | 6.13 | 1.5 | 560 | 18 | 2.07 |
| 133 | 05/11/92 | 616 | 372.0 | 85.1 | 6.74 | 2.5 | 500 | 18 | 2.58 |
| 136 | 04/27/92 | 618 | 364.8 | 81.3 | 4.90 | 3.5 | 630 | 19 | 2.72 |
| 139 | 04/13/92 | 626 | 374.7 | 72.2 | 7.11 | 2.5 | 430 | 16 | 3.28 |
| 142 | 05/11/92 | 603 | 341.1 | 72.2 | 2.45 | 1.5 | 430 | 16 | 2.32 |
| 143 | 03/16/92 | 610 | 363.6 | 75.1 | 9.19 | 1.5 | 490 | 17 | 3.06 |
| 144 | 04/13/92 | 593 | 354.8 | 91.6 | 4.29 | 2.5 | 510 | 18 | 1.87 |

Table A-5. (cont'd)

| Steer no. | Date harvested | Harvest wt., kg | HCW, kg | REA, $cm^2$ | Backfat, mm | KPH, % | Marbling score | Quality grade | Calculated yield grade |
|---|---|---|---|---|---|---|---|---|---|
| 147 | 04/13/92 | 589 | 357.3 | 74.5 | 6.74 | 3.5 | 760 | 20 | 3.18 |
| 151 | 05/11/92 | 649 | 391.9 | 84.5 | 7.96 | 3.0 | 440 | 16 | 3.00 |
| 153 | 11/11/91 | 448 | 243.1 | 67.1 | 2.94 | 3.0 | 360 | 15 | 2.09 |
| 154 | 04/13/92 | 617 | 370.1 | 80.6 | 6.74 | 3.0 | 550 | 18 | 2.89 |
| 155 | 05/11/92 | 591 | 332.5 | 82.6 | 5.51 | 2.0 | 450 | 17 | 2.15 |
| 157 | 11/11/91 | 466 | 260.8 | 66.4 | 4.90 | 2.0 | 460 | 17 | 2.27 |
| 158 | 05/11/92 | 612 | 357.3 | 68.4 | 7.35 | 1.5 | 450 | 17 | 3.15 |
| 159 | 04/13/92 | 613 | 372.2 | 80.6 | 5.51 | 4.0 | 560 | 18 | 2.98 |
| 161 | 04/27/92 | 679 | 415.0 | 90.3 | 11.52 | 4.0 | 640 | 19 | 3.47 |
| 163 | 04/27/92 | 582 | 337.8 | 77.4 | 3.68 | 2.0 | 480 | 17 | 2.26 |
| 165 | 05/11/92 | 599 | 351.0 | 74.2 | 6.74 | 2.5 | 510 | 18 | 2.95 |
| 166 | 04/27/92 | 633 | 387.7 | 89.7 | 6.86 | 2.5 | 630 | 19 | 2.50 |
| 170 | 04/27/92 | 574 | 330.1 | 76.8 | 5.39 | 1.5 | 520 | 18 | 2.31 |
| 171 | 11/11/91 | 401 | 225.2 | 66.4 | 1.23 | 3.0 | 450 | 17 | 1.80 |
| 172 | 11/11/91 | 443 | 254.7 | 74.8 | 3.68 | 2.5 | 440 | 16 | 1.78 |
| 173 | 11/11/91 | 420 | 232.3 | 57.4 | 3.68 | 2.0 | 340 | 15 | 2.36 |
| 180 | 05/11/92 | 708 | 403.2 | 82.6 | 13.48 | 1.5 | 430 | 16 | 3.46 |
| 183 | 03/16/92 | 628 | 367.6 | 79.0 | 7.35 | 4.5 | 730 | 20 | 3.31 |
| 184 | 03/16/92 | 590 | 344.4 | 81.3 | 7.35 | 1.5 | 550 | 18 | 2.40 |
| 187 | 11/11/91 | 507 | 278.5 | 69.7 | 2.45 | 1.5 | 390 | 15 | 1.91 |
| 192 | 03/16/92 | 641 | 375.5 | 62.6 | 6.74 | 1.5 | 640 | 19 | 3.53 |
| 194 | 05/11/92 | 547 | 316.7 | 67.7 | 3.06 | 2.0 | 610 | 19 | 2.51 |
| 195 | 04/13/92 | 624 | 376.1 | 71.0 | 9.19 | 3.5 | 490 | 17 | 3.77 |
| 196 | 04/13/92 | 594 | 359.6 | 85.8 | 4.90 | 4.5 | 570 | 18 | 2.66 |
| 197 | 03/16/92 | 613 | 354.8 | 78.7 | 3.06 | 2.5 | 730 | 20 | 2.38 |
| 198 | 03/16/92 | 625 | 382.9 | 77.4 | 9.19 | 3.0 | 680 | 19 | 3.41 |
| 199 | 05/11/92 | 616 | 359.5 | 81.9 | 2.45 | 2.5 | 520 | 18 | 2.20 |
| 201 | 11/11/91 | 407 | 221.8 | 58.1 | 2.45 | 3.5 | 310 | 14 | 2.42 |
| 205 | 04/13/92 | 589 | 346.5 | 73.9 | 7.35 | 3.0 | 500 | 18 | 3.09 |
| 211 | 11/11/91 | 480 | 283.1 | 69.0 | 4.90 | 2.5 | 390 | 15 | 2.43 |
| 212 | 04/27/92 | 553 | 341.1 | 76.8 | 7.35 | 3.5 | 580 | 18 | 3.00 |
| 213 | 11/11/91 | 451 | 254.7 | 68.4 | 1.84 | 2.0 | 440 | 16 | 1.82 |
| 215 | 03/16/92 | 577 | 342.4 | 82.6 | 4.29 | 2.5 | 570 | 18 | 2.21 |
| 217 | 03/16/92 | 602 | 352.9 | 81.3 | 4.90 | 1.0 | 420 | 16 | 2.12 |
| 218 | 04/13/92 | 572 | 333.8 | 80.3 | 4.29 | 2.0 | 410 | 16 | 2.15 |
| 221 | 05/11/92 | 662 | 405.6 | 87.1 | 4.90 | 4.0 | 820 | 21 | 2.88 |
| 222 | 03/16/92 | 584 | 344.8 | 77.4 | 4.90 | 3.0 | 770 | 20 | 2.65 |
| 225 | 03/16/92 | 679 | 388.1 | 108.0 | 4.90 | 1.5 | 510 | 18 | 1.19 |
| 227 | 11/11/91 | 422 | 241.4 | 68.4 | 2.45 | 4.0 | 480 | 17 | 2.17 |
| 228 | 04/13/92 | 682 | 374.7 | 71.3 | 2.45 | 2.5 | 440 | 16 | 2.85 |
| 232 | 03/16/92 | 550 | 337.8 | 83.9 | 14.09 | 3.0 | 640 | 19 | 3.21 |
| 234 | 05/11/92 | 615 | 339.7 | 68.4 | 4.29 | 2.0 | 420 | 16 | 2.79 |
| 236 | 04/27/92 | 616 | 362.6 | 83.9 | 2.45 | 3.5 | 450 | 17 | 2.33 |

Table A-5. (cont'd)

| Steer no. | Date harvested | Harvest wt., kg | HCW, kg | REA, $cm^2$ | Backfat, mm | KPH, % | Marbling score | Quality grade | Calculated yield grade |
|---|---|---|---|---|---|---|---|---|---|
| 238 | 03/16/92 | 628 | 378.4 | 71.6 | 8.58 | 1.5 | 470 | 17 | 3.29 |
| 239 | 04/27/92 | 561 | 331.3 | 79.3 | 7.35 | 2.5 | 450 | 17 | 2.59 |
| 241 | 03/16/92 | 603 | 345.6 | 87.1 | 4.90 | 2.0 | 540 | 18 | 1.98 |
| 243 | 04/13/92 | 669 | 388.8 | 75.5 | 6.13 | 2.5 | 560 | 18 | 3.14 |

[a]Marbling score:300 = traces, 400 = slight, 500 = small, 600 = modest, 700 = moderate, 800 = slightly abundant, and 900 = moderately abundant.

[b]USDA quality grade:14 = low standard, 15 = high standard, 16 = low select, 17 = high select, 18 = low choice, 19 = average choice, 20 = high choice, 21 = low prime, 22 = average prime.

[c]Calculated yield grade equation:YG = 2.5 + (2.5 * backfat) + (.0038 * HCW) + (.2 * KPH) - (.32 * REA).

Table A-6. Ninth-tenth-eleventh rib composition from Experiment BC9002

| Steer no. | 9-10-11 rib wt., g | bone wt., g | Soft tissue, g | Bone in rib, % | Soft tissue Water, % | EEL, % | CP, % |
|---|---|---|---|---|---|---|---|
| 1 | 4515.1 | 762.3 | 3752.8 | 16.88 | 45.57 | 40.72 | 12.11 |
| 2 | 5231.4 | 764.8 | 4466.6 | 14.62 | 45.41 | 40.53 | 14.01 |
| 5 | 5150.3 | 967.3 | 4183.0 | 18.78 | 50.86 | 31.95 | 14.98 |
| 8 | 3846.5 | 687.8 | 3158.7 | 17.88 | 47.64 | 37.34 | 12.64 |
| 9 | 4816.6 | 1034.3 | 3782.3 | 21.47 | 55.42 | 25.62 | 16.46 |
| 10 | 3495.3 | 718.8 | 2776.5 | 20.56 | 56.43 | 26.25 | 15.84 |
| 11 | 3471.2 | 658.0 | 2813.2 | 18.96 | 52.22 | 30.83 | 15.85 |
| 12 | 4809.6 | 683.1 | 4126.5 | 14.20 | 45.70 | 39.56 | 13.89 |
| 13 | 5242.0 | 912.6 | 4329.4 | 17.41 | 49.73 | 34.14 | 14.61 |
| 14 | 3404.6 | 705.9 | 2698.7 | 20.73 | 58.70 | 20.98 | 17.93 |
| 16 | 5368.5 | 836.5 | 4532.0 | 15.58 | 50.52 | 32.78 | 16.05 |
| 17 | 5499.3 | 1195.6 | 4303.7 | 21.74 | 57.22 | 24.80 | 17.22 |
| 18 | 4905.4 | 878.3 | 4027.1 | 17.90 | 54.23 | 27.90 | 16.91 |
| 20 | 4941.5 | 940.5 | 4001.0 | 19.03 | 48.93 | 35.20 | 14.83 |
| 21 | 4120.3 | 818.7 | 3301.6 | 19.87 | 47.20 | 36.55 | 14.23 |
| 25 | 5450.8 | 782.3 | 4668.5 | 14.35 | 41.39 | 45.57 | 12.07 |
| 27 | 3314.7 | 696.3 | 2618.4 | 21.01 | 57.55 | 23.86 | 16.67 |
| 29 | 5108.2 | 977.7 | 4130.5 | 19.14 | 49.03 | 34.93 | 13.10 |
| 31 | 4698.9 | 913.1 | 3785.8 | 19.43 | 51.80 | 31.55 | 15.46 |
| 32 | 3288.5 | 658.4 | 2630.1 | 20.02 | 57.63 | 24.33 | 16.17 |
| 34 | 5357.0 | 1082.7 | 4274.3 | 20.21 | 48.91 | 37.12 | 13.12 |
| 37 | 4965.8 | 1035.7 | 3930.1 | 20.86 | 57.04 | 24.60 | 17.76 |
| 38 | 4774.8 | 807.2 | 3967.6 | 16.91 | 54.39 | 28.74 | 16.03 |
| 40 | 3560.8 | 696.6 | 2864.2 | 19.56 | 59.18 | 19.69 | 17.13 |
| 42 | 5195.8 | 894.0 | 4301.8 | 17.21 | 49.00 | 35.63 | 13.86 |
| 43 | 5354.8 | 916.5 | 4438.3 | 17.12 | 43.01 | 44.73 | 12.11 |
| 44 | 4979.1 | 805.0 | 4174.1 | 16.17 | 52.14 | 31.07 | 15.93 |
| 45 | 3625.1 | 702.9 | 2922.2 | 19.39 | 51.00 | 31.71 | 14.49 |
| 46 | 4808.5 | 846.6 | 3961.9 | 17.61 | 50.28 | 31.94 | 15.30 |
| 47 | 6135.5 | 1012.6 | 5122.9 | 16.50 | 56.36 | 24.42 | 17.49 |
| 50 | 5477.3 | 1025.2 | 4452.1 | 18.72 | 49.04 | 34.70 | 14.91 |
| 54 | 5484.9 | 1029.5 | 4455.4 | 18.77 | 45.21 | 40.54 | 13.68 |
| 55 | 5417.2 | 891.1 | 4526.1 | 16.45 | 50.09 | 31.93 | 14.90 |
| 57 | 5003.5 | 753.9 | 4249.6 | 15.07 | 46.73 | 38.26 | 14.15 |
| 58 | 5452.2 | 799.5 | 4652.7 | 14.66 | 45.30 | 39.66 | 14.46 |
| 59 | 5893.0 | 984.1 | 4908.9 | 16.70 | 50.06 | 34.55 | 14.82 |
| 60 | 3056.8 | 735.4 | 2321.4 | 24.06 | 49.58 | 35.09 | 13.85 |
| 62 | 5011.4 | 834.8 | 4176.6 | 16.66 | 49.34 | 34.63 | 14.01 |
| 63 | 5370.4 | 814.7 | 4555.7 | 15.17 | 52.91 | 30.71 | 15.63 |
| 65 | 5210.6 | 884.0 | 4326.6 | 16.97 | 52.15 | 32.23 | 14.70 |
| 70 | 5519.5 | 937.7 | 4581.8 | 16.99 | 45.71 | 40.22 | 14.11 |

Table A-6. (cont'd)

| Steer no. | 9-10-11 rib wt., g | bone wt., g | Soft tissue, g | Bone in rib, % | Soft tissue Water, % | Soft tissue EEL, % | Soft tissue CP, % |
|---|---|---|---|---|---|---|---|
| 72 | 3864.3 | 809.9 | 3054.4 | 20.96 | 60.79 | 20.11 | 17.28 |
| 75 | 5103.7 | 1068.6 | 4035.1 | 20.94 | 55.57 | 26.20 | 16.35 |
| 76 | 5002.8 | 1025.3 | 3977.5 | 20.49 | 54.99 | 28.42 | 15.10 |
| 77 | 5234.9 | 1115.7 | 4119.2 | 21.31 | 51.95 | 31.25 | 15.73 |
| 78 | 3308.5 | 572.2 | 2736.3 | 17.29 | 48.49 | 35.98 | 13.86 |
| 80 | 5018.1 | 1105.6 | 3912.5 | 22.03 | 52.70 | 28.64 | 15.76 |
| 83 | 5953.1 | 1224.8 | 4728.3 | 20.57 | 56.79 | 26.15 | 16.84 |
| 85 | 3911.4 | 652.3 | 3259.1 | 16.68 | 47.73 | 36.82 | 13.33 |
| 86 | 5063.6 | 696.5 | 4367.1 | 13.76 | 46.02 | 38.87 | 13.03 |
| 87 | 5153.1 | 996.4 | 4156.7 | 19.34 | 52.84 | 31.28 | 15.08 |
| 89 | 4981.1 | 984.5 | 3996.6 | 19.76 | 54.41 | 27.20 | 16.69 |
| 90 | 4893.6 | 879.0 | 4014.6 | 17.96 | 52.64 | 30.59 | 15.82 |
| 95 | 3403.8 | 702.6 | 2701.2 | 20.64 | 51.80 | 31.81 | 14.47 |
| 97 | 5031.1 | 936.9 | 4094.2 | 18.62 | 49.73 | 34.58 | 13.94 |
| 98 | 3595.0 | 751.4 | 2843.6 | 20.90 | 54.98 | 26.55 | 17.14 |
| 100 | 3673.4 | 663.8 | 3009.6 | 18.07 | 55.44 | 26.69 | 14.32 |
| 101 | 5789.4 | 1156.2 | 4633.2 | 19.97 | 51.30 | 32.52 | 16.00 |
| 102 | 5647.9 | 994.0 | 4653.9 | 17.60 | 44.33 | 41.64 | 13.05 |
| 103 | 5422.1 | 1044 | 4378.1 | 19.25 | 48.25 | 35.62 | 14.11 |
| 104 | 5551.5 | 917.1 | 4634.4 | 16.52 | 42.11 | 44.49 | 11.85 |
| 106 | 3381.7 | 712.0 | 2669.7 | 21.05 | 50.38 | 33.19 | 14.92 |
| 107 | 4757.8 | 1010.7 | 3747.1 | 21.24 | 56.63 | 24.38 | 18.67 |
| 108 | 5406.8 | 1017.1 | 4389.7 | 18.81 | 59.01 | 21.60 | 17.86 |
| 109 | 5929.4 | 1262.3 | 4667.1 | 21.29 | 40.75 | 45.68 | 12.13 |
| 110 | 3144.1 | 704.1 | 2440.0 | 22.39 | 55.19 | 28.01 | 15.03 |
| 112 | 5064.6 | 855.8 | 4208.8 | 16.90 | 52.91 | 30.41 | 16.36 |
| 115 | 5587.0 | 987.4 | 4599.6 | 17.67 | 52.36 | 29.38 | 15.43 |
| 116 | 5341.0 | 931.3 | 4409.7 | 17.44 | 51.01 | 33.17 | 15.69 |
| 117 | 4775.6 | 1022.5 | 3753.1 | 21.41 | 51.32 | 32.36 | 15.12 |
| 118 | 3685.8 | 683.5 | 3002.3 | 18.54 | 53.51 | 28.89 | 15.88 |
| 119 | 4221.6 | 818.3 | 3403.3 | 19.38 | 42.09 | 44.70 | 12.47 |
| 120 | 3781.0 | 743.1 | 3037.9 | 19.65 | 55.15 | 27.67 | 15.10 |
| 121 | 5444.3 | 1033.2 | 4411.1 | 18.98 | 55.37 | 25.77 | 17.62 |
| 122 | 4015.4 | 780.1 | 3235.3 | 19.43 | 50.46 | 34.14 | 14.09 |
| 128 | 3288.6 | 646.6 | 2642.0 | 19.66 | 48.80 | 35.19 | 16.32 |
| 129 | 3818.6 | 786.5 | 3032.1 | 20.60 | 55.42 | 28.00 | 14.44 |
| 130 | 5545.5 | 995.0 | 4550.5 | 17.94 | 54.05 | 29.18 | 16.20 |
| 133 | 5125.3 | 893.7 | 4231.6 | 17.44 | 50.12 | 32.43 | 15.31 |
| 136 | 4791.5 | 760.4 | 4031.1 | 15.87 | 50.45 | 32.69 | 15.65 |
| 139 | 5069.9 | 1108.9 | 3961.0 | 21.87 | 51.02 | 33.17 | 14.76 |
| 142 | 4624.8 | 989 | 3635.8 | 21.38 | 57.57 | 24.09 | 17.81 |
| 143 | 5301.3 | 1017.3 | 4284.0 | 19.19 | 50.52 | 33.57 | 15.15 |

Table A-6. (cont'd)

| Steer no. | 9-10-11 rib wt., g | bone wt., g | Soft tissue, g | Bone in rib, % | Soft tissue | | |
|---|---|---|---|---|---|---|---|
| | | | | | Water, % | EEL, % | CP, % |
| 144 | 5098.5 | 990.0 | 4108.5 | 19.42 | 47.17 | 38.60 | 16.21 |
| 147 | 5127.9 | 791.6 | 4336.3 | 15.44 | 46.56 | 38.70 | 13.81 |
| 151 | 5590.6 | 865.8 | 4724.8 | 15.49 | 52.74 | 29.20 | 16.60 |
| 153 | 3360.9 | 788.4 | 2572.5 | 23.46 | 57.67 | 22.95 | 17.44 |
| 154 | 5414.3 | 925.5 | 4488.8 | 17.09 | 43.21 | 43.59 | 12.41 |
| 155 | 5066.9 | 950.7 | 4116.2 | 18.76 | 57.53 | 23.59 | 17.57 |
| 157 | 3860.0 | 854.7 | 3005.3 | 22.14 | 55.43 | 26.96 | 14.49 |
| 158 | 4974.0 | 875.1 | 4098.9 | 17.59 | 50.68 | 32.86 | 14.30 |
| 159 | 5624.9 | 963.3 | 4661.6 | 17.13 | 47.93 | 37.22 | 14.71 |
| 161 | 6060.4 | 860.8 | 5199.6 | 14.20 | 45.43 | 40.18 | 13.94 |
| 163 | 4717.0 | 955.3 | 3761.7 | 20.25 | 53.01 | 28.85 | 16.82 |
| 165 | 5564.6 | 827.2 | 4737.4 | 14.87 | 49.00 | 33.51 | 16.56 |
| 166 | 5884.9 | 976.4 | 4908.5 | 16.59 | 50.53 | 32.71 | 15.27 |
| 170 | 5366.1 | 972.5 | 4393.6 | 18.12 | 50.72 | 31.44 | 15.32 |
| 171 | 3348.9 | 675.9 | 2673.0 | 20.18 | 58.38 | 21.92 | 16.92 |
| 172 | 3474.7 | 602.0 | 2872.7 | 17.33 | 54.05 | 28.44 | 15.44 |
| 173 | 3309.7 | 865.3 | 2444.4 | 26.14 | 57.31 | 24.55 | 15.87 |
| 180 | 6323.7 | 1119.1 | 5204.6 | 17.70 | 49.47 | 35.08 | 13.94 |
| 183 | 5250.9 | 774.9 | 4476.0 | 14.76 | 44.52 | 41.50 | 12.82 |
| 184 | 5203.0 | 1050.0 | 4153.0 | 20.18 | 50.62 | 33.65 | 14.03 |
| 187 | 3711.8 | 721.0 | 2990.8 | 19.42 | 58.41 | 22.87 | 16.93 |
| 192 | 5432.4 | 1064.6 | 4367.8 | 19.60 | 44.69 | 40.67 | 13.42 |
| 194 | 4429.7 | 777.1 | 3652.6 | 17.54 | 53.08 | 28.40 | 14.94 |
| 195 | 5492.4 | 872.3 | 4620.1 | 15.88 | 55.46 | 27.25 | 13.72 |
| 196 | 5349.7 | 820.6 | 4529.1 | 15.34 | 46.88 | 38.51 | 14.92 |
| 197 | 5191.5 | 1101.5 | 4090.0 | 21.22 | 54.04 | 28.12 | 16.32 |
| 198 | 5732.9 | 843.3 | 4889.6 | 14.71 | 41.94 | 44.87 | 11.70 |
| 199 | 5895.1 | 1026.8 | 4868.3 | 17.42 | 50.78 | 32.67 | 15.54 |
| 201 | 3087.2 | 600.1 | 2487.1 | 19.44 | 56.22 | 25.47 | 15.85 |
| 205 | 5471.1 | 1043.0 | 4428.1 | 19.06 | 48.00 | 36.42 | 14.21 |
| 211 | 4399.6 | 846.3 | 3553.3 | 19.24 | 56.51 | 24.71 | 16.88 |
| 212 | 4907.8 | 915.3 | 3992.5 | 18.65 | 46.92 | 37.68 | 13.39 |
| 213 | 3415.5 | 729.7 | 2685.8 | 21.36 | 57.22 | 23.89 | 16.41 |
| 215 | 4991.8 | 897.3 | 4094.5 | 17.98 | 48.77 | 35.62 | 13.51 |
| 217 | 5354.7 | 1254.8 | 4099.9 | 23.43 | 54.73 | 27.38 | 16.70 |
| 218 | 5101.1 | 946.6 | 4154.5 | 18.56 | 54.33 | 28.04 | 17.02 |
| 221 | 6024.4 | 984.9 | 5039.5 | 16.35 | 49.53 | 34.54 | 14.82 |
| 222 | 5472.4 | 945.3 | 4527.1 | 17.27 | 49.35 | 34.36 | 13.81 |
| 225 | 6098.0 | 1121.3 | 4976.7 | 18.39 | 59.09 | 21.79 | 18.10 |
| 227 | 3510.9 | 728.8 | 2782.1 | 20.76 | 53.10 | 30.57 | 13.67 |
| 228 | 5191.0 | 1071.2 | 4119.8 | 20.64 | 54.12 | 28.84 | 16.38 |
| 232 | 4706.9 | 731.4 | 3975.5 | 15.54 | 43.99 | 41.87 | 12.83 |

Table A-6. (cont'd)

| Steer no. | 9-10-11 rib wt., g | bone wt., g | Soft tissue, g | Bone in rib, % | Soft tissue Water, % | Soft tissue EEL, % | Soft tissue CP, % |
|---|---|---|---|---|---|---|---|
| 234 | 4404.2 | 880.3 | 3523.9 | 19.99 | 57.53 | 24.91 | 17.29 |
| 236 | 5277.0 | 921.1 | 4355.9 | 17.45 | 53.35 | 28.30 | 16.94 |
| 238 | 5930.3 | 1072.7 | 4857.6 | 18.09 | 49.74 | 33.97 | 14.23 |
| 239 | 4526.6 | 744.9 | 3781.7 | 16.46 | 54.16 | 28.01 | 16.51 |
| 241 | 5296.9 | 981.0 | 4315.9 | 18.52 | 51.80 | 32.83 | 14.75 |
| 243 | 5311.8 | 948.1 | 4363.7 | 17.85 | 46.01 | 40.10 | 14.04 |

Table A-7. Organ and muscle weights from Experiment BC9002

| Steer no. | Liver wt., g | Spleen wt., g | Kidney wt., g | Heart wt., g | Lung wt., g | ST muscle wt., g |
|---|---|---|---|---|---|---|
| 1 | 8377 | 1414 | 1264 | 2290 | 6282 | 1958 |
| 2 | 7041 | 1273 | 1032 | 1880 | 7930 | 2658 |
| 5 | 8186 | 1173 | 1214 | 2159 | 7473 | 2587 |
| 8 | 5492 | 818 | 1096 | 1703 | 5420 | 1327 |
| 9 | 6350 | 968 | 1723 | 2298 | 9142 | 2600 |
| 10 | 6247 | 978 | ND[a] | 1652 | 5293 | 1852 |
| 11 | 5832 | 863 | 1013 | 1604 | 6115 | 1427 |
| 12 | 6159 | 945 | ND | 1758 | 7322 | 1922 |
| 13 | 7991 | 1132 | 1514 | 1876 | 7866 | 2576 |
| 14 | 5218 | 1104 | 1100 | 1502 | 5075 | 1413 |
| 16 | 6914 | 1241 | 973 | 2108 | 6441 | 2615 |
| 17 | 8127 | 1223 | 1286 | 2160 | 7358 | 2183 |
| 18 | 7759 | 1250 | 1277 | 2144 | 7167 | 2566 |
| 20 | 6809 | 1364 | 1286 | 1834 | 6573 | 2620 |
| 21 | 5955 | 1136 | 1800 | 2053 | 7126 | 2037 |
| 25 | 6536 | 1132 | 1341 | 1515 | 4191 | 2602 |
| 27 | 5930 | 1100 | 1352 | 1423 | 5509 | 1755 |
| 29 | 6432 | 895 | 1068 | 1821 | 7502 | 2294 |
| 31 | 6477 | 1268 | 1605 | 2396 | 7645 | 2279 |
| 32 | 5528 | 710 | 1054 | 1403 | 5374 | 1557 |
| 34 | 5550 | 1300 | 918 | 1916 | 7394 | 2067 |
| 37 | 7750 | 1236 | 1555 | 2247 | 8528 | 2490 |
| 38 | 7559 | 1218 | 1177 | 1960 | 7055 | 2314 |
| 40 | 6519 | 986 | 1403 | 1684 | 5556 | 1725 |
| 42 | 7132 | 1150 | 1409 | 1757 | 7932 | 2745 |
| 43 | 5764 | 918 | 1077 | 2318 | 5698 | 2394 |
| 44 | 7305 | 1177 | 1209 | 2312 | 7089 | 2477 |
| 45 | 5929 | 978 | 1208 | 1605 | 5780 | 1621 |
| 46 | 6736 | 1036 | 1386 | 1790 | 6412 | 2308 |
| 47 | 9032 | 1036 | 1300 | 2032 | 7488 | 2616 |
| 50 | 7186 | 1414 | 1873 | 2085 | 7396 | 1839 |
| 54 | 7159 | 1286 | 1541 | 2315 | 7790 | 2567 |
| 55 | 6391 | 1241 | 1327 | 2100 | 6928 | 2442 |
| 57 | 6627 | 868 | 1005 | 2731 | 7313 | 2249 |
| 58 | 7232 | ND[a] | 1059 | 2025 | 6069 | 2527 |
| 59 | 7800 | 1173 | 1368 | 2032 | 8424 | 2694 |
| 60 | 5906 | 1052 | 1342 | 1782 | 7067 | 1261 |
| 62 | 5959 | 1073 | 895 | 1879 | 6160 | 1886 |
| 63 | 7150 | 991 | 1395 | 1963 | 7896 | 2470 |
| 65 | 6205 | 1277 | 1200 | 2056 | 6161 | 2123 |
| 70 | 7318 | 1050 | 1100 | 2015 | 7775 | 2176 |

Table A-7. (cont'd)

| Steer no. | Liver wt., g | Spleen wt., g | Kidney wt., g | Heart wt., g | Lung wt., g | ST muscle wt., g |
|---|---|---|---|---|---|---|
| 72 | 5764 | 1026 | 1184 | 1593 | 6186 | 1809 |
| 75 | 6873 | 1405 | 1350 | 1940 | 6121 | 2171 |
| 76 | 7032 | 955 | 1195 | 2030 | 7150 | 2259 |
| 77 | 7068 | 1336 | 1909 | 1960 | 7943 | 2236 |
| 78 | 8673 | 788 | 1354 | 1572 | 5525 | 1462 |
| 80 | 7468 | 1545 | 1564 | 1291 | ND | 2675 |
| 83 | 7159 | 1114 | 1545 | 2036 | 6950 | 2795 |
| 85 | 6075 | 850 | 1308 | 1527 | 5582 | 1719 |
| 86 | 5973 | 1009 | 1027 | 2184 | 8575 | 1934 |
| 87 | 7618 | 1668 | 1441 | 2105 | 7983 | 2132 |
| 89 | 7195 | 1023 | 1700 | 2002 | 7412 | 2143 |
| 90 | 7700 | 1405 | 1318 | 1897 | 6298 | 2278 |
| 95 | 5330 | 994 | 1040 | 1692 | 5948 | 1432 |
| 97 | 7605 | 927 | 1209 | 2235 | 7042 | 2362 |
| 98 | 5580 | 1170 | 1146 | 1544 | 5497 | 1617 |
| 100 | 6646 | 980 | 1219 | 1812 | 6902 | 1675 |
| 101 | 7586 | 832 | 1659 | 2042 | 6396 | 2610 |
| 102 | 6527 | 1164 | 1355 | 2130 | 8037 | 2572 |
| 103 | 7205 | 1182 | 1314 | 2144 | 8788 | 2534 |
| 104 | 6309 | 955 | 1227 | 1950 | 8140 | 2603 |
| 106 | 5318 | 748 | 1266 | 1621 | 6405 | 1540 |
| 107 | 6032 | 1341 | 1559 | 1937 | 7099 | 2753 |
| 108 | 7709 | 1286 | 1409 | 2177 | 7410 | 2557 |
| 109 | 6950 | 1077 | 1273 | 2158 | 7440 | 2430 |
| 110 | 5892 | 794 | 1309 | 1224 | 6567 | 1510 |
| 112 | 7600 | 1377 | 1377 | 2302 | 7492 | 2460 |
| 115 | 7055 | 955 | 1000 | 2035 | 6508 | 2475 |
| 116 | 7877 | 1705 | 1018 | 1731 | 6719 | 2756 |
| 117 | 7455 | 1041 | 1405 | 1946 | 6348 | 2366 |
| 118 | 5878 | 1028 | 1310 | 1720 | 6583 | 1644 |
| 119 | 6559 | 1164 | 1141 | 1812 | 7368 | 1850 |
| 120 | 6555 | 922 | 1240 | 1945 | 6117 | 2030 |
| 121 | 7173 | 1459 | 1232 | 1896 | 6683 | 2163 |
| 122 | 6486 | 932 | 1255 | 1728 | 5670 | 1971 |
| 128 | 5810 | 1146 | 1058 | 1904 | 5591 | 1630 |
| 129 | 7130 | 1094 | 1390 | 1549 | 5476 | 1716 |
| 130 | 8473 | 1241 | 1364 | 2166 | 6681 | 2681 |
| 133 | 6582 | 909 | 1241 | 2110 | 7380 | 2327 |
| 136 | 8218 | 1200 | 1495 | 2441 | 7367 | 2376 |
| 139 | 7086 | 1018 | 1405 | 1922 | 6196 | 2257 |
| 142 | 8682 | 864 | 1745 | 2040 | 9096 | 2709 |
| 143 | 6459 | 1277 | 1359 | 2184 | 7678 | 2570 |
| 144 | 7123 | 1141 | 1641 | 1990 | 6946 | 2315 |

Table A-7. (cont'd)

| Steer no. | Liver wt., g | Spleen wt., g | Kidney wt., g | Heart wt., g | Lung wt., g | ST muscle wt., g |
|---|---|---|---|---|---|---|
| 147 | 7245 | 914 | 1200 | 2103 | 6197 | 2103 |
| 151 | 6691 | 1477 | 1273 | 2150 | 7696 | 2757 |
| 153 | 5776 | 1154 | 1270 | 1489 | 6188 | 1782 |
| 154 | 6582 | 1027 | 1027 | 1663 | 7265 | 2258 |
| 155 | 5977 | 1377 | 1127 | 1900 | 6509 | 2330 |
| 157 | 5981 | 1151 | 1083 | 1834 | 5255 | 1753 |
| 158 | 8714 | 891 | 1536 | 1873 | 9712 | 2638 |
| 159 | 7741 | 1027 | 1205 | 1585 | 8307 | 2050 |
| 161 | 8673 | 1082 | 1309 | 2593 | 7470 | 2260 |
| 163 | 7973 | 1395 | 1405 | 2016 | 6020 | 2562 |
| 165 | 6991 | 1145 | 1095 | 1947 | 6732 | 2224 |
| 166 | 7459 | 1218 | 1395 | 2301 | 6600 | 2566 |
| 170 | 7809 | 686 | 1041 | 2544 | 7860 | 2571 |
| 171 | 5158 | 724 | 1040 | 1669 | 7008 | 1580 |
| 172 | 6143 | 932 | 1410 | 1438 | 4936 | 1605 |
| 173 | 6509 | 1214 | 1355 | 974 | 4306 | 1460 |
| 180 | 7473 | 1295 | 1618 | 2218 | 6622 | 2665 |
| 183 | 7368 | 1091 | 1386 | 2105 | 7043 | 2000 |
| 184 | 6550 | 1059 | 1209 | 2023 | 7200 | 2358 |
| 187 | 6530 | 1454 | 1348 | 1665 | 6831 | 1836 |
| 192 | 7518 | 1055 | 1618 | 2100 | 7130 | 2640 |
| 194 | 7068 | 836 | 1186 | 2428 | 7162 | 1908 |
| 195 | 7468 | 977 | 1509 | 2035 | 7293 | 2389 |
| 196 | 6500 | 1136 | 1086 | 2098 | 6741 | 2216 |
| 197 | 7745 | 1291 | 1395 | 1953 | 7400 | 2352 |
| 198 | 7327 | 995 | 1523 | 2036 | 7718 | 2350 |
| 199 | 5632 | 1455 | 1195 | 2191 | 7235 | 2495 |
| 201 | 5586 | 981 | 980 | 1706 | 6037 | 1402 |
| 205 | 7300 | 1205 | 1236 | 2201 | 7225 | 2266 |
| 211 | 5396 | 716 | 1372 | 1733 | 6769 | 1867 |
| 212 | 6077 | 868 | 1064 | 1931 | 7254 | 2307 |
| 213 | 5631 | 924 | 1410 | 1436 | 5538 | 1596 |
| 215 | 5923 | 1227 | 1109 | 1934 | 6762 | 2252 |
| 217 | 6882 | 909 | 1318 | 1830 | 6130 | 2734 |
| 218 | 7073 | 1345 | 1259 | 2190 | 6632 | 2213 |
| 221 | 9100 | 1164 | 1686 | 1836 | 7610 | 2784 |
| 222 | 7445 | 1141 | 1295 | 1935 | 7095 | 2345 |
| 225 | 8677 | 1709 | 1859 | 2368 | 7655 | 3018 |
| 227 | 5186 | 706 | 1092 | 1506 | 5941 | 1435 |
| 228 | 8618 | 1618 | 1995 | 2975 | 7526 | 2751 |
| 232 | 5891 | 1368 | 1191 | 1979 | 7729 | 2121 |
| 234 | 7305 | 1295 | 1455 | 3048 | 11193 | 2207 |
| 236 | 8509 | 1036 | 1541 | 2316 | 7641 | 2487 |

Table A-7. (cont'd)

| Steer no. | Liver wt., g | Spleen wt., g | Kidney wt., g | Heart wt., g | Lung wt., g | ST muscle wt., g |
|---|---|---|---|---|---|---|
| 238 | 5914 | 1295 | 1436 | 2135 | 6696 | 2787 |
| 239 | 7795 | 1391 | 1705 | 2080 | 6750 | 1956 |
| 241 | 5818 | 982 | 1486 | 2102 | 6944 | 2254 |
| 243 | 7945 | 1277 | 1082 | 2050 | 8052 | 2829 |

[a]Not determined.

Table A-8. Steer hip height for Experiment BC9002

| Steer no. | 04/25/91 Initial #1 hip ht., in | 04/26/91 Initial #2 hip ht., in | Average Initial hip ht., in | 08/30/91 Day 112 hip ht., in | 10/25/91 Day 181 hip ht., in | 10/27/91 Day 183 hip ht., in | Average Day 182 hip ht., in | Final hip ht., in #1 | #2 | Avg. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 44.13 | 44.00 | 44.06 | 50.25 | 52.13 | 52.88 | 52.50 | 55.00 | 55.69 | 55.35 |
| 2 | 44.31 | 43.75 | 44.03 | 50.13 | 52.88 | 53.25 | 53.06 | 57.13 | 56.44 | 56.79 |
| 4 | 44.00 | 42.69 | 43.34 | | | | | | | |
| 5 | 44.38 | 44.44 | 44.41 | 50.50 | 52.88 | 54.63 | 53.75 | 58.13 | 57.44 | 57.79 |
| 8 | 43.38 | 43.00 | 43.19 | 48.13 | 52.00 | 51.75 | 51.88 | | | |
| 9 | 42.25 | 43.25 | 42.75 | 48.94 | 52.38 | 52.75 | 52.56 | 57.25 | 56.38 | 56.82 |
| 10 | 46.31 | 47.00 | 46.66 | 52.50 | 55.00 | 56.06 | 55.53 | | | |
| 11 | 43.25 | 44.75 | 44.00 | 49.38 | 52.38 | 53.13 | 52.75 | | | |
| 12 | 41.88 | 42.19 | 42.03 | 48.56 | 49.88 | 50.69 | 50.28 | 54.88 | 54.81 | 54.85 |
| 13 | 44.19 | 43.19 | 43.69 | 50.13 | 52.81 | 53.56 | 53.19 | 55.38 | 55.00 | 55.19 |
| 14 | 42.63 | 42.13 | 42.38 | 47.50 | 50.38 | 50.25 | 50.31 | | | |
| 16 | 42.63 | 42.13 | 42.38 | 48.31 | 52.38 | 52.56 | 52.47 | 56.13 | 55.44 | 55.79 |
| 17 | 42.56 | 43.44 | 43.00 | 50.38 | 53.50 | 53.63 | 53.56 | 59.13 | 58.50 | 58.82 |
| 18 | 42.94 | 43.81 | 43.38 | 50.19 | 52.25 | 53.75 | 53.00 | 57.81 | 57.50 | 57.66 |
| 19 | 40.50 | 42.13 | 41.31 | 47.50 | | | | | | |
| 20 | 44.19 | 43.94 | 44.06 | 49.50 | 52.50 | 53.31 | 52.91 | 56.69 | 55.81 | 56.25 |
| 21 | 43.25 | 43.50 | 43.38 | 48.63 | 50.38 | 51.38 | 50.88 | 53.50 | 53.63 | 53.57 |
| 25 | 43.13 | 43.13 | 43.13 | 49.69 | 51.81 | 52.63 | 52.22 | 56.06 | 56.06 | 56.06 |
| 27 | 41.31 | 38.88 | 40.09 | 47.69 | 50.06 | 50.38 | 50.22 | | | |
| 29 | 42.81 | 43.25 | 43.03 | 48.88 | 51.88 | 52.56 | 52.22 | 56.63 | 56.81 | 56.72 |
| 31 | 44.56 | 45.13 | 44.84 | 50.56 | 54.00 | 54.63 | 54.31 | 58.50 | 58.88 | 58.69 |
| 32 | 42.44 | 42.88 | 42.66 | 49.00 | 51.38 | 52.50 | 51.94 | | | |
| 34 | 43.88 | 45.06 | 44.47 | 50.06 | 53.75 | 52.69 | 53.22 | 57.75 | 57.13 | 57.44 |
| 37 | 42.88 | 43.06 | 42.97 | 48.44 | 51.50 | 52.13 | 51.81 | 57.06 | 56.94 | 57.00 |
| 38 | 42.56 | 43.81 | 43.19 | 48.13 | 51.06 | 52.88 | 51.97 | 56.81 | 56.75 | 56.78 |
| 39 | 43.00 | 43.81 | 43.41 | 49.00 | 52.00 | 51.63 | 51.81 | | | |
| 40 | 42.50 | 42.25 | 42.38 | 49.19 | 51.50 | 53.06 | 52.28 | | | |
| 42 | 44.88 | 44.19 | 44.53 | 51.50 | 52.75 | 53.44 | 53.09 | 56.75 | 56.94 | 56.85 |
| 43 | 43.13 | 43.13 | 43.13 | 48.56 | 51.75 | 52.50 | 52.13 | 55.44 | 56.00 | 55.72 |
| 44 | 43.50 | 42.63 | 43.06 | 49.19 | 51.38 | 52.63 | 52.00 | 56.88 | 56.06 | 56.47 |
| 45 | 43.94 | 43.88 | 43.91 | 49.56 | 51.19 | 51.75 | 51.47 | | | |
| 46 | 44.44 | 43.38 | 43.91 | 49.88 | 52.56 | 52.38 | 52.47 | 56.75 | 55.50 | 56.13 |
| 47 | 42.56 | 43.19 | 42.88 | 49.06 | 51.88 | 52.25 | 52.06 | 58.25 | 58.19 | 58.22 |
| 49 | 43.50 | 43.63 | 43.56 | | | | | | | |
| 50 | 44.50 | 43.69 | 44.09 | 51.13 | 53.25 | 53.25 | 53.25 | 56.81 | 57.00 | 56.91 |
| 54 | 43.38 | 44.44 | 43.91 | 50.44 | 53.00 | 54.00 | 53.50 | 56.81 | 56.19 | 56.50 |
| 55 | 41.25 | 42.19 | 41.72 | 48.50 | 52.00 | 53.88 | 52.94 | 57.81 | 57.38 | 57.60 |
| 56 | 42.75 | 42.56 | 42.66 | 49.13 | 52.38 | 52.25 | 52.31 | | | |
| 57 | 42.19 | 42.00 | 42.09 | 47.50 | 51.50 | 51.50 | 51.50 | 55.44 | 53.75 | 54.60 |
| 58 | 43.38 | 44.63 | 44.00 | 49.25 | 52.50 | 53.25 | 52.88 | 56.88 | 57.00 | 56.94 |

Table A-8. (cont'd)

| Steer no. | 04/25/91 Initial #1 hip ht., in | 04/26/91 Initial #2 hip ht., in | Average Initial hip ht., in | 08/30/91 Day 112 hip ht., in | 10/25/91 Day 181 hip ht., in | 10/27/91 Day 183 hip ht., in | Average Day 182 hip ht., in | Final hip ht., in #1 | #2 | Avg. |
|---|---|---|---|---|---|---|---|---|---|---|
| 59 | 40.00 | 40.13 | 40.06 | 47.25 | 49.25 | 50.56 | 49.91 | 55.13 | 55.63 | 55.38 |
| 60 | 42.50 | 41.00 | 41.75 | 48.94 | 52.75 | 53.13 | 52.94 | | | |
| 62 | 41.94 | 40.94 | 41.44 | 47.75 | 51.00 | 49.19 | 50.09 | 53.25 | 53.50 | 53.38 |
| 63 | 41.38 | 40.81 | 41.09 | 47.56 | 50.88 | 50.56 | 50.72 | 54.06 | 54.50 | 54.28 |
| 65 | 42.25 | 41.69 | 41.97 | 46.94 | 49.75 | 49.38 | 49.56 | 53.75 | 52.88 | 53.32 |
| 70 | 45.00 | 44.25 | 44.63 | 50.19 | 53.13 | 53.25 | 53.19 | 56.56 | 57.88 | 57.22 |
| 72 | 41.00 | 40.50 | 40.75 | 50.00 | 52.88 | 52.00 | 52.44 | | | |
| 73 | 42.44 | 42.25 | 42.34 | 47.31 | 51.13 | 51.56 | 51.34 | | | |
| 75 | 43.88 | 42.25 | 43.06 | 49.06 | 52.75 | 53.88 | 53.31 | 57.50 | 57.75 | 57.63 |
| 76 | 42.75 | 42.13 | 42.44 | 47.56 | 50.50 | 51.00 | 50.75 | 56.75 | 56.75 | 56.75 |
| 77 | 43.31 | 43.13 | 43.22 | 49.50 | 52.88 | 52.50 | 52.69 | 54.38 | 55.50 | 54.94 |
| 78 | 41.25 | 41.94 | 41.59 | 49.75 | 51.38 | 51.63 | 51.50 | | | |
| 79 | 39.88 | 39.69 | 39.78 | 47.50 | | | | | | |
| 80 | 44.75 | 44.44 | 44.59 | 51.50 | 54.81 | 55.69 | 55.25 | 58.88 | 59.44 | 59.16 |
| 83 | 43.44 | 44.00 | 43.72 | 50.25 | 53.38 | 52.94 | 53.16 | 56.31 | 57.31 | 56.81 |
| 84 | 45.25 | 43.94 | 44.59 | 50.00 | | | | | | |
| 85 | 42.63 | 42.19 | 42.41 | 49.00 | 51.00 | 51.25 | 51.13 | | | |
| 86 | 42.00 | 42.56 | 42.28 | 49.00 | 51.00 | 52.00 | 51.50 | 55.81 | 56.25 | 56.03 |
| 87 | 42.75 | 43.00 | 42.88 | 50.63 | 53.25 | 53.88 | 53.56 | 58.75 | 59.25 | 59.00 |
| 88 | 42.50 | 40.63 | 41.56 | 47.00 | 49.88 | 50.13 | 50.00 | | | |
| 89 | 41.81 | 41.75 | 41.78 | 49.25 | 52.25 | 53.13 | 52.69 | 58.50 | 57.38 | 57.94 |
| 90 | 43.56 | 43.44 | 43.50 | 50.19 | 52.75 | 53.44 | 53.09 | 57.56 | 58.13 | 57.85 |
| 91 | 43.56 | 44.63 | 44.09 | 48.06 | 51.00 | 52.00 | 51.50 | | | |
| 94 | 42.38 | 42.56 | 42.47 | 48.63 | 52.50 | 52.25 | 52.38 | | | |
| 95 | 42.00 | 42.63 | 42.31 | 49.06 | 53.00 | 52.44 | 52.72 | | | |
| 97 | 41.50 | 41.06 | 41.28 | 47.38 | 51.38 | 53.13 | 52.25 | 55.06 | 55.50 | 55.28 |
| 98 | 43.88 | 43.38 | 43.63 | 48.06 | 52.00 | 52.50 | 52.25 | | | |
| 99 | 41.63 | 42.63 | 42.13 | 49.56 | | | | | | |
| 100 | 43.88 | 43.88 | 43.88 | 49.69 | 52.00 | 52.38 | 52.19 | | | |
| 101 | 44.13 | 43.38 | 43.75 | 49.44 | 51.50 | 50.50 | 51.00 | 57.56 | 57.94 | 57.75 |
| 102 | 45.94 | 45.44 | 45.69 | 51.38 | 53.00 | 53.50 | 53.25 | 56.94 | 58.00 | 57.47 |
| 103 | 41.88 | 41.56 | 41.72 | 50.31 | 52.50 | 53.81 | 53.16 | 58.25 | 57.38 | 57.82 |
| 104 | 41.88 | 42.19 | 42.03 | 48.06 | 51.19 | 51.25 | 51.22 | 55.81 | 55.50 | 55.66 |
| 105 | 44.63 | 45.44 | 45.03 | 52.50 | | | | | | |
| 106 | 44.63 | 43.81 | 44.22 | 50.00 | 52.50 | 52.94 | 52.72 | | | |
| 107 | 43.50 | 42.69 | 43.09 | 49.06 | 53.38 | 53.25 | 53.31 | 59.88 | 59.00 | 59.44 |
| 108 | 43.38 | 42.75 | 43.06 | 49.13 | 52.75 | 52.50 | 52.63 | 59.44 | 60.25 | 59.85 |
| 109 | 44.13 | 44.50 | 44.31 | 51.00 | 53.00 | 54.31 | 53.66 | 56.69 | 56.25 | 56.47 |
| 110 | 41.75 | 43.19 | 42.47 | 48.06 | 51.94 | 51.56 | 51.75 | | | |
| 111 | 40.50 | 41.13 | 40.81 | 49.00 | | | | | | |

Table A-8. (cont'd)

| Steer no. | 04/25/91 Initial #1 hip ht., in | 04/26/91 Initial #2 hip ht., in | Average Initial hip ht., in | 08/30/91 Day 112 hip ht., in | 10/25/91 Day 181 hip ht., in | 10/27/91 Day 183 hip ht., in | Average Day 182 hip ht., in | Final hip ht., in #1 | Final hip ht., in #2 | Final hip ht., in Avg. |
|---|---|---|---|---|---|---|---|---|---|---|
| 112 | 42.81 | 42.94 | 42.88 | 48.69 | 52.00 | 52.94 | 52.47 | 58.06 | 57.81 | 57.94 |
| 114 | 41.44 | 40.94 | 41.19 | | | | | | | |
| 115 | 43.44 | 43.50 | 43.47 | 47.56 | 51.25 | 50.56 | 50.91 | 55.94 | 55.38 | 55.66 |
| 116 | 44.63 | 44.69 | 44.66 | 50.25 | 54.38 | 53.56 | 53.97 | 59.13 | 59.06 | 59.10 |
| 117 | 44.88 | 46.00 | 45.44 | 52.00 | 54.50 | 55.00 | 54.75 | 58.81 | 59.50 | 59.16 |
| 118 | 42.50 | 42.56 | 42.53 | 49.81 | 51.88 | 51.31 | 51.59 | | | |
| 119 | 43.75 | 43.44 | 43.59 | 49.50 | 53.44 | 52.81 | 53.13 | 56.06 | 56.50 | 56.28 |
| 120 | 44.50 | 44.75 | 44.63 | 52.75 | 53.00 | 54.56 | 53.78 | | | |
| 121 | 41.63 | 41.56 | 41.59 | 48.50 | 51.25 | 52.06 | 51.66 | 57.50 | 56.50 | 57.00 |
| 122 | 43.50 | 43.38 | 43.44 | 49.13 | 50.50 | 51.50 | 51.00 | 53.06 | 53.06 | 53.06 |
| 123 | 42.19 | 43.13 | 42.66 | 49.06 | 52.94 | 53.25 | 53.09 | | | |
| 124 | 43.00 | 42.19 | 42.59 | 48.13 | 52.88 | 51.50 | 52.19 | | | |
| 127 | 43.69 | 42.69 | 43.19 | 50.00 | | | | | | |
| 128 | 44.63 | 44.00 | 44.31 | 50.00 | 52.75 | 53.25 | 53.00 | | | |
| 129 | 44.38 | 43.75 | 44.06 | 49.75 | 52.88 | 53.75 | 53.31 | | | |
| 130 | 43.94 | 43.81 | 43.88 | 48.50 | 50.50 | 51.06 | 50.78 | 55.50 | 56.75 | 56.13 |
| 133 | 42.50 | 42.13 | 42.31 | 49.75 | 52.56 | 52.69 | 52.63 | 56.19 | 56.75 | 56.47 |
| 135 | 42.44 | 43.00 | 42.72 | 47.63 | | | | | | |
| 136 | 43.25 | 43.31 | 43.28 | 48.75 | 53.75 | 53.50 | 53.63 | 57.44 | 57.63 | 57.54 |
| 137 | 43.63 | 41.88 | 42.75 | | | | | | | |
| 139 | 42.50 | 44.31 | 43.41 | 49.88 | 52.50 | 52.25 | 52.38 | 57.19 | 56.94 | 57.07 |
| 140 | 44.94 | 46.88 | 45.91 | | | | | | | |
| 141 | 42.38 | 43.50 | 42.94 | 46.19 | 51.00 | 51.50 | 51.25 | | | |
| 142 | 42.63 | 40.44 | 41.53 | 47.25 | 49.50 | 49.81 | 49.66 | 56.00 | 56.50 | 56.25 |
| 143 | 46.25 | 45.19 | 45.72 | 51.00 | 53.25 | 54.44 | 53.84 | 59.25 | 58.38 | 58.82 |
| 144 | 41.63 | 41.44 | 41.53 | 47.88 | 50.50 | 52.13 | 51.31 | 56.25 | 55.88 | 56.07 |
| 147 | 43.94 | 45.00 | 44.47 | 51.38 | 53.75 | 53.50 | 53.63 | 57.06 | 57.75 | 57.41 |
| 151 | 42.00 | 41.69 | 41.84 | 50.19 | 51.19 | 53.50 | 52.34 | 58.00 | 57.38 | 57.69 |
| 153 | 44.25 | 44.63 | 44.44 | 48.69 | 52.06 | 52.69 | 52.38 | | | |
| 154 | 42.88 | 43.44 | 43.16 | 49.25 | 52.50 | 53.00 | 52.75 | 55.50 | 55.88 | 55.69 |
| 155 | 42.13 | 41.69 | 41.91 | 48.56 | 52.25 | 51.88 | 52.06 | 58.44 | 57.50 | 57.97 |
| 157 | 45.88 | 46.44 | 46.16 | 52.88 | 55.50 | 55.94 | 55.72 | | | |
| 158 | 41.38 | 40.38 | 40.88 | 49.00 | 52.75 | 52.25 | 52.50 | 57.50 | 53.25 | 55.38 |
| 159 | 43.63 | 43.13 | 43.38 | 49.19 | 52.50 | 52.50 | 52.50 | 56.38 | 55.88 | 56.13 |
| 161 | 42.44 | 41.00 | 41.63 | 48.19 | 52.38 | 52.88 | 52.63 | 55.63 | 55.63 | 55.63 |
| 163 | 43.25 | 43.13 | 43.19 | 48.13 | 53.25 | 53.06 | 53.16 | 58.38 | 58.44 | 58.41 |
| 165 | 42.94 | 42.31 | 42.63 | 48.19 | 51.75 | 52.56 | 52.16 | 55.31 | 55.00 | 55.16 |
| 166 | 44.50 | 43.94 | 44.22 | 49.75 | 52.88 | 53.13 | 53.00 | 59.00 | 59.00 | 59.00 |
| 170 | 43.00 | 43.38 | 43.19 | 49.56 | 52.50 | 52.50 | 52.50 | 57.00 | 56.63 | 56.82 |
| 171 | 41.94 | 42.31 | 42.13 | 48.19 | 52.00 | 52.06 | 52.03 | | | |

Table A-8. (cont'd)

| Steer no. | 04/25/91 Initial #1 hip ht., in | 04/26/91 Initial #2 hip ht., in | Average Initial hip ht., in | 08/30/91 Day 112 hip ht., in | 10/25/91 Day 181 hip ht., in | 10/27/91 Day 183 hip ht., in | Average Day 182 hip ht., in | Final hip ht., in #1 | #2 | Avg. |
|---|---|---|---|---|---|---|---|---|---|---|
| 172 | 40.50 | 41.00 | 40.75 | 45.00 | 50.25 | 50.06 | 50.16 | | | |
| 173 | 43.13 | 42.56 | 42.84 | 49.38 | 53.00 | 53.50 | 53.25 | | | |
| 180 | 41.38 | 42.63 | 42.00 | 48.69 | 51.94 | 52.88 | 52.41 | 58.19 | 57.63 | 57.91 |
| 183 | 43.38 | 43.88 | 43.63 | 49.25 | 51.00 | 52.50 | 51.75 | 54.56 | 54.81 | 54.69 |
| 184 | 45.13 | 43.63 | 44.38 | 49.94 | 52.00 | 52.38 | 52.19 | 56.25 | 56.63 | 56.44 |
| 187 | 42.63 | 43.19 | 42.91 | 49.75 | 52.81 | 53.50 | 53.16 | | | |
| 192 | 44.13 | 43.31 | 43.72 | 50.50 | 52.88 | 54.44 | 53.66 | 57.63 | 58.06 | 57.85 |
| 194 | 41.88 | 42.00 | 41.94 | 47.44 | 51.00 | 52.00 | 51.50 | 56.06 | 56.50 | 56.28 |
| 195 | 43.13 | 44.00 | 43.56 | 48.94 | 52.38 | 53.88 | 53.13 | 57.13 | 57.50 | 57.32 |
| 196 | 43.19 | 42.31 | 42.75 | 48.19 | 51.25 | 52.19 | 51.72 | 55.13 | 54.69 | 54.91 |
| 197 | 44.25 | 43.94 | 44.09 | 50.75 | 52.94 | 53.44 | 53.19 | 56.50 | 57.00 | 56.75 |
| 198 | 44.00 | 43.88 | 43.94 | 48.69 | 51.00 | 50.00 | 50.50 | 54.06 | 54.00 | 54.03 |
| 199 | 43.00 | 42.94 | 42.97 | 45.75 | 52.56 | 52.25 | 52.41 | 57.13 | 56.75 | 56.94 |
| 201 | 41.25 | 41.69 | 41.47 | 48.63 | 51.38 | 51.69 | 51.53 | | | |
| 203 | 42.00 | 43.06 | 42.53 | | | | | | | |
| 205 | 43.63 | 43.13 | 43.38 | 49.88 | 52.75 | 54.00 | 53.38 | 57.56 | 57.25 | 57.41 |
| 206 | 42.88 | 40.88 | 41.88 | | | | | | | |
| 208 | 43.06 | 42.69 | 42.88 | | | | | | | |
| 210 | 43.13 | 42.75 | 42.94 | | | | | | | |
| 211 | 43.81 | 44.00 | 43.91 | 50.13 | 53.50 | 55.00 | 54.25 | | | |
| 212 | 42.75 | 42.19 | 42.47 | 47.25 | 52.00 | 51.81 | 51.91 | 54.38 | 54.56 | 54.47 |
| 213 | 43.81 | 43.88 | 43.84 | 49.81 | 53.50 | 53.88 | 53.69 | | | |
| 215 | 44.94 | 43.00 | 43.97 | 50.81 | 52.00 | 52.31 | 52.16 | 56.56 | 56.75 | 56.66 |
| 216 | 43.44 | 42.38 | 42.91 | 50.50 | 53.00 | 53.75 | 53.38 | | | |
| 217 | 43.69 | 43.13 | 43.41 | 48.25 | 52.00 | 52.25 | 52.13 | 54.13 | 55.38 | 54.76 |
| 218 | 42.25 | 42.50 | 42.38 | 49.00 | 52.00 | 51.00 | 51.50 | 56.63 | 56.50 | 56.57 |
| 221 | 43.75 | 40.88 | 42.31 | 50.00 | 52.88 | 53.50 | 53.19 | 57.00 | 57.88 | 57.44 |
| 222 | 44.25 | 44.00 | 44.13 | 50.63 | 52.88 | 53.50 | 53.19 | 56.50 | 56.06 | 56.28 |
| 225 | 43.75 | 44.69 | 44.22 | 51.00 | 52.88 | 54.00 | 53.44 | 57.63 | 58.00 | 57.82 |
| 227 | 42.50 | 42.88 | 42.69 | 47.88 | 50.50 | 50.50 | 50.50 | | | |
| 228 | 42.50 | 43.50 | 43.00 | 49.44 | 52.50 | 51.63 | 52.06 | 57.31 | 57.31 | 57.31 |
| 231 | 43.75 | 44.13 | 43.94 | 51.50 | 53.60 | 53.38 | 53.49 | | | |
| 232 | 43.31 | 43.88 | 43.59 | 48.94 | 50.06 | 51.50 | 50.78 | 53.13 | 54.00 | 53.57 |
| 234 | 42.94 | 43.31 | 43.13 | 49.19 | 52.25 | 53.63 | 52.94 | 58.00 | 57.81 | 57.91 |
| 236 | 41.38 | 41.88 | 41.63 | 48.50 | 51.50 | 51.44 | 51.47 | 56.75 | 56.75 | 56.75 |
| 237 | 43.50 | 44.50 | 44.00 | 51.00 | 54.00 | 54.25 | 54.13 | | | |
| 238 | 44.44 | 44.06 | 44.25 | 50.00 | 51.75 | 53.13 | 52.44 | 56.00 | 56.88 | 56.44 |
| 239 | 41.94 | 42.69 | 42.31 | 47.31 | 51.38 | 51.25 | 51.31 | 54.50 | 54.63 | 54.57 |
| 241 | 45.00 | 44.38 | 44.69 | 51.63 | 53.38 | 53.75 | 53.56 | 57.69 | 56.63 | 57.16 |
| 243 | 44.75 | 43.75 | 44.25 | 49.44 | 53.00 | 54.88 | 53.94 | 59.13 | 58.25 | 58.69 |

Table A-9. Metacarpal bone characteristics for Experiment BC9002

| Steer no. | Metacarpal length, cm | Section wt., g | Section length, in | Volume, $cm^3$ | Density, $g/cm^3$ | Medial width, in | Medial depth, in | Lateral width, in | Lateral depth, in | Circum., mm | Total area, $in^2$ #1 | Total area, $in^2$ #2 | Total area, $in^2$ Avg. | Marrow area, $in^2$ #1 | Marrow area, $in^2$ #2 | Marrow area, $in^2$ Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 22.8 | 35.6993 | 1.165 | 18.91 | 1.89 | 0.725 | 0.530 | 1.456 | 1.100 | 110.0 | 1.32 | 1.37 | 1.35 | 0.40 | 0.43 | 0.42 |
| 2 | 22.0 | 38.3149 | 1.150 | 15.98 | 2.40 | 0.796 | 0.532 | 1.605 | 1.096 | 116.0 | 1.40 | 1.43 | 1.42 | 0.47 | 0.46 | 0.47 |
| 5 | 21.8 | 39.7904 | 1.184 | 19.51 | 2.04 | 0.782 | 0.573 | 1.600 | 1.175 | 121.0 | 1.55 | 1.55 | 1.55 | 0.55 | 0.55 | 0.55 |
| 6 | 19.4 | 19.1969 | 1.145 | 10.95 | 1.75 | 0.669 | 0.496 | 1.148 | 0.867 | 87.0 | 0.82 | 0.82 | 0.82 | 0.25 | 0.27 | 0.26 |
| 7 | 20.0 | 17.4251 | 1.121 | 10.45 | 1.67 | 0.755 | 0.560 | 1.155 | 0.886 | 87.5 | 0.85 | 0.83 | 0.84 | 0.30 | 0.34 | 0.32 |
| 8 | 21.9 | 28.6208 | 1.124 | 14.82 | 1.93 | 0.694 | 0.532 | 1.300 | 1.025 | 103.5 | 1.20 | 1.18 | 1.19 | 0.44 | 0.40 | 0.42 |
| 9 | 23.0 | 39.5085 | 1.113 | 22.28 | 1.77 | 0.721 | 0.575 | 1.506 | 1.172 | 115.5 | 1.44 | 1.43 | 1.44 | 0.40 | 0.41 | 0.41 |
| 10 | Cut at harvest, not all characteristics measured | | | | | | | | | 116.5 | | | | | | |
| 11 | 21.4 | 29.1171 | 1.132 | 14.43 | 2.02 | 0.642 | 0.504 | 1.329 | 1.011 | 99.0 | 1.07 | 1.10 | 1.09 | 0.35 | 0.32 | 0.33 |
| 12 | 22.3 | 33.1034 | 1.096 | 18.68 | 1.77 | 0.666 | 0.498 | 1.425 | 1.068 | 105.0 | 1.18 | 1.20 | 1.19 | 0.32 | 0.32 | 0.32 |
| 13 | 21.5 | 33.1576 | 1.145 | 16.88 | 1.96 | 0.816 | 0.575 | 1.488 | 1.061 | 113.5 | 1.33 | 1.35 | 1.34 | 0.46 | 0.45 | 0.46 |
| 14 | Cut at harvest, not all characterisitcs measured | | | | | | | | | | | | | | | |
| 16 | 23.1 | 38.0108 | 1.150 | 18.13 | 2.10 | 0.766 | 0.575 | 1.539 | 1.125 | 117.5 | 1.40 | 1.43 | 1.42 | 0.47 | 0.46 | 0.47 |
| 17 | 22.8 | 45.1849 | 1.182 | 23.92 | 1.89 | 1.061 | 0.763 | 1.816 | 1.280 | 133.0 | 1.86 | 1.90 | 1.88 | 0.73 | 0.73 | 0.73 |
| 18 | 22.3 | 41.5082 | 1.175 | 21.80 | 1.90 | 0.795 | 0.550 | 1.649 | 1.195 | 123.0 | 1.56 | 1.60 | 1.58 | 0.49 | 0.49 | 0.49 |
| 20 | 22.0 | 34.8800 | 1.134 | 18.95 | 1.84 | 0.762 | 0.571 | 1.510 | 1.013 | 110.5 | 1.34 | 1.30 | 1.32 | 0.40 | 0.44 | 0.42 |
| 21 | 22.8 | 38.2327 | 1.125 | 19.08 | 2.00 | 0.855 | 0.660 | 1.685 | 1.161 | 122.0 | 1.58 | 1.57 | 1.58 | 0.60 | 0.64 | 0.62 |
| 25 | 23.1 | 39.3600 | 1.125 | 21.35 | 1.84 | 0.762 | 0.533 | 1.505 | 1.088 | 116.0 | 1.40 | 1.40 | 1.40 | 0.44 | 0.41 | 0.43 |
| 27 | 21.1 | 32.9288 | 1.132 | 16.38 | 2.01 | 0.909 | 0.643 | 1.563 | 1.075 | 115.0 | 1.38 | 1.39 | 1.39 | 0.56 | 0.56 | 0.56 |
| 29 | 22.9 | 38.4400 | 1.115 | 20.19 | 1.90 | 0.786 | 0.605 | 1.590 | 1.136 | 118.0 | 1.48 | 1.48 | 1.48 | 0.50 | 0.49 | 0.50 |
| 31 | 23.5 | 38.3126 | 1.200 | 19.50 | 1.96 | 0.686 | 0.525 | 1.430 | 1.118 | 109.0 | 1.29 | 1.34 | 1.32 | 0.35 | 0.39 | 0.37 |
| 32 | 21.8 | 31.4460 | 1.141 | 15.61 | 2.01 | 0.767 | 0.571 | 1.467 | 1.005 | 110.0 | 1.27 | 1.25 | 1.26 | 0.43 | 0.43 | 0.43 |
| 34 | 23.2 | 35.6522 | 1.134 | 18.16 | 1.96 | 0.791 | 0.612 | 1.530 | 1.115 | 115.5 | 1.34 | 1.37 | 1.36 | 0.52 | 0.54 | 0.53 |

Table A-9. (cont'd)

| Steer no. | Metacarpal length, cm | Section wt., g | Section length, in | Volume, $cm^3$ | Density, $g/cm^3$ | Medial width, in | Medial depth, in | Lateral width, in | Lateral depth, in | Circum., mm | Total area, $in^2$ #1 | Total area, $in^2$ #2 | Total area, $in^2$ Avg. | Marrow area, $in^2$ #1 | Marrow area, $in^2$ #2 | Marrow area, $in^2$ Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 37 | 22.8 | 43.2300 | 1.194 | 22.42 | 1.93 | 0.885 | 0.655 | 1.694 | 1.210 | 123.0 | 1.56 | 1.57 | 1.57 | 0.55 | 0.50 | 0.53 |
| 38 | 23.4 | 38.3685 | 1.150 | 19.25 | 1.99 | 0.756 | 0.607 | 1.566 | 1.145 | 115.0 | 1.48 | 1.49 | 1.49 | 0.49 | 0.47 | 0.48 |
| 40 | 21.2 | 32.2135 | 1.206 | 15.75 | 2.05 | 0.746 | 0.579 | 1.445 | 1.004 | 107.0 | 1.24 | 1.25 | 1.25 | 0.46 | 0.43 | 0.45 |
| 42 | Cut at harvest, not all characterisitcs measured | | | | | | | | | 120.0 | 1.53 | 1.52 | 1.53 | 0.54 | 0.54 | 0.54 |
| 43 | 22.8 | 39.9482 | 1.125 | 19.89 | 2.01 | 0.819 | 0.597 | 1.665 | 1.107 | 122.0 | 1.54 | 1.54 | 1.54 | 0.50 | 0.50 | 0.50 |
| 44 | 21.8 | 33.2568 | 1.087 | 16.29 | 2.04 | 0.797 | 0.558 | 1.538 | 1.167 | 111.0 | 1.34 | 1.31 | 1.33 | 0.42 | 0.43 | 0.43 |
| 45 | 22.3 | 30.9168 | 1.187 | 14.86 | 2.08 | 0.732 | 0.512 | 1.430 | 1.006 | 104.0 | 1.15 | 1.16 | 1.16 | 0.37 | 0.38 | 0.38 |
| 46 | 23.1 | 36.4087 | 1.150 | 19.79 | 1.84 | 0.691 | 0.542 | 1.510 | 1.010 | 115.5 | 1.30 | 1.33 | 1.32 | 0.35 | 0.35 | 0.35 |
| 47 | 21.8 | 39.0431 | 1.067 | 20.39 | 1.91 | 0.922 | 0.610 | 1.695 | 1.161 | 125.0 | 1.69 | 1.64 | 1.67 | 0.59 | 0.56 | 0.58 |
| 50 | 22.4 | 40.1803 | 1.175 | 20.59 | 1.95 | 0.785 | 0.557 | 1.650 | 1.134 | 121.5 | 1.55 | 1.50 | 1.53 | 0.45 | 0.45 | 0.45 |
| 54 | 23.0 | 37.8483 | 1.181 | 18.91 | 2.00 | 0.842 | 0.650 | 1.600 | 1.150 | 119.0 | 1.50 | 1.52 | 1.51 | 0.48 | 0.49 | 0.49 |
| 55 | 22.7 | 37.3216 | 1.088 | 20.97 | 1.78 | 0.816 | 0.612 | 1.579 | 1.175 | 118.5 | 1.52 | 1.51 | 1.52 | 0.57 | 0.59 | 0.58 |
| 57 | 22.3 | 39.0081 | 1.187 | 19.97 | 1.95 | 0.718 | 0.508 | 1.496 | 1.122 | 112.0 | 1.37 | 1.34 | 1.36 | 0.47 | 0.41 | 0.44 |
| 58 | 22.3 | 36.7722 | 1.206 | 18.80 | 1.96 | 0.698 | 0.470 | 1.460 | 1.025 | 110.0 | 1.32 | 1.29 | 1.31 | 0.35 | 0.35 | 0.35 |
| 59 | 21.6 | 37.1815 | 1.061 | 19.33 | 1.92 | 0.750 | 0.492 | 1.537 | 1.110 | 114.5 | 1.42 | 1.44 | 1.43 | 0.40 | 0.39 | 0.40 |
| 60 | 21.8 | 30.1430 | 1.119 | 15.80 | 1.91 | 0.771 | 0.575 | 1.422 | 1.057 | 107.0 | 1.20 | 1.24 | 1.22 | 0.50 | 0.46 | 0.48 |
| 62 | 21.7 | 36.4187 | 1.118 | 17.68 | 2.06 | 0.800 | 0.579 | 1.550 | 1.084 | 115.5 | 1.38 | 1.37 | 1.38 | 0.43 | 0.44 | 0.44 |
| 63 | 22.1 | 36.9345 | 1.116 | 21.01 | 1.76 | 0.660 | 0.454 | 1.540 | 1.061 | 108.0 | 1.28 | 1.31 | 1.30 | 0.33 | 0.33 | 0.33 |
| 65 | 21.5 | 35.0553 | 1.175 | 19.17 | 1.83 | 0.771 | 0.583 | 1.511 | 1.110 | 113.0 | 1.41 | 1.35 | 1.38 | 0.42 | 0.44 | 0.43 |
| 67 | 19.2 | 18.3208 | 1.150 | 10.61 | 1.73 | 0.581 | 0.495 | 1.061 | 0.871 | 82.5 | 0.80 | 0.78 | 0.79 | 0.28 | 0.23 | 0.26 |
| 70 | 22.0 | 37.8362 | 1.212 | 18.81 | 2.01 | 0.741 | 0.538 | 1.575 | 1.100 | 115.8 | 1.34 | 1.35 | 1.35 | 0.40 | 0.40 | 0.40 |
| 72 | 21.7 | 34.8502 | 1.125 | 18.96 | 1.84 | 0.741 | 0.631 | 1.432 | 1.159 | 111.5 | 1.37 | 1.37 | 1.37 | 0.45 | 0.45 | 0.45 |
| 74 | 19.5 | 17.7565 | 1.150 | 9.87 | 1.80 | 0.645 | 0.485 | 1.075 | 0.840 | 83.0 | 0.77 | 0.75 | 0.76 | 0.27 | 0.23 | 0.25 |

Table A-9. (cont'd)

| Steer no. | Metacarpal length, cm | Section wt., g | Section length, in | Volume, $cm^3$ | Density, $g/cm^3$ | Medial width, in | Medial depth, in | Lateral width, in | Lateral depth, in | Circum., mm | Total area, $in^2$ #1 | Total area, $in^2$ #2 | Total area, $in^2$ Avg. | Marrow area, $in^2$ #1 | Marrow area, $in^2$ #2 | Marrow area, $in^2$ Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 75 | 22.1 | 40.2980 | 1.132 | 20.85 | 1.93 | 0.692 | 0.544 | 1.561 | 1.132 | 116.5 | 1.46 | 1.43 | 1.45 | 0.39 | 0.39 | 0.39 |
| 76 | 22.6 | 37.8068 | 1.175 | 19.21 | 1.97 | 0.689 | 0.491 | 1.487 | 1.075 | 112.0 | 1.32 | 1.33 | 1.33 | 0.40 | 0.40 | 0.40 |
| 77 | Cut at harvest, not all characterisitcs measured | | | | | | | | | 118.0 | 1.48 | 1.44 | 1.46 | 0.45 | 0.47 | 0.46 |
| 78 | 21.6 | 30.1885 | 1.150 | 15.12 | 2.00 | 0.722 | 0.638 | 1.384 | 1.097 | 105.5 | 1.24 | 1.21 | 1.23 | 0.42 | 0.43 | 0.43 |
| 80 | 21.4 | 36.9410 | 1.093 | 18.05 | 2.05 | 0.750 | 0.556 | 1.578 | 1.100 | 116.0 | 1.43 | 1.39 | 1.41 | 0.49 | 0.50 | 0.50 |
| 83 | 22.3 | 40.6722 | 1.104 | 20.19 | 2.01 | 0.863 | 0.611 | 1.666 | 1.131 | 121.5 | 1.55 | 1.49 | 1.52 | 0.49 | 0.50 | 0.50 |
| 85 | 21.2 | 29.2530 | 1.100 | 14.59 | 2.01 | 0.808 | 0.565 | 1.409 | 1.025 | 107.0 | 1.24 | 1.27 | 1.26 | 0.40 | 0.42 | 0.41 |
| 86 | 22.8 | 36.8016 | 1.075 | 19.06 | 1.93 | 0.750 | 0.510 | 1.590 | 1.095 | 116.0 | 1.37 | 1.38 | 1.38 | 0.38 | 0.36 | 0.37 |
| 87 | 22.5 | 41.2220 | 1.165 | 20.53 | 2.01 | 0.895 | 0.640 | 1.725 | 1.165 | 120.5 | 1.53 | 1.55 | 1.54 | 0.45 | 0.48 | 0.47 |
| 89 | Cut at harvest, not all characterisitcs measured | | | | | | | | | 120.0 | 1.54 | 1.53 | 1.54 | 0.56 | 0.57 | 0.57 |
| 90 | 22.5 | 40.7242 | 1.155 | 20.57 | 1.98 | 0.804 | 0.571 | 1.645 | 1.155 | 123.0 | 1.44 | 1.49 | 1.47 | 0.46 | 0.46 | 0.46 |
| 92 | 20.3 | 19.2481 | 1.115 | 11.40 | 1.69 | 0.749 | 0.610 | 1.219 | 0.915 | 93.0 | 0.96 | 0.97 | 0.97 | 0.39 | 0.41 | 0.40 |
| 95 | 20.8 | 32.8136 | 1.191 | 16.15 | 2.03 | 0.691 | 0.514 | 1.430 | 1.025 | 117.5 | 1.26 | 1.26 | 1.26 | 0.41 | 0.42 | 0.42 |
| 97 | 21.7 | 41.1365 | 1.198 | 20.73 | 1.98 | 0.890 | 0.691 | 1.675 | 1.175 | 121.0 | 1.49 | 1.54 | 1.52 | 0.55 | 0.58 | 0.57 |
| 98 | 22.3 | 31.6983 | 1.121 | 17.06 | 1.86 | 0.804 | 0.575 | 1.487 | 1.048 | 110.0 | 1.34 | 1.29 | 1.32 | 0.50 | 0.49 | 0.50 |
| 100 | 21.7 | 28.3737 | 1.100 | 14.07 | 2.02 | 0.709 | 0.471 | 1.385 | 0.970 | 101.0 | 1.05 | 1.07 | 1.06 | 0.29 | 0.32 | 0.31 |
| 101 | 22.9 | 38.5283 | 1.125 | 19.37 | 1.99 | 0.880 | 0.591 | 1.632 | 1.165 | 121.0 | 1.62 | 1.61 | 1.62 | 0.55 | 0.60 | 0.58 |
| 102 | 22.4 | 38.2163 | 1.106 | 19.19 | 1.99 | 0.800 | 0.594 | 1.634 | 1.156 | 119.5 | 1.50 | 1.52 | 1.51 | 0.51 | 0.55 | 0.53 |
| 103 | 23.7 | 43.6988 | 1.108 | 24.75 | 1.77 | 0.831 | 0.639 | 1.650 | 1.235 | 127.5 | 1.78 | 1.75 | 1.77 | 0.60 | 0.56 | 0.58 |
| 104 | 22.5 | 35.0886 | 1.100 | 18.66 | 1.88 | 0.889 | 0.563 | 1.572 | 1.104 | 114.5 | 1.37 | 1.41 | 1.39 | 0.51 | 0.48 | 0.50 |
| 106 | 21.6 | 30.9000 | 1.179 | 15.66 | 1.97 | 0.770 | 0.536 | 1.432 | 1.036 | 108.0 | 1.26 | 1.24 | 1.25 | 0.40 | 0.43 | 0.42 |
| 107 | 23.3 | 41.6452 | 1.175 | 21.66 | 1.92 | 0.975 | 0.690 | 1.695 | 1.208 | 129.0 | 1.79 | 1.79 | 1.79 | 0.76 | 0.76 | 0.76 |
| 108 | 23.0 | 37.4445 | 1.063 | 18.60 | 2.01 | 0.811 | 0.545 | 1.550 | 1.142 | 116.5 | 1.48 | 1.48 | 1.48 | 0.46 | 0.49 | 0.48 |

Table A-9. (cont'd)

| Steer no. | Metacarpal length, cm | Section wt., g | Section length, in | Volume, $cm^3$ | Density, $g/cm^3$ | Medial width, in | Medial depth, in | Lateral width, in | Lateral depth, in | Circum., mm | Total area, $in^2$ #1 | Total area, $in^2$ #2 | Total area, $in^2$ Avg. | Marrow area, $in^2$ #1 | Marrow area, $in^2$ #2 | Marrow area, $in^2$ Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 109 | 22.6 | 38.1420 | 1.100 | 19.37 | 1.97 | 0.715 | 0.570 | 1.560 | 1.132 | 116.0 | 1.45 | 1.45 | 1.45 | 0.47 | 0.44 | 0.46 |
| 110 | 21.8 | 30.8418 | 1.138 | 16.21 | 1.90 | 0.740 | 0.540 | 1.415 | 1.035 | 105.0 | 1.18 | 1.19 | 1.19 | 0.38 | 0.38 | 0.38 |
| 112 | 22.4 | 43.5831 | 1.210 | 23.74 | 1.84 | 0.763 | 0.605 | 1.690 | 1.180 | 119.0 | 1.54 | 1.50 | 1.52 | 0.50 | 0.50 | 0.50 |
| 115 | 21.7 | 42.2911 | 1.150 | 21.41 | 1.98 | 0.850 | 0.679 | 1.683 | 1.187 | 124.0 | 1.69 | 1.67 | 1.68 | 0.56 | 0.57 | 0.57 |
| 116 | 23.3 | 43.9112 | 1.125 | 21.64 | 2.03 | 0.790 | 0.610 | 1.738 | 1.133 | 126.0 | 1.67 | 1.62 | 1.65 | 0.50 | 0.49 | 0.50 |
| 117 | 23.0 | 36.4704 | 1.050 | 19.76 | 1.85 | 0.700 | 0.581 | 1.568 | 1.132 | 116.5 | 1.44 | 1.40 | 1.42 | 0.40 | 0.39 | 0.40 |
| 118 | 21.4 | 30.7391 | 1.108 | 15.02 | 2.05 | 0.725 | 0.555 | 1.336 | 1.050 | 107.0 | 1.30 | 1.34 | 1.32 | 0.48 | 0.48 | 0.48 |
| 119 | 21.8 | 35.8718 | 1.115 | 19.33 | 1.86 | 0.846 | 0.616 | 1.580 | 1.111 | 116.5 | 1.47 | 1.50 | 1.49 | 0.58 | 0.53 | 0.56 |
| 120 | 22.4 | 33.1875 | 1.159 | 17.25 | 1.92 | 0.729 | 0.545 | 1.425 | 1.089 | 110.0 | 1.34 | 1.32 | 1.33 | 0.46 | 0.46 | 0.46 |
| 121 | 21.9 | 44.6694 | 1.175 | 22.50 | 1.99 | 0.865 | 0.608 | 1.675 | 1.209 | 124.0 | 1.60 | 1.64 | 1.62 | 0.49 | 0.48 | 0.49 |
| 122 | 21.9 | 37.3001 | 1.118 | 18.08 | 2.06 | 0.833 | 0.600 | 1.570 | 1.120 | 115.0 | 1.47 | 1.41 | 1.44 | 0.40 | 0.40 | 0.40 |
| 128 | 21.6 | 30.7115 | 1.106 | 16.64 | 1.85 | 0.840 | 0.602 | 1.441 | 1.059 | 110.0 | 1.32 | 1.32 | 1.32 | 0.49 | 0.49 | 0.49 |
| 129 | 21.9 | 34.5563 | 1.125 | 17.08 | 2.02 | 0.712 | 0.543 | 1.504 | 1.100 | 108.0 | 1.29 | 1.24 | 1.27 | 0.37 | 0.38 | 0.38 |
| 130 | 20.8 | 40.5349 | 1.075 | 20.21 | 2.01 | 0.667 | 0.518 | 1.644 | 1.162 | 117.0 | 1.41 | 1.40 | 1.41 | 0.40 | 0.37 | 0.39 |
| 133 | 23.7 | 38.5700 | 1.075 | 21.24 | 1.82 | 0.838 | 0.565 | 1.600 | 1.090 | 118.0 | 1.50 | 1.50 | 1.50 | 0.48 | 0.49 | 0.49 |
| 136 | 22.5 | 39.9231 | 1.203 | 19.36 | 2.06 | 0.766 | 0.525 | 1.615 | 1.100 | 118.0 | 1.40 | 1.38 | 1.39 | 0.37 | 0.38 | 0.38 |
| 139 | 21.9 | 44.3168 | 1.175 | 23.28 | 1.90 | 0.857 | 0.525 | 1.665 | 1.176 | 123.5 | 1.60 | 1.58 | 1.59 | 0.43 | 0.47 | 0.45 |
| 142 | 22.3 | 40.5339 | 1.084 | 22.32 | 1.82 | 0.754 | 0.575 | 1.581 | 1.211 | 119.0 | 1.45 | 1.49 | 1.47 | 0.38 | 0.40 | 0.39 |
| 143 | 22.3 | 39.9446 | 1.142 | 20.49 | 1.95 | 0.775 | 0.622 | 1.525 | 1.175 | 119.0 | 1.55 | 1.53 | 1.54 | 0.52 | 0.48 | 0.50 |
| 144 | 22.0 | 40.2143 | 1.170 | 21.00 | 1.91 | 0.793 | 0.580 | 1.612 | 1.110 | 119.5 | 1.53 | 1.53 | 1.53 | 0.49 | 0.51 | 0.50 |
| 147 | 22.6 | 39.2722 | 1.161 | 19.33 | 2.03 | 0.995 | 0.680 | 1.644 | 1.210 | 122.5 | 1.58 | 1.57 | 1.58 | 0.57 | 0.54 | 0.56 |
| 150 | 20.0 | 18.6659 | 1.100 | 11.12 | 1.68 | 0.745 | 0.542 | 1.190 | 0.875 | 89.5 | 0.90 | 0.87 | 0.89 | 0.35 | 0.35 | 0.35 |
| 151 | 23.2 | 43.1238 | 1.100 | 20.94 | 2.06 | 0.716 | 0.505 | 1.611 | 1.146 | 118.5 | 1.48 | 1.47 | 1.48 | 0.33 | 0.34 | 0.34 |

Table A-9. (cont'd)

| Steer no. | Metacarpal length, cm | Section wt., g | Section length, in | Volume, $cm^3$ | Density, $g/cm^3$ | Medial width, in | Medial depth, in | Lateral width, in | Lateral depth, in | Circum., mm | Total area, $in^2$ #1 | Total area, $in^2$ #2 | Total area, $in^2$ Avg. | Marrow area, $in^2$ #1 | Marrow area, $in^2$ #2 | Marrow area, $in^2$ Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 153 | 22.2 | 33.8741 | 1.143 | 16.52 | 2.05 | 0.755 | 0.575 | 1.467 | 1.085 | 110.0 | 1.27 | 1.27 | 1.27 | 0.40 | 0.43 | 0.42 |
| 154 | 22.4 | 36.3100 | 1.100 | 19.86 | 1.83 | 0.675 | 0.485 | 1.462 | 1.083 | 109.0 | 1.27 | 1.27 | 1.27 | 0.27 | 0.32 | 0.30 |
| 155 | 23.0 | 41.0699 | 1.070 | 20.10 | 2.04 | 0.716 | 0.563 | 1.575 | 1.191 | 119.0 | 1.53 | 1.52 | 1.53 | 0.44 | 0.44 | 0.44 |
| 157 | 23.7 | 33.8155 | 1.140 | 17.11 | 1.98 | 0.787 | 0.594 | 1.495 | 1.113 | 113.0 | 1.46 | 1.41 | 1.44 | 0.56 | 0.50 | 0.53 |
| 158 | 23.7 | 36.6295 | 1.100 | 20.35 | 1.80 | 0.906 | 0.634 | 1.615 | 1.192 | 119.5 | 1.60 | 1.55 | 1.58 | 0.60 | 0.61 | 0.61 |
| 159 | 22.4 | 40.9271 | 1.150 | 20.11 | 2.04 | 0.790 | 0.550 | 1.668 | 1.140 | 119.0 | 1.54 | 1.57 | 1.56 | 0.51 | 0.53 | 0.52 |
| 161 | 21.5 | 39.4287 | 1.086 | 18.37 | 2.15 | 0.763 | 0.525 | 1.575 | 1.150 | 117.0 | 1.50 | 1.50 | 1.50 | 0.44 | 0.41 | 0.43 |
| 163 | 23.3 | 38.7686 | 1.175 | 19.96 | 1.94 | 0.684 | 0.525 | 1.485 | 1.120 | 114.0 | 1.45 | 1.43 | 1.44 | 0.49 | 0.48 | 0.49 |
| 164 | 19.5 | 18.0092 | 1.135 | 9.41 | 1.91 | 0.867 | 0.645 | 1.255 | 0.959 | 95.0 | 0.98 | 0.98 | 0.98 | 0.46 | 0.45 | 0.46 |
| 165 | 22.8 | 38.4186 | 1.125 | 21.50 | 1.79 | 0.744 | 0.540 | 1.548 | 1.016 | 113.0 | 1.38 | 1.37 | 1.38 | 0.40 | 0.38 | 0.39 |
| 166 | 21.9 | 40.7556 | 1.199 | 20.67 | 1.97 | 0.786 | 0.585 | 1.635 | 1.121 | 119.0 | 1.45 | 1.42 | 1.44 | 0.45 | 0.43 | 0.44 |
| 170 | 22.7 | 44.4750 | 1.197 | 21.77 | 2.04 | 0.725 | 0.486 | 1.593 | 1.170 | 117.0 | 1.37 | 1.43 | 1.40 | 0.38 | 0.36 | 0.37 |
| 171 | 21.6 | 43.9622 | 1.125 | 22.22 | 1.98 | 1.008 | 0.711 | 1.766 | 1.300 | 126.5 | 1.78 | 1.78 | 1.78 | 0.67 | 0.65 | 0.66 |
| 172 | 20.7 | 29.9243 | 1.157 | 14.62 | 2.05 | 0.625 | 0.403 | 1.359 | 0.963 | 100.5 | 1.06 | 1.06 | 1.06 | 0.32 | 0.30 | 0.31 |
| 173 | 21.7 | 30.4343 | 1.130 | 15.97 | 1.91 | 0.746 | 0.545 | 1.410 | 1.060 | 107.0 | 1.27 | 1.28 | 1.28 | 0.43 | 0.43 | 0.43 |
| 180 | 22.5 | 39.7614 | 1.130 | 20.54 | 1.94 | 0.807 | 0.580 | 1.630 | 1.125 | 117.0 | 1.42 | 1.42 | 1.42 | 0.41 | 0.41 | 0.41 |
| 183 | 22.9 | 39.3711 | 1.125 | 20.72 | 1.90 | 0.900 | 0.669 | 1.680 | 1.195 | 122.0 | 1.56 | 1.57 | 1.57 | 0.60 | 0.60 | 0.60 |
| 184 | 22.9 | 41.0754 | 1.125 | 21.77 | 1.89 | 0.761 | 0.530 | 1.563 | 1.120 | 116.0 | 1.43 | 1.42 | 1.43 | 0.35 | 0.34 | 0.35 |
| 187 | 22.1 | 31.9673 | 1.094 | 15.77 | 2.03 | 0.861 | 0.603 | 1.525 | 1.079 | 112.5 | 1.34 | 1.36 | 1.35 | 0.50 | 0.49 | 0.50 |
| 192 | 21.8 | 40.6061 | 1.100 | 20.57 | 1.97 | 0.865 | 0.600 | 1.627 | 1.206 | 121.0 | 1.58 | 1.59 | 1.59 | 0.50 | 0.52 | 0.51 |
| 194 | 23.2 | 33.1214 | 1.125 | 18.84 | 1.76 | 0.812 | 0.611 | 1.581 | 1.080 | 113.0 | 1.30 | 1.35 | 1.33 | 0.49 | 0.50 | 0.50 |
| 195 | 21.9 | 38.0241 | 1.093 | 18.66 | 2.04 | 0.740 | 0.605 | 1.575 | 1.138 | 114.0 | 1.36 | 1.40 | 1.38 | 0.37 | 0.41 | 0.39 |
| 196 | 22.7 | 36.7521 | 1.150 | 18.50 | 1.99 | 0.761 | 0.516 | 1.515 | 1.010 | 113.0 | 1.37 | 1.38 | 1.38 | 0.46 | 0.46 | 0.46 |

Table A-9. (cont'd)

| Steer no. | Metacarpal length, cm | Section wt., g | Section length, in | Volume, $cm^3$ | Density, $g/cm^3$ | Medial width, in | Medial depth, in | Lateral width, in | Lateral depth, in | Circum., mm | Total area, $in^2$ #1 | Total area, $in^2$ #2 | Total area, $in^2$ Avg. | Marrow area, $in^2$ #1 | Marrow area, $in^2$ #2 | Marrow area, $in^2$ Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 197 | 22.1 | 38.2113 | 1.162 | 18.41 | 2.08 | 0.929 | 0.665 | 1.715 | 1.110 | 122.0 | 1.50 | 1.50 | 1.50 | 0.53 | 0.50 | 0.52 |
| 198 | 22.0 | 44.4113 | 1.075 | 22.87 | 1.94 | 0.836 | 0.625 | 1.746 | 1.212 | 126.0 | 1.69 | 1.69 | 1.69 | 0.55 | 0.50 | 0.53 |
| 199 | 23.0 | 41.5683 | 1.143 | 22.81 | 1.82 | 0.746 | 0.534 | 1.571 | 1.135 | 118.0 | 1.49 | 1.47 | 1.48 | 0.43 | 0.42 | 0.43 |
| 201 | 21.8 | 30.4226 | 1.167 | 15.29 | 1.99 | 0.785 | 0.609 | 1.400 | 0.989 | 109.5 | 1.28 | 1.29 | 1.29 | 0.47 | 0.52 | 0.50 |
| 202 | 19.9 | 17.2525 | 1.083 | 9.64 | 1.79 | 0.570 | 0.406 | 1.065 | 0.830 | 83.0 | 0.76 | 0.73 | 0.75 | 0.25 | 0.24 | 0.25 |
| 205 | 22.4 | 43.5791 | 1.217 | 22.90 | 1.90 | 0.695 | 0.506 | 1.557 | 1.133 | 117.0 | 1.50 | 1.51 | 1.51 | 0.40 | 0.40 | 0.40 |
| 211 | 22.2 | 34.1627 | 1.120 | 18.16 | 1.88 | 0.780 | 0.632 | 1.505 | 1.114 | 114.5 | 1.37 | 1.40 | 1.39 | 0.49 | 0.50 | 0.50 |
| 212 | 22.2 | 39.2383 | 1.175 | 19.22 | 2.04 | 0.714 | 0.513 | 1.540 | 1.144 | 113.0 | 1.42 | 1.40 | 1.41 | 0.43 | 0.46 | 0.45 |
| 213 | 21.8 | 35.5432 | 1.150 | 17.91 | 1.98 | 0.991 | 0.666 | 1.665 | 1.106 | 121.0 | 1.60 | 1.60 | 1.60 | 0.67 | 0.65 | 0.66 |
| 215 | 22.5 | 33.0452 | 1.075 | 18.28 | 1.81 | 0.814 | 0.595 | 1.520 | 1.090 | 116.5 | 1.45 | 1.47 | 1.46 | 0.56 | 0.54 | 0.55 |
| 217 | 22.3 | 38.0636 | 1.120 | 18.88 | 2.02 | 0.740 | 0.548 | 1.510 | 1.135 | 114.5 | 1.41 | 1.40 | 1.41 | 0.38 | 0.38 | 0.38 |
| 218 | 22.5 | 35.0276 | 1.100 | 17.87 | 1.96 | 0.838 | 0.619 | 1.569 | 1.082 | 115.0 | 1.40 | 1.42 | 1.41 | 0.48 | 0.51 | 0.50 |
| 221 | 23.2 | 44.5045 | 1.129 | 21.46 | 2.07 | 0.744 | 0.492 | 1.644 | 1.136 | 122.0 | 1.57 | 1.57 | 1.57 | 0.40 | 0.44 | 0.42 |
| 222 | 22.0 | 37.1723 | 1.144 | 18.92 | 1.96 | 0.675 | 0.497 | 1.542 | 1.050 | 111.0 | 1.32 | 1.32 | 1.32 | 0.30 | 0.32 | 0.31 |
| 225 | 22.3 | 35.6800 | 1.070 | 19.43 | 1.84 | 0.775 | 0.530 | 1.491 | 1.060 | 113.5 | 1.37 | 1.33 | 1.35 | 0.45 | 0.41 | 0.43 |
| 227 | 21.4 | 29.5905 | 1.118 | 14.90 | 1.99 | 0.666 | 0.481 | 1.406 | 0.975 | 104.5 | 1.09 | 1.12 | 1.11 | 0.35 | 0.34 | 0.35 |
| 228 | 23.6 | 31.4352 | 1.175 | 15.75 | 2.00 | 0.650 | 0.550 | 1.387 | 1.050 | 102.0 | 1.23 | 1.19 | 1.21 | 0.33 | 0.33 | 0.33 |
| 232 | 22.9 | 34.1800 | 1.121 | 18.79 | 1.82 | 0.844 | 0.570 | 1.509 | 1.055 | 112.0 | 1.34 | 1.33 | 1.34 | 0.45 | 0.49 | 0.47 |
| 234 | 23.1 | 38.9675 | 1.114 | 20.59 | 1.89 | 0.765 | 0.547 | 1.566 | 1.175 | 115.0 | 1.43 | 1.45 | 1.44 | 0.46 | 0.48 | 0.47 |
| 236 | 22.2 | 37.5453 | 1.104 | 18.26 | 2.06 | 0.867 | 0.585 | 1.587 | 1.131 | 119.0 | 1.51 | 1.55 | 1.53 | 0.54 | 0.55 | 0.55 |
| 238 | 22.5 | 41.3334 | 1.150 | 20.50 | 2.02 | 0.730 | 0.493 | 1.579 | 1.150 | 116.5 | 1.46 | 1.43 | 1.45 | 0.43 | 0.43 | 0.43 |

Table A-9. (cont'd)

| Steer no. | Metacarpal length, cm | Section wt., g | Section length, in | Volume, $cm^3$ | Density, $g/cm^3$ | Medial | | Lateral | | Circum., mm | Total area, $in^2$ | | | Marrow area, $in^2$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | width, in | depth, in | width, in | depth, in | | #1 | #2 | Avg. | #1 | #2 | Avg. |
| 239 | 22.0 | 37.5944 | 1.158 | 18.44 | 2.04 | 0.800 | 0.573 | 1.557 | 1.105 | 115.0 | 1.42 | 1.40 | 1.41 | 0.45 | 0.46 | 0.46 |
| 241 | 22.7 | 44.2191 | 1.111 | 23.72 | 1.86 | 0.975 | 0.690 | 1.746 | 1.284 | 127.0 | 1.62 | 1.58 | 1.60 | 0.55 | 0.54 | 0.55 |
| 243 | 23.5 | 39.6444 | 1.069 | 19.92 | 1.99 | 0.793 | 0.600 | 1.659 | 1.175 | 120.5 | 1.59 | 1.60 | 1.60 | 0.46 | 0.48 | 0.47 |

Table A-10. Serum IGF-I concentrations (ng/ml) following initial and subsequent control or bST treatments, and following the last control or bST treatment for Experiment BC9002[a]

| Steer no. | Days after initial treatment | | | | | | Days after last treatment | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 7 | 14 | 21 | 28 | 35 | -7 | -14 | -21 | -28 |
| 13 | 467 | 710 | NC[b] | 928 | 950 | 776 | 500 | 500 | 536 | 523 |
| 17 | 378 | 497 | 442 | 660 | 570 | 660 | 1244 | 1094 | 648 | 628 |
| 18 | 333 | 608 | 394 | 622 | 565 | 666 | 407 | 510 | 465 | 428 |
| 37 | 252 | 378 | 483 | 480 | 519 | 537 | 1091 | 922 | 698 | 478 |
| 42 | 452 | 426 | 284 | 444 | 368 | 422 | 509 | 499 | 559 | 544 |
| 44 | 325 | 496 | 441 | 442 | 491 | 568 | 439 | 450 | 395 | 398 |
| 46 | 351 | 687 | 515 | 478 | 443 | 652 | 421 | 394 | 455 | 463 |
| 62 | 318 | 350 | 450 | 375 | 380 | 428 | 496 | 523 | 486 | 447 |
| 77 | 404 | 575 | 447 | 958 | 479 | 670 | 1661 | 900 | 510 | 498 |
| 86 | 227 | 323 | 288 | 322 | 256 | 348 | 282 | 267 | 296 | 304 |
| 87 | 391 | 629 | NC | 663 | 729 | 523 | 1103 | 1103 | 729 | 676 |
| 89 | 235 | 360 | 328 | 370 | 296 | 447 | 1305 | 1295 | 817 | 462 |
| 97 | 369 | 579 | 488 | 424 | 420 | 576 | 457 | 539 | 440 | 426 |
| 101 | 291 | 395 | 424 | 417 | 430 | 325 | 1307 | 954 | 487 | 442 |
| 102 | 282 | 396 | 358 | 398 | 349 | 286 | 1263 | 712 | 260 | 250 |
| 103 | 158 | 319 | 301 | 503 | 489 | 551 | 205 | 265 | 278 | 233 |
| 121 | 303 | 394 | 406 | 557 | 347 | 605 | 1129 | 785 | 504 | 355 |
| 130 | 303 | 442 | 392 | 495 | 436 | 458 | 1426 | 1044 | 617 | 506 |
| 136 | 330 | 283 | 343 | 370 | 450 | 430 | 427 | 515 | 448 | 517 |
| 142 | 101 | 141 | 257 | 344 | 256 | 336 | 1184 | 512 | 360 | 397 |
| 154 | 292 | 263 | 419 | 425 | 358 | 384 | 462 | 475 | 467 | 484 |
| 158 | 252 | 226 | 326 | 275 | 341 | 337 | 1308 | 979 | 453 | 363 |
| 163 | 353 | 366 | 460 | 455 | 476 | 485 | 1052 | 999 | 508 | 321 |
| 165 | 360 | 782 | 819 | 738 | 492 | 863 | 452 | 485 | 402 | 421 |
| 166 | 293 | 398 | 273 | 286 | 344 | 277 | 1118 | 1062 | 651 | 474 |
| 180 | 284 | 388 | 340 | 460 | 306 | 430 | 1299 | 967 | 697 | 480 |
| 183 | 329 | 396 | 427 | 364 | 336 | 506 | 328 | 307 | 305 | 297 |
| 195 | 405 | 619 | 546 | 704 | 545 | 728 | 529 | 507 | 525 | 507 |
| 199 | 283 | 275 | 359 | 360 | 377 | 421 | 440 | 400 | 446 | 448 |
| 212 | 284 | 346 | 308 | 461 | 417 | 455 | 448 | 409 | 457 | 394 |
| 225 | 654 | 848 | 1002 | 816 | 802 | 865 | 1244 | 1367 | 1069 | 614 |
| 238 | 284 | 358 | 621 | 434 | 328 | 419 | 1503 | 994 | 849 | 491 |

[a]Two steers were sampled per pen. Steers were treatment on day 0, 14, and 28. Blood was collected prior to treatment.

[b]Not collected.

Table A-11. Serum IGF-I concentrations following the final control or bST treatment, and liver IGF-I mRNA abundance for Experiment BC9002[a]

| Steer no. | Days following last treatment, IGF-I, ng/ml | | | | Liver IGF-I mRNA abundance, densitometric units |
|---|---|---|---|---|---|
| | -7 | -14 | -21 | -28 | |
| 9 | 593 | 753 | 819 | 617 | 111516 |
| 12 | 386 | 340 | 382 | 384 | 143915 |
| 25 | 251 | 383 | 298 | 314 | 88813 |
| 55 | 322 | 374 | 372 | 289 | 67567 |
| 59 | 987 | 1037 | 697 | 785 | 103413 |
| 63 | 475 | 396 | 710 | 457 | 62957 |
| 86 | 282 | 267 | 296 | 304 | 56249 |
| 89 | 1305 | 1295 | 817 | 462 | 96360 |
| 103 | 205 | 265 | 278 | 233 | 62135 |
| 104 | 225 | 312 | 183 | 224 | 104637 |
| 133 | 407 | 348 | 454 | 374 | 106711 |
| 142 | 1184 | 512 | 360 | 397 | 47797 |
| 151 | 424 | 450 | 434 | 383 | 70336 |
| 155 | 1086 | 848 | 423 | 499 | 98677 |
| 158 | 1308 | 979 | 453 | 363 | 100200 |
| 165 | 452 | 485 | 402 | 421 | 105150 |
| 180 | 1299 | 967 | 697 | 480 | 96664 |
| 194 | 1293 | 603 | 437 | 380 | 105541 |
| 199 | 440 | 400 | 446 | 448 | 111729 |
| 221 | 406 | 399 | 340 | 342 | 69999 |
| 234 | 1216 | 1058 | 462 | 373 | 107842 |

[a]Steers from Block 1, the last group to be harvested.

Table A-12. Steer equations predicting carcass composition using the 9-10-11 rib section (Hankins and Howe, 1946)

Carcass moisture, % = 16.83 + .75 x Rib % $H_20$

Carcass fat, % = 3.49 + .74 x Rib % EEL

Carcass protein, % = 6.19 + .65 x Rib % CP

Carcass bone, % = 5.52 + .57 x % Bone in rib

## APPENDIX B:

Raw data and procedures from Chapter 3
(Experiment BC9402)

Table B-1. Time line of activities for Experiment BC9402

| Day of study | Date | Activity | |
|---|---|---|---|
| | 3-3-94<br>3-9-94<br>3-18-94 | 360 Holstein steers received from Wisconsin | |
| | 4-21-94 | Steers adapted to a forage diet | |
| | 5-6-94 | Steers implanted with Implus implant | |
| | | Steers adapted to a concentrate diet | |
| | | | |
| -36 | 9-27-94 | Steers weighed and sorted into metabolism room pens | **Adaptation period d -36 to d -26** |
| -25 | 10-8-94 | **Jugular catherization** | |
| -24 | 10-9-94 | 1st day of 1st series of epinephrine challenges | **1st epinephrine challenge series d -24 to -18** |
| -18 | 10-15-94 | 7th day of 1st series of epinephrine challenges | |
| -16 | 10-17-94 | 1st day of adipose tissue biopsies | **1st adipose tissue biopsy series d -16 to -5** |
| -14 | 10-19-94 | 2nd day of adipose tissue biopsies | |
| -9 | 10-24-94 | 3rd day of adipose tissue biopsies | |
| -7 | 10-26-94 | 4th day of adipose tissue biopsies | |
| -5 | 10-28-94 | 5th day of adipose tissue biopsies | |
| -1 | 11-1-94 | 1st weight taken for initial weight | **Initial weight** |
| 0 | 11-2-94 | 1st treatment injection and 2nd weight taken for initial weight | |
| 3 | 11-5-94 | Steers weighed, blood collected | |
| 10 | 11-12-94 | Steers weighed, blood collected | |
| 17 | 11-19-94 | Steers weighed, blood collected | |
| 24 | 11-26-94 | Steers weighed, blood collected | |

Table B-1. (cont'd)

| Day of study | Date | Activity | |
|---|---|---|---|
| 30 | 12-2-94 | Steers weighed, blood collected | |
| 31 | 12-3-94 | **Jugular catherization** | |
| 32 | 12-4-94 | 1st day of 2nd series of epinephrine challenges | **2nd epinephrine challenge series d 32 to 38** |
| 38 | 12-10-94 | 7th day of 2nd series of epinephrine challenges | |
| 39 | 12-11-94 | Steers weighed | |
| 40 | 12-12-94 | 1st day of adipose tissue biopsies | **2nd adipose tissue biopsy series d 40 to 49** |
| 42 | 12-14-94 | 2nd day of adipose tissue biopsies | |
| 44 | 12-16-94 | 3rd day of adipose tissue biopsies | |
| 45 | 12-17-94 | Steers weighed | |
| 47 | 12-19-94 | 4th day of adipose tissue biopsies | |
| 49 | 12-21-94 | 5th day of adipose tissue biopsies | |
| 52 | 12-24-94 | Steers weighed, blood collected | |
| 59 | 12-31-94 | Steers weighed, blood collected | |
| 68 | 1-9-95 | Steers weighed | |
| 73 | 1-14-95 | Steers weighed, blood collected | |
| 80 | 1-21-95 | Steers weighed | |
| 87 | 1-28-95 | Steers weighed, blood collected | |
| 92 | 2-2-95 | Steers weighed | |
| 93 | 2-3-95 | **Jugular catherization** | |
| 94 | 2-4-95 | **bST absorption time course** | |
| 95 | 2-5-95 | 1st day of epinephrine challenges | **3rd series of epinephrine challenges d 95 to 101** |
| 101 | 2-11-95 | 7th day of epinephrine challenges | |

Table B-1. (cont'd)

| Day of study | Date | Activity | |
|---|---|---|---|
| 102 | 2-12-95 | Steers weighed | |
| 103 | 2-13-95 | 1 st day of adipose tissue biopsies | **3rd adipose tissue biopsy series d 103 to 112** |
| 105 | 2-15-95 | 2 nd day of adipose tissue biopsies | |
| 107 | 2-17-95 | 3rd day of adipose tissue biopsies | |
| 110 | 2-20-95 | 4 th day of adipose tissue biopsies | |
| 112 | 2-22-95 | 5 th day of adipose tissue biopsies | |
| 115 | 2-25-95 | Last treatment injection, 1 st weight taken for final weight | **Final weight** |
| 116 | 2-26-95 | 2 nd weight taken for final weight | |
| 117 | 2-27-95 | Steers transported to Ada Beef for slaughter | |

Table B-2. Steer weights for Experiment BC9402

| Steer no. | Weight block | Pen no. | Building side | Treatment | 09/13/94 live wt., lb | Day -37 09/26/94 live wt., lb | Day -36 09/27/94 live wt., lb | Average pretreat. live wt., lb | Day -25 10/08/94 live wt., lb | Day -1 11/01/94 live wt., lb | Day +0 11/02/94 live wt., lb | Average on-trt live wt., lb | Day +3 11/05/94 live wt., lb | Day +10 11/12/94 live wt., lb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 3 | 54 | S | bST | 915 | 920 | 915 | 917.5 | 925 | 995 | 1030 | 1013 | 1020 | 1055 |
| 33 | 1 | 41 | N | Control | 870 | 895 | 880 | 887.5 | 880 | 965 | 1035 | 1000 | 970 | 1000 |
| 53 | 4 | 47 | S | bST | 895 | 920 | 915 | 917.5 | 950 | 1020 | 985 | 1003 | 1045 | 1070 |
| 57 | 2 | 48 | S | bST | 845 | 890 | 890 | 890.0 | 920 | 1020 | 1030 | 1025 | 1045 | 1075 |
| 58 | 3 | 36 | N | Control | 915 | 915 | 920 | 917.5 | 920 | 960 | 1010 | 985 | 975 | 1000 |
| 69 | 1 | 50 | S | Control | 875 | 895 | 890 | 892.5 | 945 | 1005 | 1095 | 1050 | 1005 | 1050 |
| 73 | 2 | 42 | N | bST | 890 | 910 | 910 | 910.0 | 925 | 1010 | 1010 | 1010 | 1030 | 1065 |
| 92 | 3 | 55 | S | Control | 920 | 920 | 900 | 910.0 | 915 | 1040 | 1040 | 1040 | 1050 | 1075 |
| 114 | 2 | 49 | S | Control | 865 | 910 | 915 | 912.5 | 950 | 1020 | 1000 | 1010 | 1025 | 1045 |
| 116 | 5 | 52 | S | Control | 910 | 945 | 930 | 937.5 | 945 | 1040 | 980 | 1010 | 1040 | 1065 |
| 118 | 3 | 37 | N | bST | 850 | 905 | 895 | 900.0 | 920 | 975 | 1030 | 1003 | 1015 | 1020 |
| 133 | 4 | 44 | N | bST | 875 | 920 | 910 | 915.0 | 950 | 1030 | 1050 | 1040 | 1050 | 1075 |
| 157 | 5 | 39 | N | bST | 905 | 935 | 960 | 947.5 | 970 | 1065 | 1050 | 1058 | 1115 | 1150 |
| 184 | 1 | 51 | S | bST | 855 | 900 | 905 | 902.5 | 945 | 1000 | 940 | 970 | 1020 | 1060 |
| 187 | 5 | 53 | S | bST | 910 | 925 | 915 | 920.0 | 960 | 1000 | 1010 | 1005 | 1030 | 1050 |
| 199 | 4 | 45 | N | Control | 870 | 910 | 905 | 907.5 | 950 | 940 | 1020 | 980 | 945 | 925 |
| 202 | 2 | 43 | N | Control | 875 | 910 | 915 | 912.5 | 915 | 1020 | 1010 | 1015 | 1030 | 1065 |
| 217 | 4 | 46 | S | Control | 910 | 935 | 945 | 940.0 | 950 | 995 | 980 | 988 | 1020 | 1035 |
| 222 | 5 | 38 | N | Control | 920 | 935 | 930 | 932.5 | 945 | 1030 | 1035 | 1033 | 1045 | 1080 |
| 307 | 1 | 40 | N | bST | 850 | 885 | 905 | 895.0 | 920 | 1000 | 1020 | 1010 | 1040 | 1085 |

Table B-2. (cont'd)

| Steer no. | Day +17 11/19/94 live wt., lb | Day +24 11/26/94 live wt., lb | Day +30 12/02/94 live wt., lb | 12/11/94 12/13/94 live wt., lb | Day +45 12/17/94 live wt., lb | Day +52 12/24/94 live wt., lb | Day +59 12/31/94 live wt., lb | Day +68 01/09/95 live wt., lb | Day +73 01/14/95 live wt., lb | Day +80 01/21/95 live wt., lb | Day +87 01/28/95 live wt., lb | Day +92 02/02/95 live wt., lb | Day +103 02/12/95 live wt., lb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 1070 | 1100 | 1120 | 1130 | 1160 | 1185 | 1205 | 1220 | 1215 | 1230 | 1235 | 1250 | |
| 33 | 1030 | 1045 | 1050 | 1075 | 1075 | 1120 | 1135 | 1150 | 1170 | 1180 | 1180 | 1180 | 1205 |
| 53 | 1100 | 1105 | 1130 | 1140 | 1165 | 1180 | 1180 | 1225 | 1225 | 1230 | 1235 | 1250 | |
| 57 | 1105 | 1125 | 1145 | 1145 | 1170 | 1200 | 1210 | 1230 | 1235 | 1250 | 1255 | 1260 | 1275 |
| 58 | 1030 | 1055 | 1045 | 1060 | 1100 | 1135 | 1145 | 1160 | 1170 | 1190 | 1220 | 1225 | |
| 69 | 1090 | 1100 | 1100 | 1150 | 1160 | 1190 | 1185 | 1215 | 1210 | 1235 | 1220 | 1240 | 1255 |
| 73 | 1110 | 1120 | 1145 | 1125 | 1145 | 1115 | 1210 | 1250 | 1250 | 1275 | 1265 | 1285 | 1295 |
| 92 | 1090 | 1120 | 1165 | 1175 | 1195 | 1220 | 1230 | 1260 | 1275 | 1310 | 1300 | 1325 | 1330 |
| 114 | 1075 | 1080 | 1110 | 1130 | 1135 | 1160 | 1185 | 1210 | 1230 | 1235 | 1230 | 1235 | 1250 |
| 116 | 1105 | 1120 | 1155 | 1185 | 1195 | 1220 | 1245 | 1280 | 1290 | 1310 | 1330 | 1345 | 1360 |
| 118 | 1070 | 1090 | 1105 | 1090 | 1130 | 1165 | 1175 | 1185 | 1190 | 1195 | 1215 | 1215 | |
| 133 | 1100 | 1125 | 1150 | 1150 | 1185 | 1220 | 1240 | 1275 | 1290 | 1295 | 1315 | 1350 | 1360 |
| 157 | 1200 | 1230 | 1260 | 1290 | 1315 | 1360 | 1360 | 1345 | 1390 | 1410 | 1400 | 1425 | 1440 |
| 184 | 1070 | 1100 | 1145 | 1135 | 1145 | 1175 | 1200 | 1205 | 1215 | 1265 | 1245 | 1255 | 1285 |
| 187 | 1055 | 1085 | 1100 | 1125 | 1115 | 1155 | 1175 | 1195 | 1200 | 1220 | 1205 | 1230 | 1270 |
| 199 | | | | | | | | | | | | | |
| 202 | 1095 | 1105 | 1120 | 1100 | 1115 | 1145 | 1170 | 1180 | 1190 | 1215 | 1225 | 1230 | 1245 |
| 217 | 1045 | 1065 | 1070 | 1095 | 1115 | 1115 | 1105 | 1150 | 1160 | 1165 | 1165 | 1200 | 1175 |
| 222 | 1110 | 1120 | 1150 | 1145 | 1175 | 1205 | 1220 | 1215 | 1235 | 1260 | 1250 | 1270 | 1260 |
| 307 | 1100 | 1120 | 1140 | 1145 | 1160 | 1155 | 1185 | 1195 | 1210 | 1235 | 1220 | 1230 | |

Table B-2. (cont'd)

| Steer no. | Day +105 02/14/95 live wt., lb | Day +108 02/18/95 live wt., lb | Day +115 02/25/95 live wt., lb | Day +116 02/26/95 live wt., lb | Average off-trial live wt., lb |
|---|---|---|---|---|---|
| 15 | 1260 | 1285 | 1290 | 1300 | 1295 |
| 33 | | 1220 | 1260 | 1270 | 1265 |
| 53 | 1270 | 1290 | 1320 | 1335 | 1328 |
| 57 | | 1275 | 1275 | 1285 | 1280 |
| 58 | 1205 | 1210 | 1235 | 1245 | 1240 |
| 69 | | 1285 | 1330 | 1325 | 1328 |
| 73 | | 1325 | 1360 | 1370 | 1365 |
| 92 | | 1355 | 1380 | 1385 | 1383 |
| 114 | | 1265 | 1300 | 1315 | 1308 |
| 116 | | 1390 | 1415 | 1420 | 1418 |
| 118 | 1200 | 1220 | 1225 | 1220 | 1223 |
| 133 | | 1390 | 1415 | 1420 | 1418 |
| 157 | | 1480 | 1525 | 1535 | 1530 |
| 184 | | 1310 | 1355 | 1360 | 1358 |
| 187 | | 1285 | 1300 | 1310 | 1305 |
| 199 | | | | | |
| 202 | | 1280 | 1300 | 1310 | 1305 |
| 217 | | 1200 | 1220 | 1220 | 1220 |
| 222 | | 1295 | 1320 | 1335 | 1328 |
| 307 | 1230 | 1260 | 1305 | 1315 | 1310 |

Table B-3. Daily dry matter intake of steers from Experiment BC9402

| Steer no. | Total feed intake, lb DM | | | |
|---|---|---|---|---|
| | d -36 to -1 | d 0 to 30 | d 31 to 115 | d 0 to 115 |
| 15 | 615.65 | 590.26 | 1614.80 | 2205.07 |
| 33 | 674.55 | 566.44 | 1708.57 | 2275.02 |
| 53 | 722.18 | 561.75 | 1576.85 | 2138.60 |
| 57 | 778.43 | 663.92 | 1584.80 | 2248.72 |
| 58 | 629.01 | 602.06 | 1783.32 | 2385.38 |
| 69 | 638.72 | 641.61 | 1874.90 | 2516.51 |
| 73 | 673.73 | 663.24 | 1768.96 | 2432.19 |
| 92 | 726.03 | 718.28 | 2119.77 | 2838.05 |
| 114 | 705.41 | 653.77 | 1808.31 | 2462.08 |
| 116 | 689.07 | 691.70 | 2062.96 | 2754.66 |
| 118 | 675.25 | 582.81 | 1501.87 | 2084.68 |
| 133 | 728.89 | 653.68 | 1923.33 | 2577.01 |
| 157 | 763.03 | 778.88 | 2023.52 | 2802.40 |
| 184 | 661.99 | 609.39 | 1696.45 | 2305.85 |
| 187 | 667.12 | 545.80 | 1576.99 | 2122.79 |
| 202 | 675.49 | 651.40 | 1824.33 | 2475.72 |
| 217 | 634.70 | 534.50 | 1466.81 | 2001.31 |
| 222 | 727.19 | 819.78 | 2102.30 | 2922.08 |
| 307 | 694.67 | 636.14 | 1530.93 | 2167.07 |

Table B-4. Carcass characteristics of steers from Experiment BC9402

| Steer no. | Treatment | Slaughter wt., lb #1 | Slaughter wt., lb #2 | Slaughter wt., lb Avg. | Liver wt., lb | Liver score[a] | Marbling score[b] | REA in.$^2$ | KHP, % | HCW, lb | Backfat in. | Quality grade[c] | Calc. yield grade[d] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | Initial | 1000 | 1000 | 1000 | | 0 | 480 | 10.0 | 1.5 | 564 | 0.10 | 17 | 1.99 |
| 25 | Initial | 1025 | 1030 | 1028 | | 1 | 460 | 10.9 | 2.0 | 557 | 0.05 | 17 | 1.65 |
| 27 | Initial | 1000 | 1010 | 1005 | | 0 | 450 | 11.1 | 2.0 | 568 | 0.20 | 17 | 2.01 |
| 47 | Initial | 985 | 975 | 980 | | 0 | 490 | 9.8 | 2.0 | 551 | 0.10 | 17 | 2.11 |
| 60 | Initial | 1000 | 995 | 998 | | 0 | 450 | 10.7 | 2.5 | 547 | 0.10 | 17 | 1.90 |
| 68 | Initial | 980 | 985 | 983 | | 0 | 440 | 11.0 | 2.0 | 539 | 0.05 | 16 | 1.55 |
| 138 | Initial | 980 | 985 | 983 | | 0 | 480 | 10.6 | 1.5 | 536 | 0.10 | 17 | 1.69 |
| 179 | Initial | 1000 | 1000 | 1000 | | 0 | 390 | 12.5 | 2.0 | 595 | 0.10 | 15 | 1.41 |
| 15 | bST | 1290 | 1300 | 1295 | 18.09 | 0 | 425 | 13.40 | 1.0 | 779 | 0.18 | 16 | 1.81 |
| 33 | Control | 1260 | 1270 | 1265 | 18.53 | 0 | 590 | 11.70 | 2.0 | 782 | 0.25 | 18 | 2.75 |
| 53 | bST | 1320 | 1335 | 1328 | 19.07 | 0 | 475 | 11.20 | 1.3 | 758 | 0.20 | 17 | 2.55 |
| 57 | bST | 1275 | 1285 | 1280 | 20.64 | 0 | 420 | 11.15 | 1.3 | 757 | 0.18 | 16 | 2.50 |
| 58 | Control | 1235 | 1245 | 1240 | 16.53 | 1 | 580 | 12.25 | 2.3 | 733 | 0.13 | 18 | 2.13 |
| 69 | Control | 1330 | 1325 | 1328 | 18.99 | 2 | 645 | 12.30 | 2.3 | 781 | 0.30 | 19 | 2.73 |
| 73 | bST | 1360 | 1370 | 1365 | 19.81 | 1 | 470 | 14.45 | 1.3 | 821 | 0.15 | 17 | 1.62 |
| 92 | Control | 1380 | 1385 | 1383 | 19.48 | 1 | 560 | 11.65 | 2.0 | 817 | 0.28 | 18 | 2.96 |
| 114 | Control | 1300 | 1315 | 1308 | 17.06 | 0 | 525 | 11.60 | 2.3 | 768 | 0.20 | 18 | 2.66 |
| 116 | Control | 1415 | 1420 | 1418 | 20.67 | 1 | 520 | 13.70 | 2.6 | 866 | 0.15 | 18 | 2.30 |
| 118 | bST | 1225 | 1220 | 1223 | 16.93 | 1 | 425 | 12.55 | 0.9 | 678 | 0.15 | 16 | 1.61 |
| 133 | bST | 1415 | 1420 | 1418 | 21.75 | 0 | 490 | 15.30 | 1.3 | 835 | 0.20 | 17 | 1.53 |
| 157 | bST | 1525 | 1535 | 1530 | 22.6 | 1 | 450 | 12.60 | 1.0 | 872 | 0.20 | 17 | 2.48 |
| 184 | bST | 1355 | 1360 | 1358 | 20.64 | 1 | 410 | 12.60 | 1.0 | 781 | 0.13 | 16 | 1.95 |
| 187 | bST | 1300 | 1310 | 1305 | 19.69 | 2 | 440 | 12.25 | 1.0 | 763 | 0.18 | 16 | 2.12 |
| 199 | Removed | | | | 12.28 | 0 | | 10.15 | | 635 | 0.15 | | |
| 202 | Control | 1300 | 1310 | 1305 | 21.36 | 0 | 495 | 11.75 | 2.3 | 759 | 0.23 | 17 | 2.64 |
| 217 | Control | 1220 | 1220 | 1220 | 17.48 | 1 | 600 | 11.40 | 2.3 | 735 | 0.23 | 19 | 2.66 |

Table B-4 -(cont'd)

| Steer no. | Treatment | Slaughter wt., lb | | | Liver wt., lb | Liver score [a] | Marbling score [b] | REA in. $^2$ | KHP, % | HCW, lb | Backfat in. | Quality grade [c] | Calc. yield grade [d] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | #1 | #2 | Avg. | | | | | | | | | |
| 222 | Control | 1320 | 1335 | 1328 | 20.99 | 0 | 485 | 11.25 | 2.0 | 793 | 0.43 | 17 | 3.38 |
| 307 | bST | 1305 | 1315 | 1310 | 19.41 | 0 | 445 | 14.15 | 1.3 | 771 | 0.17 | 16 | 1.56 |

[a]Liver abscess score: 0 = no abscesses, 1 = only one or two very small abscesses or abscess scars are present, 2 = two to four small, well-organized abscesses.

[b]Marbling score: 300 = traces, 400 = slight, 500 = small, 600 = modest.

[c]USDA quality grade: 15 = high standard, 16 = low select, 17 = high select, 18 = low choice, 19 = average choice.

[d]Calculated yield grade equation: YG = 2.5 + (2.5 * backfat) + .0038 * HCW) + (.2 * KPH) - (.32 * REA).

Table B-5. Ninth-tenth-eleventh rib composition from Experiment BC9402

| Steer no. | 9-10-11 rib wt., g | Bone wt., g | Soft tissue wt., g | Bone in rib, % | Soft Tissue H2O, % | EEL, % | CP, % |
|---|---|---|---|---|---|---|---|
| 10 | 3750.0 | 750.5 | 2999.5 | 20.01 | 56.19 | 26.23 | 15.09 |
| 25 | 3809.6 | 646.7 | 3162.9 | 16.98 | 55.30 | 27.91 | 14.61 |
| 27 | 4081.7 | 781.0 | 3300.7 | 19.13 | 52.19 | 31.80 | 13.67 |
| 47 | 3531.2 | 664.8 | 2866.4 | 18.83 | 53.51 | 29.72 | 14.10 |
| 60 | 3933.8 | 690.6 | 3243.2 | 17.56 | 59.31 | 22.12 | 15.36 |
| 68 | 3719.4 | 716.6 | 3002.8 | 19.27 | 58.36 | 24.03 | 14.72 |
| 138 | 3587.9 | 700.2 | 2887.7 | 19.52 | 55.71 | 26.36 | 15.05 |
| 179 | 3972.8 | 718.9 | 3253.9 | 18.10 | 60.61 | 20.42 | 15.95 |
| 15 | 5384.7 | 1035.9 | 4338.1 | 19.24 | 58.72 | 21.73 | 16.80 |
| 33 | 5588.0 | 860.1 | 4719.8 | 15.39 | 48.83 | 36.10 | 12.70 |
| 53 | 5728.1 | 1093.3 | 4652.5 | 19.09 | 53.01 | 30.08 | 13.83 |
| 57 | 5136.6 | 1043.3 | 4085.9 | 20.31 | 58.20 | 22.94 | 16.37 |
| 58 | 5329.5 | 961.1 | 4356.9 | 18.03 | 45.89 | 40.02 | 11.53 |
| 69 | 6524.0 | 1073.6 | 5440.1 | 16.46 | 51.16 | 32.18 | 13.18 |
| 73 | 6029.7 | 1127.4 | 4940.6 | 18.70 | 57.34 | 25.09 | 15.20 |
| 92 | 6266.6 | 966.6 | 5279.6 | 15.42 | 46.39 | 38.79 | 12.51 |
| 114 | 5317.5 | 918.0 | 4385.4 | 17.26 | 49.78 | 33.80 | 13.35 |
| 116 | 6289.0 | 866.1 | 5374.9 | 13.77 | 47.38 | 37.24 | 13.35 |
| 118 | 4904.1 | 1019.6 | 3886.3 | 20.79 | 61.54 | 18.39 | 17.11 |
| 133 | 5985.1 | 1174.0 | 4805.7 | 19.62 | 58.56 | 22.76 | 15.55 |
| 157 | 5738.1 | 1161.3 | 4576.8 | 20.24 | 53.44 | 29.42 | 14.22 |
| 184 | 5351.1 | 1023.4 | 4301.2 | 19.13 | 62.35 | 18.13 | 16.64 |
| 187 | 5481.9 | 1062.8 | 4403.6 | 19.39 | 59.88 | 21.53 | 15.20 |
| 202 | 5332.0 | 1097.7 | 4257.0 | 20.59 | 51.65 | 31.68 | 14.68 |
| 217 | 5345.6 | 895.5 | 4456.7 | 16.75 | 48.77 | 35.85 | 12.97 |
| 222 | 5449.7 | 881.3 | 4587.8 | 16.17 | 48.37 | 35.41 | 13.06 |
| 307 | 5459.2 | 1006.3 | 4456.7 | 18.43 | 58.81 | 21.97 | 15.75 |

Table B-6. Plasma glucose concentrations (mmol/L) of steers for Experiment BC9402

| Steer no. | Days relative to first treatment | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 3 | 17 | 30 | 52 | 87 |
| 15 | 4.74 | 4.89 | 5.13 | 5.25 | 5.27 | 4.98 |
| 33 | 5.03 | 5.10 | 5.02 | 4.74 | 4.94 | 4.86 |
| 53 | 4.87 | 5.43 | 5.26 | 5.42 | 5.22 | 5.35 |
| 57 | 5.32 | 5.68 | 6.02 | 5.42 | 5.73 | 5.30 |
| 58 | 4.73 | 4.57 | 4.63 | 4.45 | 4.89 | 4.51 |
| 69 | 4.92 | 4.60 | 4.63 | 4.60 | 4.69 | 4.59 |
| 73 | 5.62 | 6.43 | 6.86 | 6.70 | 5.61 | 6.38 |
| 92 | 5.51 | 5.26 | 5.56 | 5.72 | 4.88 | 4.97 |
| 114 | 4.92 | 5.04 | 4.55 | 4.85 | 4.65 | 4.61 |
| 116 | 4.89 | 5.14 | 5.31 | 5.33 | 4.92 | 5.01 |
| 118 | 5.17 | 5.43 | 6.03 | 5.49 | 5.20 | 5.10 |
| 133 | 5.20 | 6.21 | 5.42 | 5.96 | 5.71 | 5.66 |
| 157 | 5.00 | 5.48 | 6.39 | 5.65 | 6.87 | 4.86 |
| 184 | 4.46 | 4.78 | 5.02 | 5.07 | 4.88 | 4.57 |
| 187 | 4.80 | 5.13 | 5.64 | 5.88 | 5.11 | 4.91 |
| 202 | 5.71 | 5.92 | 6.12 | 5.53 | 5.69 | 5.54 |
| 217 | 4.93 | 4.89 | 4.98 | 4.92 | 4.49 | 4.29 |
| 222 | 5.61 | 4.90 | 5.27 | 5.21 | 5.05 | 4.65 |
| 307 | 4.71 | 5.53 | 5.31 | 5.46 | 5.24 | 4.89 |

Table B-7. Plasma glycerol concentrations (μmol/L) of steers for Experiment BC9402

| Steer no. | Days relative to first treatment | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 3 | 17 | 30 | 52 | 87 |
| 15 | 55.39 | 58.85 | 76.16 | 48.47 | 58.85 | 62.32 |
| 33 | 44.14 | 47.08 | 26.48 | 29.43 | 35.31 | 44.14 |
| 53 | 52.31 | 76.84 | 67.03 | 49.05 | 65.39 | 60.49 |
| 57 | 32.93 | 49.39 | 69.14 | 60.91 | 62.56 | 77.37 |
| 58 | 51.50 | 53.34 | 38.62 | 44.14 | 34.94 | 38.62 |
| 69 | 48.83 | 34.88 | 26.16 | 40.11 | 36.62 | 36.62 |
| 73 | 45.20 | 59.32 | 56.50 | 36.73 | 22.60 | 73.45 |
| 92 | 36.35 | 38.08 | 36.35 | 34.62 | 25.97 | 38.08 |
| 114 | 34.57 | 27.99 | 16.46 | 19.76 | 14.82 | 37.86 |
| 116 | 71.50 | 64.52 | 41.85 | 36.62 | 43.60 | 45.34 |
| 118 | 44.14 | 58.85 | 49.66 | 45.98 | 57.01 | 58.85 |
| 133 | 53.67 | 48.02 | 53.67 | 64.98 | 50.85 | 67.80 |
| 157 | 42.38 | 50.85 | 42.38 | 59.32 | 53.67 | 62.15 |
| 184 | 48.83 | 59.29 | 52.31 | 41.85 | 45.34 | 59.29 |
| 187 | 73.24 | 78.47 | 62.78 | 55.80 | 57.55 | 47.08 |
| 202 | 45.20 | 31.08 | 28.25 | 28.25 | 22.60 | 39.55 |
| 217 | 39.24 | 34.33 | 34.33 | 29.43 | 42.51 | 39.24 |
| 222 | 50.85 | 42.38 | 39.55 | 39.55 | 28.25 | 45.20 |
| 307 | 35.31 | 50.03 | 47.08 | 47.08 | 44.14 | 41.20 |

Table B-8. Plasma nonesterified fatty acid concentrations (mmol/L) of steers for Experiment BC9402

| Steer | Days relative to first treatment | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| no. | 0 | 3 | 10 | 17 | 24 | 30 | 52 | 59 | 73 | 87 |
| 33 | 0.196 | 0.288 | 0.094 | 0.070 | 0.097 | 0.090 | 0.080 | 0.101 | 0.085 | 0.124 |
| 58 | 0.119 | 0.114 | 0.087 | 0.074 | 0.082 | 0.193 | 0.069 | 0.077 | 0.092 | 0.089 |
| 69 | 0.121 | 0.092 | 0.059 | 0.079 | 0.072 | 0.099 | 0.092 | 0.109 | 0.137 | 0.101 |
| 92 | 0.082 | 0.102 | 0.106 | 0.124 | 0.057 | 0.097 | 0.069 | 0.065 | 0.067 | 0.090 |
| 114 | 0.112 | 0.084 | 0.060 | 0.052 | 0.082 | 0.097 | 0.067 | 0.075 | 0.087 | 0.119 |
| 116 | 0.176 | 0.139 | 0.121 | 0.095 | 0.106 | 0.084 | 0.102 | 0.106 | 0.112 | 0.117 |
| 202 | 0.131 | 0.092 | 0.131 | 0.062 | 0.082 | 0.173 | 0.062 | 0.097 | 0.094 | 0.109 |
| 217 | 0.092 | 0.080 | 0.074 | 0.080 | 0.122 | 0.104 | 0.095 | 0.132 | 0.136 | 0.099 |
| 222 | 0.114 | 0.111 | 0.079 | 0.095 | 0.107 | 0.129 | 0.089 | 0.112 | 0.111 | 0.126 |
| 15 | 0.116 | 0.216 | 0.194 | 0.193 | 0.173 | 0.151 | 0.147 | 0.129 | 0.228 | 0.276 |
| 53 | 0.099 | 0.296 | 0.126 | 0.220 | 0.300 | 0.223 | 0.204 | 0.189 | 0.171 | 0.240 |
| 57 | 0.104 | 0.296 | 0.246 | 0.278 | 0.280 | 0.278 | 0.223 | 0.256 | 0.235 | 0.347 |
| 73 | 0.101 | 0.193 | 0.102 | 0.136 | 0.119 | 0.097 | 0.169 | 0.127 | 0.142 | 0.188 |
| 118 | 0.109 | 0.198 | 0.116 | 0.147 | 0.188 | 0.119 | 0.233 | 0.147 | 0.142 | 0.191 |
| 133 | 0.127 | 0.196 | 0.265 | 0.132 | 0.219 | 0.174 | 0.154 | 0.221 | 0.188 | 0.149 |
| 157 | 0.092 | 0.151 | 0.117 | 0.119 | 0.119 | 0.203 | 0.137 | 0.201 | 0.104 | 0.226 |
| 184 | 0.067 | 0.201 | 0.196 | 0.147 | 0.166 | 0.164 | 0.161 | 0.231 | 0.144 | 0.162 |
| 187 | 0.173 | 0.256 | 0.238 | 0.265 | 0.196 | 0.240 | 0.176 | 0.194 | 0.204 | 0.174 |
| 307 | 0.072 | 0.183 | 0.147 | 0.139 | 0.169 | 0.152 | 0.178 | 0.147 | 0.196 | 0.159 |

Table B-9. Plasma insulin concentrations (ng/ml) of steers for Experiment BC9402

| Steer | Days relative to first treatment | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| no. | 0 | 3 | 10 | 17 | 24 | 30 | 52 | 59 | 73 | 87 |
| 15 | 1.708 | 3.622 | 4.281 | 4.807 | 4.424 | 5.453 | 9.702 | 9.222 | 8.477 | 11.482 |
| 33 | 2.150 | 1.747 | 1.807 | 5.216 | 2.223 | 1.051 | 2.779 | 2.503 | 4.674 | 2.402 |
| 53 | 2.818 | 8.697 | 18.285 | 9.503 | 8.991 | 6.447 | 16.095 | 11.365 | 11.182 | 14.035 |
| 57 | 3.531 | 23.901 | 16.513 | 39.435 | 73.469 | 23.551 | 37.635 | ND[a] | 36.059 | 66.853 |
| 58 | 1.317 | 1.210 | 2.008 | 1.902 | 2.197 | 1.320 | 2.395 | 4.568 | 3.084 | 3.603 |
| 69 | 2.21 | 1.70 | 3.44 | 2.55 | 2.86 | 1.52 | 2.74 | 1.74 | 2.00 | 1.80 |
| 73 | 1.651 | 6.854 | 6.246 | 15.482 | 14.706 | 14.188 | 3.680 | 10.513 | 10.238 | 19.451 |
| 92 | 3.315 | 1.265 | 2.384 | 1.764 | 4.238 | 2.525 | 2.109 | 2.214 | 3.178 | 2.480 |
| 114 | 1.968 | 0.820 | 1.777 | 1.303 | 1.008 | 1.015 | 1.338 | 0.762 | 1.292 | 1.125 |
| 116 | 2.683 | 1.193 | 2.204 | 2.817 | 2.980 | 4.538 | 3.876 | 3.481 | 4.879 | 8.743 |
| 118 | 2.685 | 11.046 | 10.628 | 15.472 | 36.529 | 48.331 | 29.607 | ND | 54.292 | 51.697 |
| 133 | 1.942 | 10.794 | 3.036 | 8.509 | 6.986 | 8.102 | 13.754 | 12.699 | 10.688 | 17.904 |
| 157 | 2.285 | 9.715 | 23.766 | 34.517 | 32.663 | 17.371 | 41.543 | ND | 36.838 | 12.669 |
| 184 | 2.64 | 5.93 | 6.51 | 3.67 | 5.35 | 11.20 | 7.34 | 8.68 | 7.11 | 4.39 |
| 187 | 2.007 | 4.535 | 4.490 | 4.669 | 7.877 | 10.157 | 7.053 | 11.422 | 7.456 | 6.076 |
| 202 | 2.444 | 3.000 | 3.041 | 3.876 | 2.957 | 1.535 | 4.423 | 3.054 | 3.193 | 2.840 |
| 217 | 2.135 | 1.129 | 2.193 | 1.870 | 1.925 | 1.468 | 1.655 | 1.957 | 1.471 | 1.411 |
| 222 | 7.673 | 2.404 | 6.520 | 9.270 | 5.917 | 6.992 | 8.496 | 6.586 | 4.396 | 2.709 |
| 307 | 2.568 | 14.008 | 9.550 | 11.669 | 23.089 | 9.019 | 10.468 | 11.905 | 9.274 | 8.069 |

[a]Not determined

Table B-10. Plasma IGF-I concentrations (ng/ml) of steers for Experiment BC9402

| Steer | Days relative to first treatment | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| no. | 0 | 3 | 10 | 17 | 24 | 30 | 52 | 59 | 73 | 87 |
| 15 | 580 | 1169 | 1220 | 1187 | 1205 | 1104 | 1206 | 1224 | 1227 | 1076 |
| 33 | 585 | 581 | 482 | 491 | 476 | 464 | 458 | 491 | 534 | 459 |
| 53 | 573 | 954 | 1108 | 1103 | 904 | 1075 | 1158 | 1198 | 1072 | 1083 |
| 57 | 779 | 1426 | 1258 | 1674 | 1615 | 1677 | 1550 | 1558 | 1551 | 1514 |
| 58 | 523 | 512 | 474 | 529 | 539 | 509 | 546 | 502 | 482 | 479 |
| 69 | 549 | 518 | 538 | 572 | 538 | 546 | 546 | 455 | 477 | 474 |
| 73 | 861 | 1368 | 1367 | 1568 | 1367 | 1468 | 1481 | 1458 | 1585 | 1598 |
| 92 | 543 | 471 | 400 | 462 | 435 | 480 | 388 | 394 | 390 | 366 |
| 114 | 522 | 589 | 543 | 541 | 519 | 413 | 506 | 529 | 459 | 433 |
| 116 | 529 | 487 | 581 | 550 | 522 | 576 | 532 | 541 | 516 | 514 |
| 118 | 758 | 1094 | 1137 | 1081 | 1293 | 1142 | 1218 | 1084 | 1087 | 1142 |
| 133 | 618 | 1337 | 1308 | 1354 | 1551 | 1459 | 1388 | 1380 | 1565 | 1673 |
| 157 | 802 | 1240 | 1141 | 1238 | 1276 | 1158 | 1078 | 1160 | 1050 | 1116 |
| 184 | 673 | 1034 | 1104 | 1116 | 1154 | 1317 | 1175 | 1035 | 1183 | 1184 |
| 187 | 1077 | 1103 | 1149 | 1092 | 1178 | 629 | 908 | 902 | 1136 | 988 |
| 202 | 803 | 809 | 684 | 750 | 746 | 669 | 669 | 697 | 595 | 631 |
| 217 | 519 | 542 | 499 | 520 | 450 | 433 | 421 | 366 | 416 | 395 |
| 222 | 555 | 524 | 564 | 601 | 608 | 498 | 572 | 529 | 533 | 524 |
| 307 | 758 | 1086 | 1103 | 1111 | 1193 | 1162 | 1104 | 1046 | 1015 | 1019 |

Table B-11. Plasma bovine somatotropin concentrations (ng/ml) for steers from day 94 of Experiment BC9402

| Steer | Hour of day | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| no. | 630 | 700 | 730 | 800 | 830 | 900 | 930 | 1000 | 1030 | 1100 | 1130 | 1200 | 1230 | 1300 | 1330 | 1400 |
| 15 | 7.556 | 7.294 | 6.846 | 19.307 | 43.187 | 72.380 | 110.812 | 108.344 | 115.996 | 83.616 | 56.535 | 45.799 | 58.968 | 61.446 | 59.269 | 59.948 |
| 33 | 1.510 | 2.066 | 1.789 | 10.247 | 5.490 | 2.825 | 3.086 | 2.958 | 1.535 | 2.435 | 3.851 | 2.766 | 0.979 | 0.766 | 0.859 | 1.579 |
| 53 | 5.877 | 5.103 | 4.864 | 17.444 | 26.021 | 32.505 | 39.980 | 39.628 | 35.014 | 22.981 | 19.712 | 17.645 | 18.660 | 19.374 | 19.052 | 13.420 |
| 57 | 5.452 | 5.634 | 5.346 | 13.221 | 19.142 | 30.515 | 35.049 | 38.674 | 26.772 | 19.355 | 18.260 | 16.230 | 15.192 | 14.576 | 11.670 | 11.403 |
| 69 | 0.638 | 0.504 | 0.707 | 0.576 | 0.682 | 2.638 | 1.859 | 0.954 | 1.875 | 0.902 | 0.772 | 0.547 | 0.581 | 0.534 | 0.664 | 0.579 |
| 73 | 5.138 | 4.987 | 14.436 | 26.536 | 31.667 | 44.514 | 42.558 | 37.938 | 30.286 | 26.915 | 28.465 | 28.223 | 25.656 | 19.583 | 13.719 | 11.201 |
| 92 | 0.661 | 1.187 | 0.783 | 0.627 | 1.295 | 1.188 | 1.138 | 0.947 | 0.896 | 1.055 | 0.592 | 0.728 | 0.742 | 0.650 | 0.827 | 0.914 |
| 114 | 0.597 | 0.484 | 0.558 | 0.561 | 0.488 | 0.514 | 0.481 | 0.523 | 1.050 | 1.167 | 2.253 | 0.819 | 0.690 | 0.592 | 0.589 | 0.524 |
| 116 | 0.550 | 0.656 | 0.677 | 0.640 | 0.649 | 0.564 | 1.161 | 0.788 | 0.909 | 1.203 | 0.849 | 0.999 | 0.767 | 0.600 | 0.738 | 1.204 |
| 118 | 10.667 | 9.804 | 6.810 | 3.717 | 32.476 | 57.488 | 65.090 | 69.883 | 86.725 | 93.641 | 101.665 | 89.076 | 90.966 | 79.268 | 79.697 | 59.470 |
| 157 | 5.146 | 3.719 | 2.479 | 5.835 | 14.859 | 17.466 | 18.722 | 17.639 | 18.578 | 21.722 | 19.121 | 15.377 | 14.257 | 12.239 | 10.867 | 10.848 |
| 184 | 16.971 | 5.043 | 6.495 | 6.382 | 59.131 | 117.290 | 118.894 | 77.192 | 78.719 | 55.503 | 40.362 | 33.084 | 38.602 | 28.798 | 34.418 | 23.261 |
| 187 | 4.596 | 4.871 | 4.481 | 41.312 | 86.246 | 74.405 | 62.519 | 51.866 | 43.266 | 44.811 | 37.387 | 29.766 | 30.998 | 24.758 | 19.696 | 15.711 |
| 202 | 0.645 | 0.551 | 0.517 | 1.044 | 0.954 | 1.761 | 0.807 | 0.773 | 1.979 | 1.899 | 1.149 | 0.717 | 0.572 | 0.479 | 0.432 | 0.463 |
| 217 | 0.620 | 0.565 | 0.559 | 0.418 | 0.524 | 0.530 | 0.504 | 0.612 | 0.536 | ND[a] | 0.564 | 0.583 | 0.593 | 0.674 | 1.913 | 2.236 |
| 222 | 1.050 | 0.471 | 0.595 | 0.505 | 0.534 | 0.730 | 0.725 | 0.578 | 0.834 | 0.501 | 0.497 | 1.073 | 0.481 | 0.580 | 0.626 | 0.508 |

307 No samples collected due to catheter problems

Table B-11. (cont'd)

| Steer no. | Hour of day | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1430 | 1500 | 1530 | 1600 | 1630 | 1700 | 1730 | 1800 |
| 15 | 46.268 | 38.220 | 29.633 | 31.061 | ND | 28.461 | 30.768 | 28.983 |
| 33 | 2.113 | 1.657 | 0.910 | 1.015 | 2.780 | 1.610 | 1.531 | 0.822 |
| 53 | 11.689 | 12.920 | 14.000 | 14.630 | 10.540 | 10.546 | 8.723 | 11.245 |
| 57 | 9.837 | 13.967 | 14.183 | 13.944 | 15.223 | 11.678 | 11.816 | 11.967 |
| 69 | 1.197 | 0.457 | 0.414 | 0.514 | ND | 0.555 | 0.594 | 0.601 |
| 73 | 10.935 | 12.209 | 10.849 | 14.724 | 11.208 | 12.735 | 8.878 | 9.652 |
| 92 | 1.361 | 1.102 | 0.485 | 0.733 | 0.660 | 0.793 | 0.806 | 1.229 |
| 114 | 0.433 | 0.485 | 0.559 | 0.513 | 0.434 | 0.570 | 0.536 | 0.424 |
| 116 | 1.091 | 0.920 | 0.998 | 0.664 | 0.474 | 0.649 | 1.111 | 0.566 |
| 118 | 76.531 | 67.950 | 66.803 | 65.446 | 64.817 | 59.381 | 55.476 | 58.631 |
| 157 | 10.923 | 10.668 | 13.641 | 15.196 | 12.120 | 11.064 | 11.022 | 11.931 |
| 184 | 19.588 | 19.848 | 11.508 | 13.586 | 16.451 | 15.324 | 13.353 | 9.847 |
| 187 | 10.990 | 12.951 | 12.957 | 12.146 | 9.275 | 9.008 | 9.027 | 10.984 |
| 202 | 0.537 | 0.527 | 0.569 | 0.632 | 0.853 | 0.810 | 2.573 | 0.744 |
| 217 | 1.697 | 0.706 | 0.547 | 0.584 | 0.425 | 0.590 | 0.631 | 0.487 |
| 222 | 0.487 | 0.479 | 0.705 | 0.488 | 0.640 | 0.463 | 0.480 | 0.562 |
| 307 | No samples collected due to catheter problems | | | | | | | |

[a]Not determined

Table B-12. Tritium incorporation into fatty acids, fatty acid synthase activity, NADP-isocitrate dehydrogenase activity, and enzyme assay soluble protein content for fat biopsies from Experiment BC9402

| Steer no. | Tritium incorporation, nmol $H_2O$ converted to FA $\cdot min^{-1} \cdot 100mg\ tissue^{-1}$ | | | Fatty acid synthase activity, units/mg protein | | | NADP-isocitrate dehydrogenase activity units/mg protein | | | Soluble protein, mg/g tissue | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Biopsy 1 | Biopsy 2 | Biopsy 3 | Biopsy 1 | Biopsy 2 | Biopsy 3 | Biopsy 1 | Biopsy 2 | Biopsy 3 | Biopsy 1 | Biopsy 2 | Biopsy 3 |
| 15 | 0.71 | 0.57 | 0.95 | 8.43 | 3.93 | 3.57 | 405.68 | 152.60 | 202.89 | 1.80 | 2.69 | 1.98 |
| 33 | 2.93 | 0.46 | 1.11 | 10.50 | 4.35 | 4.70 | 269.32 | 144.06 | 67.48 | 3.46 | 2.52 | 10.01 |
| 53 | 3.68 | 1.08 | 0.84 | 4.22 | 1.43 | 1.80 | 68.26 | 138.06 | 153.15 | 14.29 | 5.24 | 3.55 |
| 57 | 5.42 | 1.48 | 1.43 | 8.92 | 2.03 | 1.90 | 319.46 | 127.87 | 167.57 | 4.34 | 7.53 | 3.67 |
| 58 | 3.83 | 4.74 | 1.84 | 16.59 | 11.92 | 18.31 | 535.79 | 338.15 | 387.10 | 2.92 | 6.07 | 3.17 |
| 69 | 3.21 | 1.79 | 1.29 | 14.20 | 15.41 | 10.51 | 372.63 | 312.87 | 246.07 | 2.96 | 3.63 | 2.96 |
| 73 | 1.93 | 1.02 | 1.32 | 19.74 | 2.60 | 11.80 | 265.78 | 227.03 | 225.10 | 4.43 | 3.77 | 3.83 |
| 92 | 3.18 | 2.30 | 2.14 | 16.57 | 6.25 | 1.45 | 260.72 | 135.30 | 167.47 | 3.97 | 7.39 | 6.14 |
| 114 | 4.46 | 1.94 | 0.80 | 10.06 | 8.46 | 3.58 | 229.84 | 227.58 | 144.54 | 6.72 | 4.82 | 4.06 |
| 116 | 3.22 | 3.81 | 3.06 | 1.84 | 6.41 | 12.00 | 175.41 | 210.93 | 137.12 | 4.45 | 6.78 | 5.45 |
| 118 | 2.65 | 1.38 | 0.79 | 23.40 | 1.17 | 3.39 | 340.14 | 104.64 | 136.56 | 3.79 | 4.45 | 4.12 |
| 133 | 3.80 | 3.65 | 2.56 | 16.72 | 1.09 | 6.57 | 317.53 | 105.32 | 86.73 | 3.52 | 6.21 | 9.49 |
| 157 | 3.30 | 2.95 | 1.17 | 21.81 | 9.17 | 1.94 | 488.38 | 296.28 | 103.89 | 3.42 | 3.92 | 3.42 |
| 184 | 3.74 | 0.54 | 1.44 | 11.14 | 3.44 | 2.22 | 290.62 | 112.48 | 53.83 | 3.20 | 5.74 | 7.92 |
| 187 | 2.57 | 0.04 | 1.24 | 6.37 | 1.09 | 6.64 | 122.92 | 112.39 | 121.71 | 5.97 | 4.36 | 6.11 |
| 199 | 0.67 | ND[a] | ND | 6.82 | ND | ND | 163.20 | ND | ND | ND | ND | ND |
| 202 | 3.12 | 1.72 | 1.20 | 6.66 | 4.15 | 4.78 | 223.40 | 178.85 | 95.18 | 4.54 | 5.02 | 7.55 |
| 217 | 3.99 | 3.99 | 1.58 | 7.12 | 2.73 | 9.80 | 158.54 | 148.65 | 139.30 | 8.61 | 8.31 | 3.69 |
| 222 | 2.40 | 1.08 | 0.63 | 16.85 | 3.55 | 5.26 | 363.96 | 253.14 | 118.41 | 3.24 | 5.06 | 6.87 |
| 307 | 3.73 | 0.95 | 2.11 | 12.15 | 5.23 | 5.89 | 266.40 | 161.21 | 106.05 | 4.55 | 3.27 | 5.39 |

[a]Not Determined, steer removed from study.

Table B-13. Basal and epinephrine-stimulated glycerol release (nmol glycerol released•2h$^{-1}$•100 mg tissue$^{-1}$) for fat biopsies from Experiment BC9402

| Steer no. | Basal | | | Epinephrine stimulated | | |
|---|---|---|---|---|---|---|
| | Biopsy 1 | Biopsy 2 | Biopsy 3 | Biopsy 1 | Biopsy 2 | Biopsy 3 |
| 15 | 93.8 | 50.8 | 105.5 | 240.3 | 292.3 | 255.0 |
| 33 | 127.8 | 109.3 | 87.7 | 416.0 | 223.0 | 294.6 |
| 53 | 23.0 | 127.7 | 54.5 | 283.8 | 235.2 | 325.2 |
| 57 | 51.8 | 187.5 | 151.4 | ND[a] | 331.5 | 288.9 |
| 58 | 63.1 | 65.1 | 68.5 | 224.0 | 411.5 | 260.8 |
| 69 | 106.3 | 34.9 | 99.9 | 295.0 | 143.0 | 316.7 |
| 73 | 86.3 | 149.1 | 203.7 | 277.7 | 319.2 | 325.9 |
| 92 | 51.0 | 69.3 | 54.5 | 355.5 | 340.9 | 244.0 |
| 114 | 75.3 | 115.1 | 75.0 | 199.8 | 308.7 | 265.8 |
| 116 | 14.5 | 67.9 | 58.6 | 167.1 | 187.3 | 235.5 |
| 118 | 51.1 | 105.7 | 162.1 | 192.0 | 338.5 | 295.8 |
| 133 | 83.2 | 151.4 | 103.3 | 340.8 | 284.6 | 213.0 |
| 157 | 232.0 | 58.9 | 132.9 | 199.1 | 293.5 | 268.0 |
| 184 | 74.6 | 105.6 | 47.5 | 273.2 | 312.6 | 330.7 |
| 187 | 104.2 | 32.9 | 139.9 | 333.8 | 131.0 | 293.0 |
| 199 | 83.8 | ND | ND | 245.4 | ND | ND |
| 202 | 99.6 | 52.7 | 84.5 | 229.5 | 281.7 | 352.5 |
| 217 | 53.2 | 178.7 | 101.2 | 256.9 | 314.2 | 235.9 |
| 222 | 90.7 | 82.3 | 102.4 | 206.7 | 137.1 | 179.0 |
| 307 | 135.5 | 95.2 | 84.6 | 359.4 | 210.4 | 226.9 |

[a]Not determined, steer no. 199 removed from study

Table B-14. Nonesterified fatty acid response (mmol/L) to seven epinephrine doses (μg/kg BW) during three different weeks for Experiment BC9402

| Week | Steer no. | Epi. dose[a] | Minutes relative to the epinephrine challenge | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | -30 | -15 | -10 | -5 | 0 | 2.5 | 5 | 10 | 15 | 20 | 120 | 125 | 130 |
| -3 | 15 | 0 | 0.067 | 0.068 | 0.05 | 0.076 | 0.072 | 0.072 | 0.074 | 0.065 | 0.056 | 0.061 | 0.059 | 0.056 | 0.061 |
| -3 | 15 | 0.1 | 0.083 | 0.088 | 0.077 | 0.067 | 0.059 | 0.119 | 0.099 | 0.083 | 0.077 | 0.072 | 0.061 | 0.076 | 0.072 |
| -3 | 15 | 0.2 | NC[b] | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| -3 | 15 | 0.4 | 0.076 | 0.103 | 0.041 | 0.079 | 0.083 | 0.076 | 0.159 | 0.168 | 0.119 | 0.124 | 0.058 | 0.050 | 0.052 |
| -3 | 15 | 0.8 | 0.094 | 0.097 | 0.095 | 0.088 | 0.07 | 0.177 | 0.234 | 0.220 | 0.200 | 0.146 | 0.088 | 0.108 | 0.077 |
| -3 | 15 | 1.2 | 0.058 | 0.061 | 0.056 | 0.074 | 0.063 | 0.059 | 0.126 | 0.092 | 0.090 | 0.079 | 0.062 | 0.141 | 0.065 |
| -3 | 15 | 1.6 | 0.077 | 0.054 | 0.056 | 0.056 | 0.056 | 0.110 | 0.193 | 0.200 | 0.123 | 0.095 | 0.063 | 0.054 | 0.049 |
| 6 | 15 | 0 | 0.37 | 0.305 | 0.28 | 0.27 | 0.28 | 0.277 | 0.275 | 0.321 | 0.335 | 0.332 | 0.400 | 0.390 | 0.395 |
| 6 | 15 | 0.1 | 0.231 | 0.194 | 0.189 | 0.196 | 0.162 | 0.205 | 0.233 | 0.210 | 0.178 | 0.145 | 0.206 | 0.212 | 0.213 |
| 6 | 15 | 0.2 | 0.085 | 0.099 | 0.095 | 0.097 | 0.086 | 0.136 | 0.199 | 0.199 | 0.189 | 0.136 | 0.123 | 0.132 | 0.125 |
| 6 | 15 | 0.4 | 0.159 | 0.102 | 0.095 | 0.097 | 0.078 | 0.242 | 0.291 | NC | 0.242 | 0.187 | 0.196 | 0.127 | 0.192 |
| 6 | 15 | 0.8 | 0.187 | 0.12 | 0.099 | 0.108 | 0.086 | 0.116 | 0.210 | 0.295 | 0.280 | 0.226 | 0.143 | 0.159 | 0.213 |
| 6 | 15 | 1.2 | 0.111 | 0.108 | 0.108 | 0.118 | 0.127 | 0.280 | 0.333 | 0.353 | 0.286 | 0.109 | 0.138 | 0.120 | 0.141 |
| 6 | 15 | 1.6 | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| 15 | 15 | 0 | 0.052 | NC | NC | NC | 0.073 | NC | NC | 0.082 | 0.080 | 0.080 | 0.150 | NC | NC |
| 15 | 15 | 0.1 | 0.093 | 0.089 | 0.062 | 0.073 | 0.073 | 0.155 | 0.162 | 0.130 | 0.119 | 0.102 | 0.155 | 0.109 | 0.130 |
| 15 | 15 | 0.2 | 0.1 | 0.103 | 0.111 | 0.112 | 0.209 | 0.127 | 0.228 | 0.216 | 0.175 | 0.180 | 0.239 | 0.241 | 0.226 |
| 15 | 15 | 0.4 | 0.07 | 0.067 | 0.053 | 0.061 | 0.052 | 0.144 | 0.194 | 0.155 | 0.115 | 0.080 | 0.110 | 0.089 | 0.105 |
| 15 | 15 | 0.8 | 0.057 | 0.062 | 0.064 | 0.059 | 0.05 | 0.139 | 0.184 | 0.198 | 0.159 | 0.073 | 0.100 | 0.114 | 0.121 |
| 15 | 15 | 1.2 | 0.08 | 0.068 | 0.082 | 0.096 | 0.064 | 0.164 | 0.232 | 0.234 | 0.175 | 0.107 | 0.102 | 0.096 | 0.118 |
| 15 | 15 | 1.6 | 0.078 | 0.073 | 0.068 | 0.07 | 0.08 | 0.250 | 0.212 | 0.248 | 0.178 | 0.152 | 0.110 | 0.103 | 0.114 |
| -3 | 33 | 0 | 0.053 | NC | 0.037 | 0.033 | 0.047 | 0.053 | 0.051 | 0.076 | 0.068 | 0.062 | 0.035 | 0.053 | 0.051 |
| -3 | 33 | 0.1 | 0.070 | 0.056 | 0.034 | 0.039 | 0.051 | 0.064 | 0.072 | 0.078 | 0.062 | 0.043 | 0.047 | 0.058 | 0.066 |
| -3 | 33 | 0.2 | 0.053 | 0.049 | 0.053 | 0.062 | NC | 0.051 | 0.099 | 0.080 | 0.060 | 0.035 | 0.070 | 0.043 | 0.039 |
| -3 | 33 | 0.4 | 0.041 | 0.037 | 0.037 | 0.035 | 0.049 | 0.097 | 0.128 | 0.088 | 0.064 | 0.045 | 0.027 | 0.043 | 0.037 |

Table B-14. (cont'd)

| Week | Steer no. | Epi. dose [a] | Minutes relative to the epinephrine challenge | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | -30 | -15 | -10 | -5 | 0 | 2.5 | 5 | 10 | 15 | 20 | 120 | 125 | 130 |
| -3 | 33 | 0.8 | 0.035 | NC | 0.019 | 0.033 | 0.053 | 0.074 | 0.111 | 0.097 | 0.165 | 0.045 | 0.043 | 0.045 | 0.041 |
| -3 | 33 | 1.2 | 0.039 | NC | 0.034 | 0.051 | 0.049 | 0.082 | 0.196 | 0.163 | 0.099 | 0.064 | 0.033 | 0.049 | 0.043 |
| -3 | 33 | 1.6 | 0.060 | 0.060 | 0.043 | 0.039 | 0.049 | 0.109 | 0.109 | 0.136 | 0.080 | 0.047 | 0.041 | 0.051 | 0.043 |
| 6 | 33 | 0 | 0.037 | 0.035 | 0.035 | 0.032 | 0.028 | 0.048 | 0.030 | 0.042 | 0.046 | 0.035 | 0.032 | 0.037 | 0.030 |
| 6 | 33 | 0.1 | 0.055 | 0.060 | 0.060 | 0.048 | 0.042 | 0.083 | 0.055 | 0.086 | 0.060 | 0.037 | 0.048 | 0.042 | 0.044 |
| 6 | 33 | 0.2 | 0.046 | 0.030 | 0.048 | 0.048 | 0.043 | 0.046 | 0.053 | 0.055 | 0.042 | 0.039 | 0.042 | 0.032 | 0.045 |
| 6 | 33 | 0.4 | 0.042 | 0.044 | 0.041 | 0.037 | 0.046 | 0.074 | 0.102 | 0.104 | 0.071 | 0.086 | 0.045 | NC | 0.034 |
| 6 | 33 | 0.8 | 0.051 | 0.043 | 0.034 | 0.032 | 0.044 | 0.136 | 0.146 | 0.131 | 0.071 | 0.041 | 0.046 | 0.044 | 0.034 |
| 6 | 33 | 1.2 | 0.037 | NC | 0.021 | 0.025 | 0.026 | 0.065 | 0.090 | 0.055 | 0.042 | 0.037 | 0.056 | 0.056 | 0.046 |
| 6 | 33 | 1.6 | 0.039 | 0.039 | 0.030 | 0.055 | 0.032 | 0.079 | 0.173 | 0.122 | 0.076 | 0.046 | 0.028 | 0.032 | 0.044 |
| 15 | 33 | 0 | 0.043 | 0.036 | 0.043 | 0.070 | 0.048 | 0.057 | 0.065 | 0.054 | 0.057 | 0.056 | 0.047 | 0.038 | 0.045 |
| 15 | 33 | 0.1 | 0.054 | 0.057 | 0.065 | 0.059 | 0.045 | 0.091 | 0.084 | 0.066 | 0.063 | 0.047 | 0.049 | 0.036 | 0.041 |
| 15 | 33 | 0.2 | 0.052 | 0.048 | 0.048 | 0.052 | NC | 0.077 | 0.066 | 0.093 | 0.079 | 0.036 | 0.049 | 0.029 | 0.025 |
| 15 | 33 | 0.4 | 0.043 | 0.041 | 0.068 | 0.052 | 0.057 | 0.106 | 0.116 | 0.102 | 0.072 | 0.057 | 0.047 | 0.038 | 0.047 |
| 15 | 33 | 0.8 | 0.057 | 0.039 | 0.054 | 0.057 | 0.043 | 0.152 | 0.145 | 0.129 | 0.077 | 0.063 | 0.057 | 0.047 | 0.065 |
| 15 | 33 | 1.2 | 0.054 | 0.047 | 0.052 | 0.056 | NC | NC | 0.143 | 0.115 | 0.070 | 0.057 | 0.047 | 0.054 | 0.048 |
| 15 | 33 | 1.6 | 0.054 | 0.038 | 0.039 | 0.050 | 0.041 | 0.086 | 0.140 | 0.152 | 0.124 | 0.099 | 0.047 | 0.039 | 0.032 |
| -3 | 53 | 0 | 0.038 | 0.050 | 0.029 | 0.033 | 0.026 | 0.144 | 0.059 | 0.069 | 0.038 | 0.055 | 0.062 | 0.028 | 0.028 |
| -3 | 53 | 0.1 | 0.013 | 0.043 | 0.035 | 0.060 | 0.064 | 0.092 | 0.071 | 0.067 | 0.067 | 0.052 | 0.041 | 0.040 | 0.045 |
| -3 | 53 | 0.2 | 0.033 | 0.033 | 0.038 | 0.040 | 0.024 | 0.079 | 0.117 | 0.074 | 0.074 | 0.048 | 0.060 | 0.047 | 0.036 |
| -3 | 53 | 0.4 | 0.035 | 0.040 | 0.041 | 0.043 | 0.034 | 0.079 | 0.126 | 0.088 | 0.074 | 0.057 | 0.044 | 0.029 | 0.040 |
| -3 | 53 | 0.8 | 0.040 | 0.034 | 0.033 | 0.064 | 0.033 | 0.104 | 0.147 | 0.119 | 0.066 | 0.047 | 0.041 | 0.039 | 0.035 |
| -3 | 53 | 1.2 | 0.028 | 0.034 | 0.026 | 0.028 | 0.029 | 0.078 | 0.142 | 0.116 | 0.071 | 0.039 | 0.036 | 0.028 | 0.021 |
| -3 | 53 | 1.6 | 0.058 | 0.051 | 0.043 | 0.050 | 0.033 | 0.136 | 0.121 | 0.111 | 0.107 | 0.064 | 0.040 | 0.035 | 0.047 |
| 6 | 53 | 0 | 0.049 | 0.072 | 0.045 | 0.056 | 0.049 | 0.054 | 0.052 | 0.054 | 0.066 | 0.049 | 0.047 | 0.061 | 0.056 |
| 6 | 53 | 0.1 | 0.061 | 0.055 | 0.042 | 0.059 | 0.092 | 0.044 | 0.105 | NC | 0.066 | 0.058 | 0.037 | 0.038 | 0.045 |

Table B-14. (cont'd)

| Week | Steer no. | Epi. dose [a] | Minutes relative to the epinephrine challenge | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | -30 | -15 | -10 | -5 | 0 | 2.5 | 5 | 10 | 15 | 20 | 120 | 125 | 130 |
| 6 | 53 | 0.2 | 0.045 | 0.065 | 0.051 | 0.052 | 0.042 | 0.124 | 0.099 | 0.098 | 0.092 | 0.113 | 0.056 | 0.037 | 0.038 |
| 6 | 53 | 0.4 | 0.068 | 0.089 | 0.049 | 0.051 | 0.038 | 0.083 | 0.148 | 0.145 | 0.108 | 0.058 | 0.089 | NC | 0.037 |
| 6 | 53 | 0.8 | 0.079 | 0.077 | 0.058 | 0.113 | 0.103 | 0.122 | 0.208 | 0.271 | 0.175 | 0.094 | 0.070 | 0.061 | 0.059 |
| 6 | 53 | 1.2 | NC | 0.077 | 0.058 | 0.051 | 0.040 | 0.089 | 0.160 | 0.223 | 0.141 | 0.089 | 0.056 | 0.047 | 0.031 |
| 6 | 53 | 1.6 | 0.056 | 0.058 | 0.045 | 0.058 | 0.033 | 0.070 | 0.098 | 0.143 | 0.094 | 0.096 | 0.028 | 0.053 | 0.049 |
| 15 | 53 | 0 | 0.067 | 0.046 | 0.029 | 0.043 | 0.036 | 0.051 | 0.043 | 0.058 | 0.046 | 0.043 | 0.056 | 0.113 | 0.080 |
| 15 | 53 | 0.1 | 0.036 | 0.055 | 0.041 | 0.038 | 0.041 | 0.108 | 0.108 | 0.096 | 0.072 | 0.077 | 0.096 | 0.077 | 0.077 |
| 15 | 53 | 0.2 | 0.029 | 0.029 | 0.032 | 0.036 | 0.029 | 0.096 | 0.116 | 0.091 | 0.080 | 0.055 | 0.079 | 0.079 | 0.068 |
| 15 | 53 | 0.4 | 0.036 | 0.031 | 0.029 | 0.041 | 0.050 | 0.121 | 0.115 | 0.121 | 0.048 | 0.051 | 0.039 | 0.041 | 0.038 |
| 15 | 53 | 0.8 | 0.092 | 0.085 | 0.094 | 0.106 | 0.101 | 0.156 | 0.226 | 0.253 | 0.315 | 0.272 | 0.215 | 0.227 | 0.191 |
| 15 | 53 | 1.2 | 0.085 | 0.084 | 0.096 | 0.072 | 0.067 | 0.157 | 0.186 | 0.217 | 0.168 | 0.138 | 0.087 | 0.082 | 0.103 |
| 15 | 53 | 1.6 | 0.050 | 0.044 | 0.056 | 0.044 | 0.058 | 0.109 | 0.193 | 0.227 | 0.202 | 0.120 | 0.060 | 0.056 | 0.063 |
| -3 | 57 | 0 | 0.045 | 0.052 | 0.052 | 0.048 | 0.041 | 0.057 | 0.057 | 0.045 | 0.056 | 0.054 | 0.075 | 0.063 | 0.073 |
| -3 | 57 | 0.1 | 0.050 | 0.036 | 0.034 | 0.041 | 0.036 | 0.066 | 0.056 | 0.054 | 0.045 | 0.039 | 0.041 | 0.057 | 0.056 |
| -3 | 57 | 0.2 | 0.070 | 0.073 | 0.075 | 0.084 | 0.073 | 0.118 | 0.151 | 0.267 | 0.105 | 0.109 | 0.050 | 0.063 | 0.056 |
| -3 | 57 | 0.4 | 0.050 | 0.032 | 0.023 | 0.048 | 0.027 | 0.068 | 0.127 | 0.079 | 0.056 | 0.061 | 0.045 | 0.047 | 0.045 |
| -3 | 57 | 0.8 | 0.077 | 0.078 | 0.027 | 0.067 | 0.030 | 0.131 | 0.127 | 0.120 | 0.066 | 0.052 | 0.054 | 0.036 | 0.054 |
| -3 | 57 | 1.2 | 0.045 | 0.025 | 0.043 | 0.036 | 0.027 | 0.077 | 0.122 | 0.100 | 0.072 | 0.059 | 0.038 | 0.036 | 0.076 |
| -3 | 57 | 1.6 | 0.038 | 0.045 | 0.043 | 0.032 | 0.038 | 0.066 | 0.137 | 0.116 | 0.115 | 0.062 | 0.039 | 0.048 | 0.057 |
| 6 | 57 | 0 | 0.076 | 0.069 | 0.059 | 0.073 | 0.057 | 0.076 | 0.051 | 0.051 | 0.074 | 0.051 | 0.119 | 0.080 | 0.048 |
| 6 | 57 | 0.1 | 0.055 | 0.073 | 0.110 | 0.103 | 0.085 | 0.170 | 0.183 | 0.181 | 0.144 | 0.119 | 0.167 | 0.161 | 0.117 |
| 6 | 57 | 0.2 | 0.057 | 0.062 | 0.060 | 0.060 | 0.064 | 0.140 | 0.183 | 0.139 | 0.093 | 0.115 | 0.064 | 0.101 | 0.098 |
| 6 | 57 | 0.4 | 0.117 | 0.090 | 0.098 | 0.099 | 0.206 | 0.096 | 0.261 | 0.229 | 0.197 | 0.144 | 0.236 | 0.186 | 0.160 |
| 6 | 57 | 0.8 | 0.184 | 0.204 | 0.234 | 0.225 | 0.218 | 0.309 | 0.415 | 0.395 | 0.300 | 0.252 | 0.238 | 0.204 | 0.257 |
| 6 | 57 | 1.2 | 0.197 | 0.249 | 0.246 | 0.227 | 0.197 | 0.270 | 0.441 | 0.470 | 0.461 | 0.441 | 0.255 | 0.255 | 0.301 |
| 6 | 57 | 1.6 | 0.122 | 0.080 | 0.076 | 0.099 | 0.088 | 0.106 | 0.152 | 0.199 | 0.152 | 0.133 | 0.174 | 0.164 | 0.128 |

Table B-14. (cont'd)

| Week | Steer no. | Epi. dose [a] | Minutes relative to the epinephrine challenge | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | -30 | -15 | -10 | -5 | 0 | 2.5 | 5 | 10 | 15 | 20 | 120 | 125 | 130 |
| 15 | 57 | 0 | 0.094 | 0.074 | 0.079 | 0.090 | 0.088 | 0.108 | 0.097 | 0.132 | 0.139 | 0.121 | 0.299 | 0.362 | 0.317 |
| 15 | 57 | 0.1 | 0.171 | 0.150 | 0.175 | 0.157 | 0.162 | 0.247 | 0.250 | 0.236 | 0.223 | 0.220 | 0.395 | 0.402 | 0.416 |
| 15 | 57 | 0.2 | 0.074 | 0.056 | 0.065 | 0.058 | 0.050 | 0.108 | 0.173 | 0.169 | 0.128 | 0.085 | 0.175 | 0.178 | 0.189 |
| 15 | 57 | 0.4 | 0.058 | 0.059 | 0.063 | 0.068 | 0.054 | 0.193 | 0.205 | 0.173 | 0.148 | 0.085 | 0.099 | 0.106 | 0.112 |
| 15 | 57 | 0.8 | 0.034 | 0.035 | 0.022 | 0.032 | 0.027 | 0.198 | 0.209 | 0.187 | 0.086 | 0.059 | 0.072 | 0.077 | 0.076 |
| 15 | 57 | 1.2 | 0.103 | 0.058 | 0.043 | 0.065 | 0.056 | 0.105 | 0.252 | 0.274 | 0.204 | 0.166 | 0.450 | 0.436 | 0.362 |
| 15 | 57 | 1.6 | 0.105 | 0.047 | 0.049 | 0.050 | 0.088 | 0.175 | 0.337 | 0.305 | 0.220 | 0.135 | 0.097 | 0.097 | 0.108 |
| -3 | 58 | 0 | 0.071 | 0.048 | 0.094 | 0.037 | 0.046 | 0.048 | 0.057 | 0.043 | 0.057 | 0.074 | 0.055 | 0.112 | 0.059 |
| -3 | 58 | 0.1 | 0.055 | 0.039 | 0.098 | 0.032 | 0.044 | 0.078 | 0.08 | 0.067 | 0.05 | 0.046 | 0.037 | 0.078 | 0.037 |
| -3 | 58 | 0.2 | 0.06 | 0.041 | 0.089 | 0.037 | 0.041 | 0.089 | 0.137 | 0.083 | 0.064 | 0.057 | 0.037 | 0.055 | 0.056 |
| -3 | 58 | 0.4 | 0.059 | 0.066 | 0.087 | 0.037 | 0.05 | 0.078 | 0.147 | 0.133 | 0.069 | 0.059 | 0.059 | 0.085 | 0.083 |
| -3 | 58 | 0.8 | 0.06 | 0.037 | 0.087 | 0.037 | 0.071 | 0.131 | 0.165 | 0.158 | 0.099 | 0.053 | 0.05 | 0.129 | 0.059 |
| -3 | 58 | 1.2 | 0.071 | 0.067 | 0.105 | 0.05 | 0.059 | 0.066 | 0.176 | 0.16 | 0.105 | 0.082 | 0.117 | 0.106 | 0.128 |
| -3 | 58 | 1.6 | 0.059 | 0.05 | 0.103 | 0.051 | 0.048 | 0.089 | 0.168 | 0.16 | 0.128 | 0.055 | 0.06 | 0.053 | 0.043 |
| 6 | 58 | 0 | 0.053 | 0.042 | 0.035 | 0.032 | 0.047 | 0.032 | 0.040 | 0.051 | 0.042 | 0.037 | 0.037 | 0.053 | 0.053 |
| 6 | 58 | 0.1 | 0.037 | 0.033 | 0.035 | 0.032 | 0.037 | 0.058 | 0.132 | 0.109 | 0.084 | 0.042 | 0.042 | 0.058 | 0.071 |
| 6 | 58 | 0.2 | 0.047 | 0.040 | 0.050 | 0.044 | 0.053 | 0.058 | 0.091 | 0.096 | 0.096 | 0.053 | 0.060 | 0.063 | 0.047 |
| 6 | 58 | 0.4 | 0.032 | 0.019 | 0.047 | 0.033 | 0.039 | 0.109 | 0.121 | 0.114 | 0.053 | 0.053 | 0.018 | 0.040 | 0.009 |
| 6 | 58 | 0.8 | 0.075 | 0.039 | 0.043 | 0.047 | 0.054 | 0.053 | 0.146 | 0.167 | 0.174 | 0.102 | 0.063 | 0.093 | 0.060 |
| 6 | 58 | 1.2 | 0.037 | 0.037 | 0.027 | 0.044 | 0.049 | 0.100 | 0.188 | 0.161 | 0.128 | 0.065 | 0.067 | 0.053 | 0.053 |
| 6 | 58 | 1.6 | 0.056 | 0.051 | 0.045 | 0.039 | 0.049 | 0.079 | 0.174 | 0.181 | 0.125 | 0.070 | 0.063 | 0.088 | 0.050 |
| 15 | 58 | 0 | 0.055 | 0.052 | 0.052 | 0.073 | 0.054 | 0.076 | 0.065 | 0.068 | 0.076 | 0.065 | 0.098 | 0.084 | 0.082 |
| 15 | 58 | 0.1 | 0.057 | 0.046 | 0.036 | 0.052 | 0.054 | 0.081 | 0.100 | 0.081 | 0.075 | 0.043 | 0.043 | 0.045 | 0.052 |
| 15 | 58 | 0.2 | 0.045 | 0.043 | 0.049 | 0.035 | 0.035 | 0.109 | 0.098 | 0.095 | 0.086 | 0.059 | 0.062 | 0.050 | 0.033 |
| 15 | 58 | 0.4 | 0.052 | 0.069 | 0.055 | 0.038 | 0.049 | 0.076 | 0.149 | 0.082 | 0.109 | 0.066 | 0.049 | 0.048 | 0.059 |
| 15 | 58 | 0.8 | 0.114 | 0.092 | 0.123 | 0.109 | 0.141 | 0.109 | 0.177 | 0.178 | 0.212 | 0.177 | 0.162 | 0.192 | 0.201 |

Table B-14. (cont'd)

| Week | Steer no. | Epi. dose [a] | Minutes relative to the epinephrine challenge | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | -30 | -15 | -10 | -5 | 0 | 2.5 | 5 | 10 | 15 | 20 | 120 | 125 | 130 |
| 15 | 58 | 1.2 | 0.056 | 0.054 | 0.065 | 0.065 | 0.065 | 0.084 | 0.121 | 0.207 | 0.190 | 0.082 | 0.065 | 0.057 | 0.087 |
| 15 | 58 | 1.6 | 0.052 | 0.045 | 0.033 | 0.035 | 0.041 | 0.143 | 0.173 | 0.141 | 0.106 | 0.088 | 0.043 | 0.057 | 0.043 |
| -3 | 69 | 0 | 0.058 | NC | 0.036 | 0.038 | 0.027 | 0.052 | 0.045 | 0.050 | 0.043 | 0.057 | 0.038 | 0.046 | 0.049 |
| -3 | 69 | 0.1 | 0.047 | 0.043 | 0.036 | 0.038 | 0.038 | 0.068 | 0.059 | 0.056 | 0.047 | 0.052 | 0.056 | 0.036 | 0.039 |
| -3 | 69 | 0.2 | 0.045 | 0.048 | 0.050 | 0.052 | 0.043 | 0.068 | 0.154 | 0.152 | 0.124 | 0.084 | 0.060 | 0.047 | 0.052 |
| -3 | 69 | 0.4 | 0.154 | 0.127 | 0.136 | 0.138 | 0.120 | 0.201 | 0.249 | 0.258 | 0.226 | 0.213 | 0.109 | 0.099 | 0.108 |
| -3 | 69 | 0.8 | 0.043 | 0.045 | 0.048 | 0.056 | 0.049 | 0.093 | 0.179 | 0.174 | 0.113 | 0.079 | 0.051 | 0.054 | 0.045 |
| -3 | 69 | 1.2 | 0.039 | 0.062 | 0.041 | 0.039 | 0.048 | 0.082 | 0.210 | 0.219 | 0.179 | 0.095 | 0.077 | 0.057 | 0.057 |
| -3 | 69 | 1.6 | 0.048 | 0.047 | 0.047 | 0.041 | 0.061 | 0.090 | 0.181 | 0.186 | 0.131 | 0.095 | 0.051 | 0.045 | 0.043 |
| 6 | 69 | 0 | 0.058 | NC | 0.036 | 0.038 | 0.027 | 0.035 | 0.035 | 0.038 | 0.043 | 0.151 | 0.038 | 0.046 | 0.049 |
| 6 | 69 | 0.1 | 0.047 | 0.049 | 0.050 | 0.047 | 0.034 | 0.068 | 0.059 | 0.038 | 0.068 | 0.061 | 0.046 | 0.061 | 0.061 |
| 6 | 69 | 0.2 | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| 6 | 69 | 0.4 | 0.067 | 0.058 | 0.063 | 0.067 | 0.067 | 0.148 | 0.168 | 0.137 | 0.095 | 0.068 | 0.050 | 0.049 | 0.049 |
| 6 | 69 | 0.8 | 0.050 | 0.036 | 0.045 | 0.049 | 0.040 | 0.092 | 0.148 | 0.133 | 0.103 | 0.065 | 0.049 | 0.040 | 0.035 |
| 6 | 69 | 1.2 | 0.038 | 0.049 | 0.056 | 0.045 | 0.041 | 0.081 | 0.159 | 0.135 | 0.106 | 0.086 | 0.056 | 0.052 | 0.049 |
| 6 | 69 | 1.6 | 0.041 | 0.052 | 0.041 | 0.043 | 0.086 | 0.115 | 0.182 | 0.148 | 0.114 | 0.046 | 0.036 | 0.029 | 0.038 |
| 15 | 69 | 0 | 0.032 | 0.038 | 0.041 | 0.043 | 0.081 | 0.050 | 0.043 | 0.048 | 0.065 | 0.043 | 0.075 | 0.036 | 0.048 |
| 15 | 69 | 0.1 | 0.047 | 0.048 | 0.059 | 0.048 | 0.047 | 0.084 | 0.091 | 0.095 | 0.088 | 0.073 | 0.057 | 0.079 | 0.059 |
| 15 | 69 | 0.2 | 0.050 | 0.054 | 0.052 | 0.052 | 0.045 | 0.122 | 0.133 | 0.149 | 0.090 | 0.104 | 0.049 | 0.050 | 0.057 |
| 15 | 69 | 0.4 | 0.059 | 0.065 | 0.038 | 0.041 | NC | 0.124 | 0.167 | 0.134 | 0.086 | 0.043 | 0.045 | 0.036 | 0.030 |
| 15 | 69 | 0.8 | 0.041 | 0.043 | 0.045 | 0.041 | 0.045 | 0.188 | 0.210 | 0.181 | 0.132 | 0.068 | 0.049 | 0.045 | 0.041 |
| 15 | 69 | 1.2 | 0.032 | 0.043 | 0.027 | 0.030 | 0.032 | 0.082 | 0.220 | 0.222 | 0.134 | 0.070 | 0.032 | 0.027 | 0.030 |
| 15 | 69 | 1.6 | 0.048 | 0.048 | 0.039 | 0.036 | 0.029 | 0.093 | 0.168 | 0.177 | 0.136 | 0.095 | 0.036 | 0.030 | 0.048 |
| -3 | 73 | 0 | 0.103 | 0.100 | 0.100 | 0.082 | 0.102 | 0.123 | 0.121 | 0.142 | 0.153 | 0.128 | 0.063 | 0.069 | 0.079 |
| -3 | 73 | 0.1 | 0.065 | 0.052 | 0.038 | 0.042 | 0.040 | 0.086 | 0.086 | 0.071 | 0.077 | 0.065 | 0.073 | 0.100 | 0.105 |
| -3 | 73 | 0.2 | 0.071 | 0.044 | 0.040 | 0.033 | 0.040 | 0.105 | 0.092 | 0.094 | 0.083 | 0.073 | 0.034 | 0.063 | 0.086 |

Table B-14. (cont'd)

| Week | Steer no. | Epi. dose [a] | Minutes relative to the epinephrine challenge | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | -30 | -15 | -10 | -5 | 0 | 2.5 | 5 | 10 | 15 | 20 | 120 | 125 | 130 |
| -3 | 73 | 0.4 | 0.056 | 0.042 | 0.048 | 0.044 | 0.040 | 0.102 | 0.115 | 0.084 | 0.067 | 0.048 | 0.056 | 0.046 | 0.052 |
| -3 | 73 | 0.8 | 0.067 | 0.059 | 0.050 | 0.063 | 0.050 | 0.096 | 0.169 | 0.201 | 0.128 | 0.103 | 0.054 | 0.061 | 0.057 |
| -3 | 73 | 1.2 | 0.086 | 0.069 | 0.073 | 0.067 | 0.056 | 0.140 | 0.199 | 0.224 | 0.178 | 0.121 | 0.059 | 0.077 | 0.082 |
| -3 | 73 | 1.6 | 0.090 | 0.079 | 0.069 | 0.067 | 0.065 | 0.128 | 0.190 | 0.213 | 0.195 | 0.117 | 0.066 | 0.069 | 0.063 |
| 6 | 73 | 0 | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| 6 | 73 | 0.1 | 0.127 | 0.090 | 0.102 | 0.082 | 0.072 | 0.113 | 0.154 | 0.138 | 0.140 | 0.136 | 0.111 | 0.120 | 0.084 |
| 6 | 73 | 0.2 | 0.095 | 0.090 | 0.100 | 0.116 | 0.131 | 0.222 | 0.204 | 0.197 | 0.147 | 0.142 | 0.090 | 0.084 | 0.075 |
| 6 | 73 | 0.4 | 0.077 | 0.073 | 0.086 | 0.070 | 0.086 | 0.176 | 0.222 | 0.233 | 0.219 | 0.190 | 0.970 | 0.751 | 0.647 |
| 6 | 73 | 0.8 | NC | 0.154 | 0.156 | 0.136 | 0.111 | 0.190 | 0.242 | 0.360 | 0.305 | 0.238 | 0.253 | 0.215 | 0.188 |
| 6 | 73 | 1.2 | 0.115 | 0.143 | 0.244 | 0.278 | 0.319 | 0.360 | 0.392 | 0.391 | 0.303 | 0.253 | 0.201 | 0.167 | 0.147 |
| 6 | 73 | 1.6 | 0.088 | 0.109 | 0.104 | 0.100 | 0.097 | 0.224 | 0.254 | 0.294 | 0.228 | 0.210 | 0.104 | 0.082 | 0.095 |
| 15 | 73 | 0 | 0.094 | 0.094 | 0.084 | 0.093 | 0.075 | 0.326 | 0.403 | 0.460 | 0.390 | 0.242 | 0.089 | 0.057 | 0.055 |
| 15 | 73 | 0.1 | NC | 0.107 | 0.098 | 0.096 | 0.107 | 0.162 | 0.152 | 0.153 | 0.130 | 0.118 | 0.123 | 0.139 | 0.111 |
| 15 | 73 | 0.2 | 0.084 | 0.094 | 0.086 | 0.070 | 0.073 | 0.128 | 0.157 | 0.150 | 0.128 | 0.118 | 0.127 | 0.096 | 0.084 |
| 15 | 73 | 0.4 | 0.098 | 0.118 | 0.121 | 0.109 | 0.087 | 0.198 | 0.219 | 0.205 | 0.155 | 0.118 | 0.084 | 0.066 | 0.064 |
| 15 | 73 | 0.8 | 0.089 | 0.107 | 0.093 | 0.112 | 0.121 | 0.196 | 0.235 | 0.273 | 0.260 | 0.255 | 0.171 | 0.139 | 0.143 |
| 15 | 73 | 1.2 | 0.081 | 0.091 | 0.077 | 0.062 | 0.043 | 0.169 | 0.214 | 0.189 | 0.160 | 0.096 | 0.091 | 0.084 | 0.048 |
| 15 | 73 | 1.6 | 0.062 | 0.057 | 0.073 | 0.062 | 0.053 | 0.148 | 0.230 | 0.207 | 0.155 | 0.077 | 0.046 | 0.052 | 0.053 |
| -3 | 92 | 0 | 0.074 | 0.074 | 0.067 | 0.063 | 0.05 | 0.063 | 0.059 | 0.054 | 0.065 | 0.061 | 0.049 | 0.074 | 0.065 |
| -3 | 92 | 0.1 | 0.045 | 0.052 | 0.061 | 0.052 | 0.038 | 0.059 | 0.083 | 0.072 | 0.076 | 0.058 | 0.049 | 0.047 | 0.059 |
| -3 | 92 | 0.2 | 0.067 | 0.062 | 0.045 | 0.052 | 0.049 | 0.088 | 0.115 | 0.101 | 0.065 | 0.058 | 0.058 | 0.054 | 0.057 |
| -3 | 92 | 0.4 | 0.09 | 0.077 | 0.108 | 0.063 | 0.07 | 0.110 | 0.130 | 0.106 | 0.067 | 0.074 | 0.085 | 0.058 | 0.072 |
| -3 | 92 | 0.8 | 0.092 | 0.065 | 0.061 | 0.065 | 0.059 | 0.139 | 0.123 | 0.094 | 0.063 | 0.059 | 0.067 | 0.065 | 0.056 |
| -3 | 92 | 1.2 | 0.09 | 0.077 | 0.085 | 0.076 | 0.083 | 0.090 | 0.169 | 0.123 | 0.085 | 0.063 | 0.056 | 0.068 | 0.083 |
| -3 | 92 | 1.6 | 0.056 | 0.059 | 0.054 | 0.047 | 0.045 | 0.077 | 0.160 | 0.119 | 0.067 | 0.074 | 0.068 | 0.065 | 0.063 |
| 6 | 92 | 0 | 0.083 | 0.078 | 0.072 | 0.069 | 0.065 | 0.079 | 0.072 | 0.079 | 0.078 | 0.085 | 0.076 | 0.078 | 0.071 |

Table B-14. (cont'd)

| Week | Steer no. | Epi. dose[a] | Minutes relative to the epinephrine challenge | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | -30 | -15 | -10 | -5 | 0 | 2.5 | 5 | 10 | 15 | 20 | 120 | 125 | 130 |
| 6 | 92 | 0.1 | 0.093 | 0.09 | 0.088 | 0.099 | 0.085 | 0.116 | 0.092 | 0.092 | 0.083 | 0.090 | 0.079 | 0.078 | 0.081 |
| 6 | 92 | 0.2 | 0.092 | 0.085 | 0.088 | 0.095 | 0.078 | 0.171 | 0.153 | NC | 0.116 | 0.093 | 0.076 | 0.083 | 0.071 |
| 6 | 92 | 0.4 | 0.086 | 0.076 | 0.072 | 0.078 | 0.063 | 0.085 | 0.122 | 0.131 | 0.116 | 0.078 | 0.083 | 0.098 | 0.076 |
| 6 | 92 | 0.8 | 0.136 | 0.136 | 0.122 | 0.095 | 0.065 | 0.129 | 0.164 | 0.122 | 0.115 | 0.097 | 0.078 | 0.086 | 0.088 |
| 6 | 92 | 1.2 | 0.106 | 0.104 | 0.104 | 0.088 | 0.074 | 0.162 | 0.213 | 0.155 | 0.129 | 0.108 | 0.086 | 0.101 | 0.102 |
| 6 | 92 | 1.6 | 0.071 | 0.074 | 0.076 | 0.071 | 0.076 | 0.143 | 0.148 | 0.138 | 0.109 | 0.085 | 0.063 | 0.076 | 0.092 |
| 15 | 92 | 0 | 0.043 | 0.078 | 0.07 | 0.064 | 0.045 | 0.064 | 0.078 | 0.070 | 0.071 | 0.062 | 0.059 | 0.077 | 0.077 |
| 15 | 92 | 0.1 | 0.062 | 0.061 | 0.077 | 0.096 | 0.057 | 0.066 | 0.120 | 0.123 | 0.102 | 0.075 | 0.068 | 0.061 | 0.059 |
| 15 | 92 | 0.2 | 0.071 | 0.089 | 0.08 | 0.078 | NC | 0.141 | 0.132 | 0.146 | 0.118 | 0.121 | 0.124 | 0.082 | 0.059 |
| 15 | 92 | 0.4 | 0.071 | 0.07 | 0.075 | 0.059 | 0.061 | 0.139 | 0.150 | 0.150 | 0.103 | 0.082 | 0.087 | 0.082 | 0.073 |
| 15 | 92 | 0.8 | 0.086 | 0.082 | 0.077 | 0.07 | 0.07 | 0.114 | 0.137 | 0.125 | 0.123 | 0.098 | 0.068 | 0.071 | 0.075 |
| 15 | 92 | 1.2 | 0.082 | 0.089 | 0.096 | 0.093 | 0.091 | 0.109 | 0.148 | 0.178 | 0.148 | 0.096 | 0.064 | 0.086 | 0.073 |
| 15 | 92 | 1.6 | 0.077 | 0.066 | 0.052 | 0.052 | 0.059 | 0.082 | 0.107 | 0.193 | 0.164 | 0.148 | 0.070 | 0.062 | 0.064 |
| -3 | 114 | 0 | 0.054 | 0.070 | 0.039 | 0.048 | 0.041 | 0.077 | 0.045 | 0.070 | 0.057 | 0.054 | 0.072 | 0.036 | 0.034 |
| -3 | 114 | 0.1 | 0.036 | 0.036 | 0.039 | 0.036 | 0.036 | 0.066 | 0.063 | 0.063 | 0.056 | 0.065 | 0.049 | 0.047 | 0.077 |
| -3 | 114 | 0.2 | 0.039 | 0.039 | 0.034 | 0.047 | 0.034 | 0.093 | 0.077 | 0.047 | 0.041 | 0.047 | 0.038 | 0.038 | 0.059 |
| -3 | 114 | 0.4 | 0.045 | 0.036 | 0.036 | 0.034 | 0.030 | 0.057 | 0.082 | 0.063 | 0.057 | 0.063 | 0.032 | 0.036 | 0.038 |
| -3 | 114 | 0.8 | 0.041 | 0.057 | 0.046 | 0.047 | 0.030 | 0.077 | 0.124 | 0.072 | 0.061 | 0.057 | NC | 0.045 | 0.045 |
| -3 | 114 | 1.2 | 0.038 | 0.050 | 0.045 | 0.045 | 0.034 | 0.065 | 0.113 | 0.088 | 0.081 | 0.054 | 0.054 | 0.047 | 0.045 |
| -3 | 114 | 1.6 | 0.050 | 0.040 | 0.013 | 0.030 | 0.022 | 0.030 | 0.089 | 0.091 | 0.072 | 0.030 | 0.036 | 0.038 | 0.030 |
| 6 | 114 | 0 | 0.053 | 0.051 | 0.044 | 0.050 | 0.043 | 0.062 | 0.037 | 0.048 | 0.046 | 0.046 | 0.048 | 0.050 | 0.048 |
| 6 | 114 | 0.1 | 0.041 | 0.041 | 0.048 | 0.050 | 0.044 | 0.073 | 0.082 | 0.062 | 0.080 | 0.062 | 0.044 | 0.048 | 0.046 |
| 6 | 114 | 0.2 | 0.051 | 0.053 | 0.059 | 0.060 | 0.062 | 0.099 | 0.105 | 0.083 | 0.066 | 0.062 | 0.082 | 0.105 | 0.101 |
| 6 | 114 | 0.4 | 0.037 | 0.043 | 0.025 | 0.030 | 0.028 | 0.039 | 0.101 | 0.094 | 0.087 | 0.041 | 0.035 | 0.025 | 0.041 |
| 6 | 114 | 0.8 | 0.032 | 0.039 | 0.044 | 0.041 | 0.044 | 0.106 | 0.128 | 0.112 | 0.085 | 0.059 | 0.059 | 0.050 | 0.050 |
| 6 | 114 | 1.2 | 0.035 | 0.043 | 0.050 | 0.037 | 0.035 | 0.071 | 0.094 | 0.126 | 0.087 | 0.066 | 0.037 | 0.032 | 0.035 |

Table B-14. (cont'd)

| Week | Steer no. | Epi. dose[a] | Minutes relative to the epinephrine challenge | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | -30 | -15 | -10 | -5 | 0 | 2.5 | 5 | 10 | 15 | 20 | 120 | 125 | 130 |
| 6 | 114 | 1.6 | 0.030 | 0.030 | 0.039 | 0.043 | 0.035 | 0.046 | 0.071 | 0.115 | 0.105 | 0.076 | 0.056 | 0.043 | 0.039 |
| 15 | 114 | 0 | 0.067 | 0.059 | 0.056 | 0.068 | 0.058 | 0.059 | 0.092 | 0.067 | 0.050 | 0.052 | 0.059 | 0.041 | 0.043 |
| 15 | 114 | 0.1 | 0.043 | 0.041 | 0.041 | 0.040 | 0.038 | 0.085 | 0.088 | 0.067 | 0.056 | 0.041 | 0.044 | 0.038 | 0.036 |
| 15 | 114 | 0.2 | 0.049 | 0.038 | 0.040 | 0.038 | 0.034 | 0.076 | 0.085 | 0.083 | 0.059 | 0.047 | 0.030 | 0.034 | 0.047 |
| 15 | 114 | 0.4 | 0.040 | 0.045 | 0.056 | 0.036 | 0.030 | 0.121 | 0.142 | 0.097 | 0.068 | 0.043 | 0.038 | 0.040 | 0.034 |
| 15 | 114 | 0.8 | 0.040 | 0.043 | 0.029 | 0.036 | 0.054 | 0.117 | 0.139 | 0.144 | 0.106 | 0.065 | 0.029 | 0.025 | 0.032 |
| 15 | 114 | 1.2 | 0.041 | 0.038 | 0.022 | 0.029 | 0.043 | 0.077 | 0.150 | 0.135 | 0.081 | 0.043 | 0.034 | 0.036 | 0.040 |
| 15 | 114 | 1.6 | 0.070 | 0.058 | 0.067 | 0.063 | 0.056 | 0.094 | 0.126 | 0.216 | 0.213 | 0.168 | 0.060 | 0.058 | 0.061 |
| -3 | 116 | 0 | 0.044 | 0.051 | 0.075 | 0.056 | 0.040 | 0.051 | 0.053 | 0.068 | 0.068 | 0.054 | 0.047 | 0.061 | 0.081 |
| -3 | 116 | 0.1 | 0.044 | 0.045 | 0.032 | 0.035 | 0.028 | 0.082 | 0.049 | 0.047 | 0.039 | 0.035 | 0.033 | 0.033 | 0.050 |
| -3 | 116 | 0.2 | 0.029 | 0.039 | 0.040 | 0.030 | 0.032 | 0.056 | 0.089 | 0.054 | 0.056 | 0.047 | 0.045 | 0.033 | 0.047 |
| -3 | 116 | 0.4 | 0.040 | 0.042 | 0.049 | 0.040 | 0.033 | 0.067 | 0.128 | 0.123 | 0.070 | 0.058 | 0.033 | 0.032 | 0.044 |
| -3 | 116 | 0.8 | 0.046 | 0.058 | 0.028 | 0.033 | 0.033 | 0.072 | 0.123 | 0.091 | 0.073 | 0.077 | 0.046 | 0.053 | 0.071 |
| -3 | 116 | 1.2 | 0.060 | 0.050 | 0.082 | 0.046 | 0.033 | 0.128 | 0.133 | 0.129 | 0.075 | 0.074 | 0.032 | 0.054 | 0.039 |
| -3 | 116 | 1.6 | 0.070 | 0.063 | 0.056 | 0.056 | 0.042 | 0.089 | 0.128 | 0.153 | 0.082 | 0.068 | 0.039 | 0.037 | 0.037 |
| 6 | 116 | 0 | NC | 0.046 | 0.055 | 0.046 | 0.037 | 0.118 | 0.111 | 0.094 | 0.061 | 0.043 | 0.038 | 0.032 | 0.036 |
| 6 | 116 | 0.1 | 0.045 | 0.050 | 0.045 | 0.045 | 0.039 | 0.075 | 0.053 | NC | 0.068 | 0.046 | 0.046 | 0.032 | 0.059 |
| 6 | 116 | 0.2 | 0.039 | 0.046 | 0.055 | 0.059 | 0.050 | 0.103 | 0.119 | 0.061 | 0.066 | 0.064 | 0.051 | 0.041 | 0.043 |
| 6 | 116 | 0.4 | 0.045 | 0.056 | 0.035 | 0.046 | 0.043 | 0.107 | 0.093 | 0.086 | 0.061 | 0.043 | 0.043 | 0.105 | 0.059 |
| 6 | 116 | 0.8 | 0.046 | 0.067 | 0.041 | 0.050 | 0.037 | 0.103 | 0.153 | 0.130 | 0.100 | 0.059 | 0.048 | 0.039 | 0.045 |
| 6 | 116 | 1.2 | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| 6 | 116 | 1.6 | 0.068 | 0.062 | 0.046 | 0.053 | 0.041 | 0.166 | 0.182 | 0.128 | 0.082 | 0.073 | 0.053 | 0.078 | 0.048 |
| 15 | 116 | 0 | 0.061 | 0.084 | 0.054 | 0.056 | 0.047 | 0.050 | 0.047 | 0.045 | 0.059 | 0.041 | 0.045 | 0.047 | 0.061 |
| 15 | 116 | 0.1 | 0.097 | 0.108 | 0.077 | 0.099 | 0.084 | 0.156 | 0.137 | 0.142 | 0.131 | 0.106 | 0.088 | NC | 0.093 |
| 15 | 116 | 0.2 | 0.047 | 0.041 | 0.043 | 0.041 | 0.039 | 0.070 | 0.070 | 0.066 | 0.075 | 0.065 | 0.059 | 0.079 | 0.099 |
| 15 | 116 | 0.4 | 0.073 | 0.063 | 0.056 | 0.059 | 0.050 | 0.168 | 0.168 | 0.151 | 0.113 | 0.091 | 0.057 | 0.057 | 0.065 |

Table B-14. (cont'd)

| Week | Steer no. | Epi. dose[a] | Minutes relative to the epinephrine challenge -30 | -15 | -10 | -5 | 0 | 2.5 | 5 | 10 | 15 | 20 | 120 | 125 | 130 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 116 | 0.8 | 0.068 | 0.052 | 0.045 | 0.050 | 0.048 | 0.045 | 0.143 | 0.136 | 0.099 | 0.073 | 0.054 | 0.047 | 0.061 |
| 15 | 116 | 1.2 | 0.068 | 0.061 | 0.059 | 0.084 | 0.061 | 0.140 | 0.170 | 0.176 | 0.145 | 0.088 | 0.056 | 0.047 | 0.054 |
| 15 | 116 | 1.6 | 0.057 | 0.059 | 0.066 | 0.065 | 0.068 | 0.127 | 0.181 | 0.217 | 0.186 | 0.140 | 0.059 | 0.072 | 0.077 |
| -3 | 118 | 0 | 0.082 | 0.076 | 0.103 | 0.08 | 0.073 | 0.053 | 0.094 | 0.08 | 0.126 | 0.115 | 0.126 | 0.09 | 0.069 |
| -3 | 118 | 0.1 | 0.067 | 0.046 | 0.094 | 0.039 | 0.051 | 0.064 | 0.142 | 0.06 | 0.046 | 0.044 | 0.053 | 0.089 | 0.044 |
| -3 | 118 | 0.2 | 0.087 | 0.064 | 0.089 | 0.051 | 0.074 | 0.103 | 0.174 | 0.117 | 0.087 | 0.059 | 0.059 | 0.055 | 0.051 |
| -3 | 118 | 0.4 | 0.096 | 0.066 | 0.115 | 0.074 | 0.071 | 0.117 | 0.188 | 0.119 | 0.087 | 0.08 | 0.117 | 0.074 | 0.062 |
| -3 | 118 | 0.8 | 0.089 | 0.078 | 0.110 | 0.06 | 0.06 | 0.087 | 0.158 | 0.138 | 0.101 | 0.062 | 0.057 | 0.066 | 0.077 |
| -3 | 118 | 1.2 | 0.069 | 0.062 | 0.110 | 0.053 | 0.067 | 0.108 | 0.165 | 0.14 | 0.062 | 0.046 | 0.044 | 0.057 | 0.087 |
| -3 | 118 | 1.6 | 0.066 | 0.057 | 0.101 | 0.044 | 0.057 | 0.074 | 0.181 | 0.165 | 0.119 | 0.078 | 0.05 | 0.053 | 0.071 |
| 6 | 118 | 0 | 0.109 | 0.121 | 0.145 | 0.133 | 0.175 | 0.167 | 0.179 | 0.156 | 0.137 | 0.123 | 0.093 | 0.105 | 0.114 |
| 6 | 118 | 0.1 | 0.077 | 0.051 | 0.050 | 0.046 | 0.072 | 0.128 | 0.160 | 0.133 | 0.150 | 0.089 | 0.123 | 0.063 | 0.074 |
| 6 | 118 | 0.2 | 0.065 | 0.086 | 0.071 | 0.068 | 0.067 | 0.132 | 0.191 | 0.182 | 0.151 | 0.074 | 0.102 | 0.118 | 0.107 |
| 6 | 118 | 0.4 | 0.072 | 0.074 | 0.063 | 0.084 | 0.103 | 0.144 | 0.223 | 0.211 | 0.114 | 0.135 | 0.184 | 0.163 | 0.189 |
| 6 | 118 | 0.8 | 0.084 | 0.068 | 0.076 | 0.058 | 0.074 | 0.102 | 0.209 | 0.246 | 0.218 | 0.144 | 0.104 | 0.093 | 0.093 |
| 6 | 118 | 1.2 | 0.074 | 0.050 | 0.048 | 0.079 | 0.063 | 0.125 | 0.230 | 0.219 | 0.174 | 0.118 | 0.091 | 0.100 | 0.084 |
| 6 | 118 | 1.6 | 0.119 | 0.123 | 0.121 | 0.135 | 0.158 | 0.253 | 0.363 | 0.286 | 0.244 | 0.193 | 0.119 | 0.130 | 0.107 |
| 15 | 118 | 0 | 0.117 | 0.126 | 0.090 | 0.101 | 0.122 | 0.128 | 0.147 | 0.154 | 0.149 | 0.158 | 0.168 | 0.149 | 0.117 |
| 15 | 118 | 0.1 | 0.095 | 0.064 | 0.065 | 0.078 | 0.084 | 0.133 | 0.177 | 0.141 | 0.149 | 0.092 | 0.109 | 0.109 | 0.098 |
| 15 | 118 | 0.2 | 0.073 | 0.054 | 0.051 | 0.068 | 0.082 | 0.174 | 0.201 | 0.165 | 0.144 | 0.114 | 0.166 | 0.193 | 0.228 |
| 15 | 118 | 0.4 | 0.090 | 0.071 | 0.071 | 0.079 | 0.095 | 0.166 | 0.198 | 0.198 | 0.164 | 0.144 | 0.264 | 0.190 | 0.142 |
| 15 | 118 | 0.8 | 0.128 | 0.109 | 0.126 | 0.130 | 0.188 | 0.225 | 0.291 | 0.307 | 0.302 | 0.201 | 0.179 | 0.147 | 0.160 |
| 15 | 118 | 1.2 | 0.122 | 0.084 | 0.092 | 0.117 | 0.111 | 0.139 | 0.198 | 0.234 | 0.236 | 0.171 | 0.457 | 0.272 | 0.196 |
| 15 | 118 | 1.6 | 0.188 | 0.217 | 0.190 | 0.234 | 0.231 | 0.220 | 0.337 | 0.086 | 0.321 | 0.295 | 0.315 | 0.278 | 0.253 |
| -3 | 133 | 0 | 0.053 | 0.046 | 0.050 | 0.048 | 0.037 | 0.051 | 0.041 | 0.046 | 0.044 | 0.048 | 0.050 | 0.041 | 0.053 |
| -3 | 133 | 0.1 | 0.055 | 0.059 | 0.048 | 0.043 | 0.037 | 0.066 | 0.071 | 0.069 | 0.069 | 0.046 | 0.037 | 0.050 | 0.050 |

Table B-14. (cont'd)

| Week | Steer no. | Epi. dose [a] | Minutes relative to the epinephrine challenge | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | -30 | -15 | -10 | -5 | 0 | 2.5 | 5 | 10 | 15 | 20 | 120 | 125 | 130 |
| -3 | 133 | 0.2 | 0.059 | 0.046 | 0.046 | 0.050 | 0.041 | 0.087 | 0.099 | 0.062 | 0.074 | 0.062 | 0.035 | 0.048 | 0.066 |
| -3 | 133 | 0.4 | 0.060 | 0.051 | 0.046 | 0.044 | 0.037 | 0.135 | 0.133 | 0.083 | 0.071 | 0.048 | 0.037 | 0.050 | 0.050 |
| -3 | 133 | 0.8 | 0.059 | 0.046 | 0.050 | 0.060 | 0.068 | 0.106 | 0.135 | 0.099 | 0.062 | 0.048 | 0.041 | 0.039 | 0.035 |
| -3 | 133 | 1.2 | 0.051 | 0.037 | 0.039 | 0.044 | 0.046 | 0.108 | 0.170 | 0.152 | 0.101 | 0.062 | 0.059 | 0.043 | 0.050 |
| -3 | 133 | 1.6 | 0.060 | 0.039 | 0.046 | 0.041 | 0.046 | 0.082 | 0.142 | 0.138 | 0.073 | 0.059 | 0.043 | 0.096 | 0.051 |
| 6 | 133 | 0 | 0.106 | 0.101 | 0.112 | 0.112 | 0.138 | 0.138 | 0.131 | 0.133 | 0.131 | 0.124 | 0.183 | 0.179 | 0.188 |
| 6 | 133 | 0.1 | 0.064 | 0.050 | 0.064 | 0.089 | 0.083 | 0.168 | 0.156 | 0.129 | 0.094 | 0.085 | 0.113 | 0.105 | 0.113 |
| 6 | 133 | 0.2 | 0.055 | 0.050 | 0.051 | 0.046 | 0.043 | 0.057 | 0.103 | 0.110 | 0.085 | 0.059 | 0.073 | 0.067 | 0.083 |
| 6 | 133 | 0.4 | 0.073 | 0.062 | 0.069 | 0.087 | 0.067 | 0.215 | 0.213 | 0.168 | 0.105 | 0.090 | 0.168 | 0.137 | 0.191 |
| 6 | 133 | 0.8 | 0.067 | 0.067 | 0.073 | 0.067 | 0.096 | 0.232 | 0.270 | 0.268 | 0.209 | 0.147 | 0.160 | 0.165 | 0.183 |
| 6 | 133 | 1.2 | 0.112 | 0.119 | 0.096 | 0.103 | 0.085 | 0.105 | 0.211 | 0.284 | 0.241 | 0.165 | 0.099 | 0.121 | 0.129 |
| 6 | 133 | 1.6 | 0.071 | 0.069 | 0.076 | 0.060 | 0.055 | 0.223 | 0.284 | 0.262 | 0.200 | 0.094 | 0.106 | 0.080 | 0.131 |
| 15 | 133 | 0 | 0.072 | 0.034 | 0.041 | 0.035 | 0.034 | 0.049 | 0.039 | 0.041 | 0.060 | 0.055 | 0.049 | 0.056 | 0.049 |
| 15 | 133 | 0.1 | NC | NC | NC | 0.078 | 0.063 | 0.122 | 0.120 | 0.085 | 0.055 | 0.044 | 0.101 | 0.155 | 0.159 |
| 15 | 133 | 0.2 | 0.037 | 0.037 | 0.044 | 0.048 | 0.035 | 0.141 | 0.131 | 0.115 | 0.081 | 0.048 | 0.190 | 0.157 | 0.141 |
| 15 | 133 | 0.4 | 0.049 | 0.053 | 0.051 | 0.049 | 0.062 | 0.238 | 0.238 | 0.182 | 0.138 | 0.093 | 0.099 | 0.152 | 0.141 |
| 15 | 133 | 0.8 | 0.035 | 0.023 | 0.032 | 0.032 | 0.035 | 0.138 | 0.194 | 0.213 | 0.131 | 0.067 | 0.120 | 0.113 | 0.122 |
| 15 | 133 | 1.2 | 0.055 | 0.048 | 0.048 | 0.049 | 0.051 | 0.245 | 0.220 | 0.201 | 0.106 | 0.079 | 0.120 | 0.104 | 0.097 |
| 15 | 133 | 1.6 | 0.037 | 0.039 | 0.044 | 0.034 | 0.034 | 0.113 | 0.236 | 0.183 | 0.153 | 0.065 | 0.037 | 0.035 | 0.046 |
| -3 | 157 | 0 | 0.030 | 0.030 | 0.020 | 0.051 | 0.047 | 0.047 | 0.040 | 0.056 | 0.043 | 0.035 | 0.034 | 0.035 | 0.045 |
| -3 | 157 | 0.1 | 0.031 | 0.021 | 0.024 | 0.021 | 0.023 | 0.054 | 0.059 | 0.045 | 0.033 | 0.038 | 0.045 | 0.089 | 0.092 |
| -3 | 157 | 0.2 | 0.035 | 0.033 | 0.035 | 0.038 | 0.050 | 0.063 | NC | 0.043 | 0.052 | 0.040 | 0.039 | 0.028 | 0.030 |
| -3 | 157 | 0.4 | 0.026 | 0.024 | 0.030 | 0.028 | 0.031 | 0.035 | 0.111 | 0.066 | 0.059 | 0.040 | 0.044 | 0.031 | 0.047 |
| -3 | 157 | 0.8 | NC | 0.047 | 0.033 | 0.024 | 0.031 | 0.057 | 0.090 | 0.087 | 0.062 | 0.036 | 0.034 | 0.038 | 0.026 |
| -3 | 157 | 1.2 | 0.035 | 0.016 | 0.028 | 0.040 | 0.060 | 0.097 | 0.149 | 0.135 | 0.056 | 0.036 | 0.030 | 0.043 | 0.030 |
| -3 | 157 | 1.6 | 0.045 | 0.042 | 0.045 | 0.043 | 0.035 | 0.116 | 0.148 | 0.106 | 0.078 | 0.052 | 0.052 | 0.036 | 0.042 |

Table B-14. (cont'd)

| Week | Steer no. | Epi. dose [a] | Minutes relative to the epinephrine challenge | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | -30 | -15 | -10 | -5 | 0 | 2.5 | 5 | 10 | 15 | 20 | 120 | 125 | 130 |
| 6 | 157 | 0 | 0.055 | 0.040 | 0.036 | 0.037 | 0.039 | 0.050 | 0.039 | 0.039 | 0.039 | 0.037 | 0.050 | 0.043 | 0.048 |
| 6 | 157 | 0.1 | 0.061 | 0.055 | 0.066 | 0.057 | 0.053 | 0.116 | 0.127 | 0.093 | 0.080 | 0.078 | 0.139 | 0.137 | 0.164 |
| 6 | 157 | 0.2 | 0.057 | 0.048 | 0.041 | 0.066 | 0.135 | 0.196 | 0.191 | 0.130 | 0.089 | 0.057 | 0.041 | 0.037 | 0.037 |
| 6 | 157 | 0.4 | 0.062 | 0.075 | 0.094 | 0.077 | 0.061 | 0.114 | 0.207 | 0.159 | 0.125 | 0.084 | 0.036 | 0.053 | 0.080 |
| 6 | 157 | 0.8 | 0.052 | 0.030 | 0.032 | 0.037 | 0.039 | 0.148 | 0.194 | 0.123 | 0.078 | 0.071 | 0.114 | 0.112 | 0.102 |
| 6 | 157 | 1.2 | 0.041 | 0.048 | 0.057 | 0.055 | 0.059 | 0.091 | 0.162 | 0.178 | 0.144 | 0.091 | 0.059 | 0.057 | 0.057 |
| 6 | 157 | 1.6 | 0.071 | 0.064 | 0.064 | 0.061 | 0.059 | 0.075 | 0.173 | 0.241 | 0.235 | 0.175 | 0.173 | 0.225 | 0.155 |
| 15 | 157 | 0 | 0.058 | 0.085 | 0.074 | 0.095 | 0.088 | 0.101 | 0.094 | 0.081 | 0.092 | 0.119 | 0.150 | 0.178 | 0.180 |
| 15 | 157 | 0.1 | 0.085 | 0.076 | 0.092 | 0.065 | 0.128 | 0.169 | 0.254 | 0.193 | 0.209 | 0.191 | 0.088 | 0.106 | 0.123 |
| 15 | 157 | 0.2 | 0.083 | 0.041 | 0.047 | 0.043 | 0.348 | 0.463 | 0.441 | 0.326 | 0.240 | 0.231 | 0.114 | 0.126 | 0.112 |
| 15 | 157 | 0.4 | 0.058 | 0.045 | 0.041 | 0.047 | 0.141 | 0.249 | 0.254 | 0.213 | 0.126 | 0.105 | 0.092 | 0.074 | 0.067 |
| 15 | 157 | 0.8 | 0.059 | 0.079 | 0.094 | 0.072 | 0.052 | 0.160 | 0.234 | 0.223 | 0.141 | 0.106 | 0.108 | 0.117 | 0.128 |
| 15 | 157 | 1.2 | 0.041 | 0.052 | 0.054 | 0.050 | 0.041 | 0.099 | 0.216 | 0.247 | 0.173 | 0.070 | 0.103 | 0.086 | 0.095 |
| 15 | 157 | 1.6 | 0.058 | 0.077 | 0.056 | 0.059 | 0.070 | 0.099 | 0.213 | 0.240 | 0.196 | 0.126 | 0.088 | 0.083 | 0.095 |
| -3 | 184 | 0 | 0.115 | 0.093 | 0.097 | 0.086 | 0.075 | 0.081 | 0.091 | 0.089 | 0.097 | 0.108 | 0.201 | 0.188 | 0.204 |
| -3 | 184 | 0.1 | 0.036 | 0.040 | 0.032 | 0.061 | 0.032 | 0.077 | 0.045 | 0.041 | 0.039 | 0.059 | 0.029 | 0.027 | 0.011 |
| -3 | 184 | 0.2 | 0.043 | 0.040 | 0.061 | 0.029 | 0.027 | 0.063 | 0.052 | 0.082 | 0.032 | 0.076 | 0.041 | 0.034 | 0.029 |
| -3 | 184 | 0.4 | 0.090 | 0.145 | 0.122 | 0.108 | 0.095 | 0.122 | 0.154 | 0.168 | 0.163 | 0.136 | 0.113 | 0.131 | 0.156 |
| -3 | 184 | 0.8 | 0.125 | 0.068 | 0.068 | 0.075 | 0.095 | 0.140 | 0.176 | 0.154 | 0.124 | 0.095 | 0.100 | 0.125 | 0.104 |
| -3 | 184 | 1.2 | 0.030 | 0.029 | 0.029 | 0.035 | 0.027 | 0.065 | 0.120 | 0.091 | 0.047 | 0.050 | 0.030 | 0.027 | 0.029 |
| -3 | 184 | 1.6 | 0.027 | 0.030 | 0.054 | 0.039 | 0.027 | 0.038 | 0.061 | 0.056 | 0.052 | 0.043 | 0.045 | 0.039 | 0.030 |
| 6 | 184 | 0 | 0.070 | 0.088 | 0.043 | 0.034 | 0.049 | 0.058 | 0.049 | 0.054 | 0.052 | 0.050 | 0.061 | 0.063 | 0.081 |
| 6 | 184 | 0.1 | 0.056 | 0.054 | 0.047 | 0.046 | 0.043 | 0.105 | 0.108 | 0.095 | 0.088 | 0.081 | 0.060 | 0.070 | 0.070 |
| 6 | 184 | 0.2 | 0.168 | 0.135 | 0.200 | 0.142 | 0.072 | 0.137 | 0.135 | 0.130 | 0.126 | 0.092 | 0.128 | 0.063 | 0.135 |
| 6 | 184 | 0.4 | 0.040 | 0.032 | 0.117 | 0.032 | 0.031 | 0.146 | 0.133 | 0.105 | 0.077 | 0.043 | 0.032 | 0.023 | 0.027 |
| 6 | 184 | 0.8 | 0.090 | 0.105 | 0.108 | 0.099 | 0.123 | 0.202 | 0.241 | 0.243 | 0.196 | 0.198 | 0.166 | 0.214 | 0.173 |

Table B-14. (cont'd)

| Week | Steer no. | Epi. dose [a] | Minutes relative to the epinephrine challenge | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | -30 | -15 | -10 | -5 | 0 | 2.5 | 5 | 10 | 15 | 20 | 120 | 125 | 130 |
| 6 | 184 | 1.2 | 0.045 | 0.045 | 0.047 | 0.040 | NC | 0.050 | 0.067 | 0.094 | 0.142 | 0.124 | 0.063 | 0.079 | 0.079 |
| 6 | 184 | 1.6 | 0.085 | 0.077 | 0.076 | 0.077 | 0.081 | 0.119 | 0.196 | 0.274 | 0.306 | 0.192 | 0.106 | 0.090 | 0.077 |
| 15 | 184 | 0 | 0.045 | 0.050 | 0.045 | 0.041 | 0.027 | 0.048 | 0.057 | 0.056 | 0.057 | 0.048 | 0.054 | 0.057 | 0.066 |
| 15 | 184 | 0.1 | 0.061 | 0.048 | 0.027 | 0.034 | 0.038 | 0.091 | 0.090 | 0.075 | 0.056 | 0.036 | 0.065 | 0.056 | 0.065 |
| 15 | 184 | 0.2 | 0.041 | 0.043 | 0.039 | 0.039 | 0.041 | 0.145 | 0.115 | 0.106 | 0.075 | 0.059 | 0.049 | 0.061 | 0.068 |
| 15 | 184 | 0.4 | 0.070 | 0.063 | 0.050 | 0.059 | 0.056 | 0.154 | 0.167 | 0.162 | 0.108 | 0.093 | 0.116 | 0.086 | 0.099 |
| 15 | 184 | 0.8 | 0.027 | 0.038 | 0.022 | 0.027 | 0.022 | 0.120 | 0.131 | 0.113 | 0.075 | 0.057 | 0.056 | 0.052 | 0.063 |
| 15 | 184 | 1.2 | 0.034 | 0.023 | 0.027 | 0.030 | 0.022 | 0.109 | 0.140 | 0.115 | 0.111 | 0.082 | 0.041 | 0.030 | 0.048 |
| 15 | 184 | 1.6 | 0.039 | 0.033 | 0.029 | 0.029 | 0.036 | 0.093 | 0.108 | 0.133 | 0.099 | 0.073 | 0.039 | 0.054 | 0.070 |
| -3 | 187 | 0 | 0.030 | 0.030 | 0.042 | 0.039 | 0.044 | 0.056 | 0.055 | 0.051 | 0.046 | 0.068 | 0.050 | 0.056 | 0.049 |
| -3 | 187 | 0.1 | 0.056 | 0.054 | 0.049 | 0.042 | 0.053 | 0.058 | 0.074 | 0.067 | 0.058 | 0.053 | 0.042 | 0.035 | 0.044 |
| -3 | 187 | 0.2 | 0.072 | 0.063 | 0.049 | 0.088 | 0.049 | 0.114 | 0.109 | 0.108 | 0.075 | 0.049 | 0.044 | 0.054 | 0.049 |
| -3 | 187 | 0.4 | 0.068 | 0.049 | 0.047 | 0.042 | 0.033 | 0.054 | 0.119 | 0.127 | 0.074 | 0.053 | 0.051 | 0.056 | 0.049 |
| -3 | 187 | 0.8 | 0.056 | 0.061 | 0.051 | 0.044 | 0.037 | 0.075 | 0.135 | 0.137 | 0.091 | 0.070 | 0.037 | 0.046 | 0.035 |
| -3 | 187 | 1.2 | 0.051 | 0.061 | 0.051 | 0.047 | 0.042 | 0.053 | 0.109 | 0.168 | 0.156 | 0.112 | 0.051 | 0.056 | 0.056 |
| -3 | 187 | 1.6 | 0.070 | 0.060 | 0.046 | 0.054 | 0.035 | 0.082 | 0.179 | 0.177 | 0.142 | 0.068 | 0.035 | 0.040 | 0.039 |
| 6 | 187 | 0 | 0.048 | 0.053 | 0.057 | 0.066 | 0.055 | 0.071 | 0.075 | 0.075 | 0.082 | 0.080 | 0.176 | 0.134 | 0.157 |
| 6 | 187 | 0.1 | 0.073 | 0.065 | 0.061 | 0.055 | 0.073 | 0.152 | 0.144 | 0.127 | 0.094 | 0.055 | 0.066 | 0.059 | 0.064 |
| 6 | 187 | 0.2 | 0.057 | 0.051 | 0.032 | 0.043 | 0.037 | 0.153 | 0.166 | NC | 0.107 | 0.064 | 0.061 | 0.089 | 0.086 |
| 6 | 187 | 0.4 | 0.089 | 0.075 | 0.093 | 0.077 | 0.078 | 0.178 | 0.239 | 0.230 | 0.176 | 0.137 | 0.103 | 0.160 | 0.125 |
| 6 | 187 | 0.8 | 0.116 | 0.114 | 0.143 | 0.178 | 0.196 | 0.191 | 0.296 | 0.351 | 0.512 | 0.282 | 0.166 | 0.128 | 0.148 |
| 6 | 187 | 1.2 | 0.148 | 0.166 | 0.093 | 0.102 | 0.078 | 0.089 | 0.127 | 0.219 | 0.216 | 0.160 | 0.068 | 0.062 | 0.064 |
| 6 | 187 | 1.6 | 0.061 | 0.045 | 0.043 | 0.041 | 0.046 | 0.094 | 0.139 | 0.219 | 0.209 | 0.144 | 0.065 | 0.068 | 0.077 |
| 15 | 187 | 0 | 0.047 | 0.057 | 0.045 | 0.036 | 0.035 | 0.066 | 0.061 | 0.050 | 0.059 | 0.057 | 0.059 | 0.073 | 0.056 |
| 15 | 187 | 0.1 | 0.066 | 0.047 | 0.041 | 0.039 | 0.034 | 0.091 | 0.118 | 0.106 | 0.116 | 0.057 | 0.043 | 0.056 | 0.054 |
| 15 | 187 | 0.2 | 0.109 | 0.061 | 0.079 | 0.072 | 0.052 | 0.081 | 0.145 | 0.118 | 0.104 | 0.068 | 0.118 | 0.102 | 0.061 |

Table B-14. (cont'd)

| Week | Steer no. | Epi. dose [a] | Minutes relative to the epinephrine challenge | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | -30 | -15 | -10 | -5 | 0 | 2.5 | 5 | 10 | 15 | 20 | 120 | 125 | 130 |
| 15 | 187 | 0.4 | 0.054 | 0.057 | 0.047 | 0.054 | 0.038 | 0.115 | 0.134 | 0.147 | 0.118 | 0.084 | 0.059 | 0.054 | 0.050 |
| 15 | 187 | 0.8 | 0.059 | 0.059 | 0.065 | 0.059 | 0.073 | 0.159 | 0.190 | 0.186 | 0.131 | 0.097 | 0.102 | 0.113 | 0.111 |
| 15 | 187 | 1.2 | 0.102 | 0.081 | 0.097 | 0.070 | 0.072 | 0.158 | 0.158 | 0.179 | 0.113 | 0.082 | 0.094 | 0.076 | 0.081 |
| 15 | 187 | 1.6 | 0.070 | 0.052 | 0.068 | 0.056 | 0.039 | 0.131 | 0.201 | 0.203 | 0.195 | 0.111 | 0.065 | 0.084 | 0.084 |
| -3 | 202 | 0 | 0.121 | 0.107 | 0.088 | 0.075 | 0.063 | 0.102 | 0.107 | 0.125 | 0.126 | 0.111 | 0.071 | 0.069 | 0.054 |
| -3 | 202 | 0.1 | NC | NC | 0.105 | 0.094 | 0.067 | 0.138 | 0.132 | 0.136 | 0.094 | 0.077 | 0.054 | 0.071 | 0.057 |
| -3 | 202 | 0.2 | 0.096 | 0.094 | 0.115 | 0.122 | 0.119 | 0.188 | 0.232 | 0.241 | 0.165 | 0.134 | 0.055 | 0.086 | 0.077 |
| -3 | 202 | 0.4 | 0.057 | 0.059 | 0.046 | 0.073 | 0.063 | 0.142 | 0.190 | 0.130 | 0.115 | 0.080 | 0.058 | 0.065 | 0.063 |
| -3 | 202 | 0.8 | 0.102 | 0.098 | 0.102 | 0.084 | 0.065 | 0.192 | 0.193 | 0.113 | 0.065 | 0.063 | 0.058 | 0.079 | 0.077 |
| -3 | 202 | 1.2 | 0.061 | 0.052 | 0.048 | 0.050 | 0.033 | 0.136 | 0.203 | 0.184 | 0.088 | 0.073 | 0.046 | 0.075 | 0.065 |
| -3 | 202 | 1.6 | 0.123 | 0.123 | 0.088 | 0.094 | 0.077 | 0.190 | 0.247 | 0.236 | 0.197 | 0.121 | 0.067 | 0.077 | 0.071 |
| 6 | 202 | 0 | 0.127 | 0.066 | 0.061 | 0.059 | 0.048 | 0.059 | 0.047 | 0.050 | 0.050 | 0.045 | 0.057 | 0.059 | 0.048 |
| 6 | 202 | 0.1 | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| 6 | 202 | 0.2 | 0.156 | 0.109 | 0.113 | 0.104 | 0.105 | 0.219 | 0.213 | 0.197 | 0.165 | 0.143 | 0.086 | 0.091 | 0.095 |
| 6 | 202 | 0.4 | 0.070 | 0.054 | 0.059 | 0.079 | 0.073 | 0.134 | 0.210 | 0.204 | 0.151 | 0.122 | 0.047 | 0.047 | 0.048 |
| 6 | 202 | 0.8 | 0.111 | 0.073 | 0.056 | 0.056 | 0.056 | 0.124 | 0.195 | 0.201 | 0.147 | 0.097 | 0.065 | 0.082 | 0.091 |
| 6 | 202 | 1.2 | 0.054 | 0.070 | 0.066 | 0.056 | 0.041 | 0.097 | 0.134 | 0.176 | 0.172 | 0.124 | 0.054 | 0.057 | 0.057 |
| 6 | 202 | 1.6 | 0.095 | 0.045 | 0.045 | 0.203 | 0.068 | 0.158 | 0.057 | 0.188 | 0.147 | 0.109 | 0.052 | 0.050 | 0.041 |
| 15 | 202 | 0 | 0.061 | 0.070 | 0.062 | 0.059 | 0.039 | 0.066 | 0.050 | 0.050 | 0.055 | 0.053 | 0.052 | 0.062 | 0.078 |
| 15 | 202 | 0.1 | 0.048 | 0.070 | 0.066 | 0.071 | 0.048 | 0.119 | 0.114 | 0.103 | 0.071 | 0.105 | 0.061 | 0.053 | 0.082 |
| 15 | 202 | 0.2 | 0.057 | 0.050 | 0.052 | 0.048 | 0.039 | 0.121 | 0.111 | 0.102 | 0.070 | 0.050 | 0.041 | 0.053 | 0.055 |
| 15 | 202 | 0.4 | 0.071 | 0.059 | 0.039 | 0.039 | 0.030 | 0.109 | 0.143 | 0.119 | 0.089 | 0.046 | 0.041 | 0.066 | 0.045 |
| 15 | 202 | 0.8 | 0.094 | 0.066 | 0.055 | 0.057 | 0.052 | 0.128 | 0.132 | 0.152 | 0.094 | 0.064 | 0.052 | 0.048 | 0.057 |
| 15 | 202 | 1.2 | 0.062 | 0.077 | 0.070 | 0.061 | 0.053 | 0.144 | 0.160 | 0.146 | 0.132 | 0.077 | 0.043 | 0.055 | 0.061 |
| 15 | 202 | 1.6 | 0.059 | 0.053 | 0.053 | 0.055 | 0.041 | 0.102 | 0.164 | 0.152 | 0.127 | 0.066 | 0.045 | 0.032 | 0.041 |
| -3 | 217 | 0 | 0.035 | 0.035 | 0.045 | 0.040 | 0.026 | 0.043 | 0.047 | 0.040 | 0.040 | 0.031 | 0.028 | 0.054 | 0.055 |

Table B-14. (cont'd)

| Week | Steer no. | Epi. dose [a] | Minutes relative to the epinephrine challenge | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | -30 | -15 | -10 | -5 | 0 | 2.5 | 5 | 10 | 15 | 20 | 120 | 125 | 130 |
| -3 | 217 | 0.1 | 0.040 | 0.048 | 0.047 | 0.041 | 0.044 | 0.093 | 0.098 | 0.066 | 0.062 | 0.060 | 0.041 | 0.036 | 0.040 |
| -3 | 217 | 0.2 | 0.055 | 0.035 | 0.035 | 0.043 | 0.031 | 0.065 | 0.097 | 0.073 | 0.066 | 0.042 | 0.028 | 0.031 | 0.029 |
| -3 | 217 | 0.4 | 0.036 | 0.052 | 0.041 | 0.052 | 0.029 | 0.086 | 0.131 | 0.097 | 0.062 | 0.055 | 0.045 | 0.031 | 0.031 |
| -3 | 217 | 0.8 | 0.033 | 0.024 | 0.021 | 0.035 | 0.031 | 0.078 | 0.109 | 0.139 | 0.062 | 0.052 | 0.034 | 0.026 | 0.031 |
| -3 | 217 | 1.2 | 0.048 | 0.055 | 0.045 | 0.045 | 0.031 | 0.133 | 0.128 | 0.098 | 0.064 | 0.054 | 0.043 | 0.033 | 0.043 |
| -3 | 217 | 1.6 | 0.045 | 0.078 | 0.071 | 0.069 | 0.041 | 0.097 | 0.157 | 0.107 | 0.081 | 0.043 | 0.050 | 0.045 | 0.071 |
| 6 | 217 | 0 | 0.026 | 0.042 | 0.024 | 0.026 | 0.029 | 0.031 | 0.047 | 0.052 | 0.061 | 0.042 | 0.040 | 0.045 | 0.030 |
| 6 | 217 | 0.1 | 0.038 | 0.038 | 0.033 | 0.037 | 0.029 | 0.065 | 0.075 | 0.072 | 0.051 | 0.044 | 0.014 | 0.019 | 0.026 |
| 6 | 217 | 0.2 | 0.042 | 0.055 | 0.029 | 0.044 | 0.026 | 0.077 | 0.092 | 0.059 | 0.056 | 0.045 | 0.044 | 0.035 | 0.040 |
| 6 | 217 | 0.4 | 0.037 | 0.038 | 0.033 | 0.030 | 0.026 | 0.065 | 0.126 | 0.105 | 0.084 | 0.063 | 0.044 | 0.031 | 0.033 |
| 6 | 217 | 0.8 | 0.037 | 0.034 | 0.038 | 0.037 | 0.037 | 0.099 | 0.112 | 0.112 | 0.075 | 0.110 | 0.045 | 0.052 | 0.037 |
| 6 | 217 | 1.2 | 0.037 | 0.035 | 0.040 | 0.031 | 0.028 | 0.073 | 0.126 | 0.122 | 0.098 | 0.054 | 0.029 | 0.040 | 0.049 |
| 6 | 217 | 1.6 | 0.026 | 0.021 | 0.024 | 0.026 | 0.059 | 0.034 | 0.147 | NC | 0.077 | 0.073 | 0.029 | 0.026 | 0.024 |
| 15 | 217 | 0 | 0.036 | 0.044 | 0.027 | 0.043 | 0.046 | 0.039 | 0.039 | 0.038 | 0.058 | 0.050 | 0.039 | 0.043 | 0.034 |
| 15 | 217 | 0.1 | 0.038 | 0.039 | 0.046 | 0.038 | 0.031 | 0.067 | 0.075 | 0.070 | 0.070 | 0.051 | 0.049 | 0.027 | 0.032 |
| 15 | 217 | 0.2 | 0.038 | 0.036 | 0.043 | 0.039 | 0.041 | 0.091 | 0.116 | 0.113 | 0.099 | 0.074 | 0.051 | 0.043 | 0.050 |
| 15 | 217 | 0.4 | 0.046 | 0.046 | 0.036 | 0.050 | 0.058 | 0.068 | 0.076 | 0.111 | 0.074 | 0.115 | 0.041 | 0.039 | 0.046 |
| 15 | 217 | 0.8 | 0.048 | 0.039 | 0.031 | 0.046 | 0.041 | 0.053 | 0.074 | 0.115 | 0.087 | 0.077 | 0.055 | 0.058 | 0.053 |
| 15 | 217 | 1.2 | 0.050 | 0.036 | 0.041 | 0.038 | 0.031 | 0.062 | 0.075 | 0.124 | 0.130 | 0.101 | 0.051 | 0.036 | 0.063 |
| 15 | 217 | 1.6 | 0.038 | 0.031 | 0.039 | 0.032 | 0.015 | 0.074 | 0.121 | 0.140 | 0.104 | 0.079 | 0.044 | 0.044 | 0.051 |
| -3 | 222 | 0 | 0.061 | 0.038 | 0.040 | 0.040 | 0.036 | 0.052 | 0.047 | 0.049 | 0.045 | 0.054 | 0.042 | 0.059 | 0.045 |
| -3 | 222 | 0.1 | 0.094 | 0.049 | 0.056 | 0.057 | 0.050 | 0.094 | 0.085 | 0.087 | 0.064 | 0.059 | 0.064 | 0.050 | 0.043 |
| -3 | 222 | 0.2 | 0.085 | 0.060 | 0.083 | 0.082 | 0.062 | 0.113 | 0.130 | 0.112 | 0.111 | 0.083 | 0.057 | 0.075 | 0.059 |
| -3 | 222 | 0.4 | 0.061 | 0.040 | 0.063 | 0.064 | 0.045 | 0.089 | 0.044 | 0.116 | 0.080 | 0.050 | 0.036 | 0.056 | 0.040 |
| -3 | 222 | 0.8 | 0.081 | 0.071 | 0.079 | 0.049 | 0.049 | 0.073 | 0.113 | 0.116 | 0.068 | 0.068 | 0.050 | 0.056 | 0.036 |
| -3 | 222 | 1.2 | 0.102 | 0.085 | 0.189 | 0.085 | 0.097 | 0.101 | 0.207 | 0.104 | 0.104 | 0.083 | 0.037 | 0.068 | 0.075 |

Table B-14. (cont'd)

| Week | Steer no. | Epi. dose[a] | Minutes relative to the epinephrine challenge -30 | -15 | -10 | -5 | 0 | 2.5 | 5 | 10 | 15 | 20 | 120 | 125 | 130 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -3 | 222 | 1.6 | 0.087 | 0.057 | 0.047 | 0.056 | 0.061 | 0.094 | 0.161 | 0.179 | 0.132 | 0.094 | 0.082 | 0.087 | 0.094 |
| 6 | 222 | 0 | 0.059 | 0.052 | 0.057 | 0.053 | 0.055 | 0.070 | 0.061 | 0.057 | 0.057 | 0.061 | 0.078 | 0.066 | 0.064 |
| 6 | 222 | 0.1 | 0.066 | 0.070 | 0.068 | 0.057 | 0.048 | 0.094 | 0.107 | 0.084 | 0.089 | 0.073 | 0.040 | 0.061 | 0.055 |
| 6 | 222 | 0.2 | 0.052 | 0.050 | 0.053 | 0.057 | 0.052 | 0.105 | 0.111 | 0.105 | 0.073 | 0.062 | 0.055 | 0.043 | 0.064 |
| 6 | 222 | 0.4 | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| 6 | 222 | 0.8 | 0.062 | 0.066 | 0.064 | 0.070 | 0.024 | 0.068 | 0.143 | 0.146 | 0.123 | 0.103 | 0.066 | 0.064 | 0.062 |
| 6 | 222 | 1.2 | 0.050 | 0.045 | 0.055 | 0.048 | 0.053 | 0.127 | 0.162 | 0.141 | 0.102 | 0.080 | 0.068 | 0.059 | 0.064 |
| 6 | 222 | 1.6 | 0.070 | 0.059 | 0.061 | 0.055 | 0.045 | 0.078 | 0.134 | 0.125 | 0.137 | 0.078 | 0.052 | 0.059 | 0.062 |
| 15 | 222 | 0 | 0.124 | 0.076 | 0.081 | 0.085 | 0.072 | 0.081 | 0.094 | 0.085 | 0.083 | 0.081 | 0.072 | 0.072 | 0.101 |
| 15 | 222 | 0.1 | 0.094 | 0.085 | 0.083 | 0.079 | 0.056 | 0.086 | 0.112 | 0.105 | 0.115 | 0.081 | 0.052 | 0.063 | 0.076 |
| 15 | 222 | 0.2 | 0.068 | 0.063 | 0.063 | 0.056 | 0.056 | 0.092 | 0.121 | 0.115 | 0.086 | 0.072 | 0.072 | 0.056 | 0.054 |
| 15 | 222 | 0.4 | 0.054 | 0.054 | 0.076 | 0.058 | 0.054 | 0.099 | 0.142 | 0.441 | 0.108 | 0.076 | 0.051 | 0.061 | 0.050 |
| 15 | 222 | 0.8 | 0.058 | 0.068 | 0.056 | 0.045 | 0.038 | 0.068 | 0.114 | 0.148 | 0.123 | 0.076 | 0.054 | 0.040 | 0.050 |
| 15 | 222 | 1.2 | 0.090 | 0.056 | 0.061 | 0.068 | 0.063 | 0.067 | 0.106 | 0.169 | 0.146 | 0.119 | 0.054 | 0.072 | 0.058 |
| 15 | 222 | 1.6 | 0.094 | NC | 0.088 | 0.097 | 0.065 | 0.110 | 0.157 | 0.193 | 0.157 | 0.146 | 0.061 | 0.074 | 0.067 |
| 15 | 307 | 0 | 0.116 | NC | NC | NC | 0.088 | 0.102 | 0.095 | 0.108 | 0.100 | 0.118 | 0.199 | NC | 0.190 |
| 15 | 307 | 0.1 | 0.170 | 0.154 | 0.104 | 0.109 | 0.120 | 0.177 | 0.177 | 0.177 | 0.149 | 0.129 | 0.142 | 0.127 | 0.138 |
| 15 | 307 | 0.2 | 0.122 | 0.100 | 0.102 | 0.099 | 0.115 | 0.168 | 0.183 | 0.183 | 0.154 | 0.159 | 0.186 | 0.199 | 0.192 |
| 15 | 307 | 0.4 | 0.070 | 0.099 | 0.072 | 0.059 | 0.048 | 0.086 | 0.138 | 0.129 | 0.102 | 0.065 | 0.045 | 0.050 | 0.052 |
| 15 | 307 | 0.8 | 0.108 | 0.079 | 0.082 | 0.084 | 0.095 | 0.116 | 0.163 | 0.244 | 0.208 | 0.124 | 0.113 | 0.116 | 0.082 |
| 15 | 307 | 1.2 | 0.061 | 0.034 | 0.062 | 0.048 | 0.046 | 0.131 | 0.185 | 0.142 | 0.111 | 0.099 | 0.056 | 0.036 | 0.077 |
| 15 | 307 | 1.6 | 0.073 | 0.068 | 0.066 | 0.061 | 0.063 | 0.108 | 0.186 | 0.188 | 0.143 | 0.113 | 0.124 | 0.111 | 0.075 |

[a]Epinephrine dose, µg/kg BW.
[b]Sample not collected.

Table B-15. Plasma glycerol response (μmol/L) to a 1.6 μg epinephrine/kg BW dose during the 15th week of treatment for Experiment BC9402

| Steer no. | Minutes relative to epinephrine challenge | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | -30 | -15 | -10 | -5 | 0 | 2.5 | 5 | 10 | 15 | 20 | 120 | 125 | 130 |
| 15 | 42.32 | 30.93 | 34.18 | 32.56 | 32.56 | 58.60 | 58.60 | 68.37 | 55.34 | 50.46 | 60.23 | 47.21 | 42.32 |
| 33 | 24.24 | 19.39 | 17.77 | 19.39 | 17.77 | 40.40 | 56.56 | 58.17 | 56.56 | 54.94 | 33.93 | 25.85 | 24.24 |
| 53 | 41.87 | 24.16 | 27.38 | 30.60 | 25.77 | 67.64 | 101.45 | 83.74 | 69.25 | 54.75 | 35.43 | 40.26 | 35.43 |
| 57 | 22.82 | 11.41 | 14.67 | 21.19 | 24.45 | 53.79 | 60.31 | 63.57 | 45.64 | 37.49 | 26.08 | 22.82 | 27.71 |
| 58 | 35.89 | 45.68 | 52.20 | 37.52 | 92.98 | 148.45 | 122.35 | 110.93 | 138.66 | 125.61 | 42.41 | 61.99 | 73.41 |
| 69 | 21.88 | 15.15 | 15.15 | 18.51 | 15.15 | 47.13 | 67.32 | 55.54 | 48.81 | 37.03 | 20.20 | 15.15 | 23.56 |
| 73 | 30.98 | 17.04 | 23.23 | 13.94 | 21.68 | 66.60 | 72.79 | 69.70 | 77.44 | 71.24 | 21.68 | 32.52 | 21.68 |
| 92 | 29.30 | 21.16 | 27.67 | 21.16 | 34.18 | 40.69 | 58.60 | 65.11 | 45.58 | 40.69 | 21.16 | 24.42 | 27.67 |
| 114 | 19.56 | 9.78 | 13.04 | 11.41 | 13.04 | 27.71 | 27.71 | 47.27 | 45.64 | 32.60 | 19.56 | 16.30 | 17.93 |
| 116 | 17.01 | 17.01 | 13.61 | 10.21 | 20.42 | 22.12 | 17.01 | 18.71 | 17.01 | 17.01 | 23.82 | 52.74 | 25.52 |
| 118 | 55.46 | 63.62 | 101.14 | 63.62 | 79.93 | 120.72 | 141.92 | 55.46 | 205.54 | 106.03 | 106.03 | 70.15 | 60.36 |
| 133 | 24.19 | 27.41 | 25.80 | 29.02 | 24.19 | 62.89 | 70.95 | 58.05 | 49.99 | 41.92 | 37.09 | 22.57 | 61.27 |
| 157 | 42.10 | 24.29 | 35.63 | 29.15 | 48.58 | 63.16 | 71.25 | 134.41 | 90.69 | 108.50 | 27.53 | 30.77 | 30.77 |
| 184 | 15.15 | 11.78 | 20.20 | 20.20 | 20.20 | 40.39 | 48.81 | 55.54 | 47.13 | 45.44 | 25.25 | 28.61 | 28.61 |
| 187 | 25.52 | 23.82 | 20.42 | 45.93 | 45.93 | 49.34 | 57.84 | 37.43 | 51.04 | 47.64 | 25.52 | 30.62 | 32.32 |
| 202 | 17.04 | 4.65 | 10.84 | 13.94 | 9.29 | 35.62 | 41.82 | 37.17 | 46.46 | 49.56 | 12.39 | 7.74 | 37.17 |
| 217 | 20.93 | 14.49 | 17.71 | 14.49 | 11.27 | 30.60 | 57.97 | 57.97 | 41.87 | 41.87 | 17.71 | 27.38 | 19.32 |
| 222 | 19.43 | NC[a] | 14.57 | 19.43 | 32.39 | 50.20 | 56.68 | 95.54 | 50.20 | 58.30 | 34.01 | 37.25 | 61.54 |
| 307 | 24.24 | 17.77 | 24.24 | 22.62 | 30.70 | 43.63 | 61.40 | 48.48 | 40.40 | 45.25 | 30.70 | 46.86 | 25.85 |

[a]Sample not collected.

## SAS program to calculate area under the curve of epinephrine challenge and to calculate a segmented curve to a plateau (Rmax response)

```
Data area;
title1 'Animal 114 weeks -3, 6, 15, area under curve';
input week anno dose t2a5 t5 t10 t15 t20 baseline;

baseline=baseline*1000;
TH = baseline;
t2a5=t2a5*1000;
t5=t5*1000;
t10=t10*1000;
t15=t15*1000;
t20=t20*1000;

cards;
-3   114  0    0.077  0.045  0.070  0.057  0.054  0.050
-3   114  0.1  0.066  0.063  0.063  0.056  0.065  0.037
-3   114  0.2  0.093  0.077  0.047  0.041  0.047  0.039
-3   114  0.4  0.057  0.082  0.063  0.057  0.063  0.036
-3   114  0.8  0.077  0.124  0.072  0.061  0.057  0.044
-3   114  1.2  0.065  0.113  0.088  0.081  0.054  0.042
-3   114  1.6  0.030  0.089  0.091  0.072  0.030  0.031
6    114  0    0.062  0.037  0.048  0.046  0.046  0.048
6    114  0.1  0.073  0.082  0.062  0.080  0.062  0.045
6    114  0.2  0.099  0.105  0.083  0.066  0.062  0.057
6    114  0.4  0.039  0.101  0.094  0.087  0.041  0.033
6    114  0.8  0.106  0.128  0.112  0.085  0.059  0.040
6    114  1.2  0.071  0.094  0.126  0.087  0.066  0.040
6    114  1.6  0.046  0.071  0.115  0.105  0.076  0.035
15   114  0    0.059  0.092  0.067  0.050  0.052  0.062
15   114  0.1  0.085  0.088  0.067  0.056  0.041  0.041
15   114  0.2  0.076  0.085  0.083  0.059  0.047  0.040
15   114  0.4  0.121  0.142  0.097  0.068  0.043  0.041
15   114  0.8  0.117  0.139  0.144  0.106  0.065  0.040
15   114  1.2  0.077  0.150  0.135  0.081  0.043  0.035
15   114  1.6  0.094  0.126  0.216  0.213  0.168  0.063

Proc print data = area;

Data auc; set area;

/* Calculation of Area 1 */
        If t2a5 <=th then a1=0;
          else a1=(2.5*(.5*(t2a5-th)));

/* Calculation of Area 2 */
        If t5 <=th and t2a5<=th then a2=0;
        If t5 <=th and t2a5<=th then a2c=1;
        If t5>th and t2a5<th then a2=((((t5-th)/t5)*2.5)*(.5*(t5-th)));
        If t5>th and t2a5<th then a2c=2;
        If t5>th and th=<t2a5<=t5 then a2=(2.5*(t2a5+(.5*(t5-t2a5)))-(2.5*th)) ;
        If t5>th and th=<t2a5<=t5 then a2c=3;
        If t5>th and t2a5>t5 then a2=(2.5*(t5+(.5*(t2a5-t5)))-(2.5*th)) ;
        If t5>th and t2a5>t5 then a2c=4;
        If t5<=th and t2a5>th then a2=((((t2a5-th)/t2a5)*2.5)*(.5*(t2a5-th)));
```

```
        If t5<=th and t2a5>th then a2c=5;

/* Calculation of Area 3 */
        If t10 <=th and t5<=th then a3=0;
        If t10 <=th and t5<=th then a3c=1;
        If t10>th and t5<th then a3=((((t10-th)/t10)*5))*(.5*abs(t10-th));
        If t10>th and t5<th then a3c=2;
        If t10>th and th=<t5<=t10 then a3=(5*(t5+(.5*(t10-t5)))-(5*th));
        If t10>th and th=<t5<=t10 then a3c=3;
        If t10>th and t5>t10 then a3=(5*(t10+(.5*(t5-t10)))-(5*th));
        If t10>th and t5>t10 then a3c=4;
        If t10<=th and t5>th then a3=((((t5-th)/t5)*5)*((.5*(t5-th))));
        If t10<=th and t5>th then a3c=5;

/* Calculation of Area 4 */
        If t15 <=th and t10<=th then a4=0;
        If t15 <=th and t10<=th then a4c=1;
        If t15>th and t10<th then a4=((((t15-th)/t15)*5)*(.5*abs(t15-th)));
        If t15>th and t10<th then a4c=2;
        If t15>th and th=<t10<=t15 then a4=(5*(t10+(.5*(t15-t10)))-(5*th));
        If t15>th and th=<t10<=t15 then a4c=3;
        If t15>th and t10>t15 then a4=(5*(t15+(.5*(t10-t15)))-(5*th));
        If t15>th and t10>t15 then a4c=4;
        If t15<=th and t10>th then a4=((((t10-th)/t10)*5)*(.5*(t10-th)));
        If t15<=th and t10>th then a4c=5;

/* Calculation of Area 5 */
        If t20 <=th and t15<=th then a5=0;
        If t20 <=th and t15<=th then a5c=1;
        If t20>th and t15<th then a5=((((t20-th)/t20)*5)*(.5*abs(t20-th)));
        If t20>th and t15<th then a5c=2;
        If t20>th and th=<t15<=t20 then a5=(5*(t15+(.5*(t20-t15)))-(5*th));
        If t20>th and th=<t15<=t20 then a5c=3;
        If t20>th and t15>t20 then a5=(5*(t20+(.5*(t15-t20)))-(5*th));
        If t20>th and t15>t20 then a5c=4;
        If t20<=th and t15>th then a5=((((t15-th)/t15)*5)*(.5*(t15-th)));
        If t20<=th and t15>th then a5c=5;

/* Summation of all areas */
        areauc=sum(a1, a2, a3, a4, a5);
        drop  t2a5 t5 t10 t15 t20 bl1 bl2 th;

Proc print data = auc;
Proc plot data = auc;
by week;
plot areauc*dose;
run;

data curve; set auc;

/* Fitting a Segmented Model using NLIN  */
        if dose = 0 then areauc = 0;
        proc nlin method=marquardt;
        by week;
        parms a= 437 b= 1603 c=-911;
        file print;
        dose0=-.5*b / c;   /* Estimate Join Point    */
```

```
        db=-.5 / c;     /* Deriv of dose0 wrt B      */
        dc=.5*b / c**2; /* Deriv of dose0 wrt C      */

        if dose<dose0 then    /* Quadratic Part of Model */
          do;
           model areauc=a+b*dose+c*dose*dose;
           der.a=1;
           der.b=dose;
           der.c=dose*dose;
          end;

else         /* Plateau Part of Model   */
  do;
   model areauc=a+b*dose0+c*dose0*dose0;
   der.a=1;
   der.b=dose0+b*db+2*c*dose0*db;
   der.c=b*dc+dose0*dose0+2*c*dose0*dc;
  end;

if _obs_=1 & _model_=1 then    /*  Print out if 1st obs */
  do;
   plateau=a+b*dose0+c*dose0*dose0;
   put dose0=plateau=;
  end;
output out=b predicted=aucplat;
run;
proc plot;
by week;
 plot areauc*dose aucplat*dose='*' / overlay;
run;
```

## APPENDIX C

Approval letters from the All-University Committee on Animal Use and Care

MICHIGAN STATE UNIVERSITY

ALL-UNIVERSITY COMMITTEE ON ANIMAL USE AND CARE
C BUILDING • CLINICAL CENTER
TELEPHONE (517) 353-9064

EAST LANSING • MICHIGAN • 48824-1313

**MEMORANDUM**

**TO:** RUST, S.
ANIMAL SCIENCE
113 ANTHONY

R.J. Aulerich

**FROM:** Richard J. Aulerich, Chairperson
All-University Committee on Animal Use and Care

**DATE:** 12/06/91

**SUBJECT:** APPROVAL OF APPLICATION TO USE VERTEBRATE ANIMALS IN RESEARCH

This is to notify you that your recent application to use animals in research or teaching has been approved by the All-University Committee on Animal Use and Care. This approval is for a one-year period, beginning on the date of approval by the committee. *** For external funding agencies, if the Office of the Vice President for Research and Graduate Studies, or the Dean's Office notifies us of a funding date, your approval will be extended for one year following the funding date. ***

Should your project extend beyond one year, you should resubmit your request to the committee. For your convenience, the new Yearly Renewal Form is designed so that resubmissions maybe accomplished by merely identifying the earlier proposal and assuring that the proposal is being resubmitted with revisions.

The title of your approved proposal, the date of approval and the tracking numbers assigned (both ORD and AUF numbers) are given below. You should retain this information for future use. Please note that, according to University policy, no significant changes may be made to your animal-use plan without prior approval from the AUCAUC. Requests for review of proposed revisions may be made by submitting a new Animal Use Form or by sending a letter to the AUCAUC, C103 Clinical Center.

**Title** USE OF GROWTH PROMOTING SUBSTANCES FOR INCREASED SKELETAL AND TEAR TISSUE GROWTH OF HOLSTEIN CATTLE

**AUF Number:** 10/90-308-02 **ORD Number:**

**Funded By:** ELI LILLY LABORATORIES

**Approved:** 12/06/91 **Expires:** 12/06/92

RJA/cjf

CC: Maynard G. Hogberg, Chairperson
ANIMAL SCIENCE
102 ANTHONY HALL

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MICHIGAN STATE UNIVERSITY

ALL-UNIVERSITY COMMITTEE ON ANIMAL USE AND CARE
C BUILDING • CLINICAL CENTER
TELEPHONE (517) 353-5064

EAST LANSING • MICHIGAN • 48824-1313

MEMORANDUM
----------

TO: SCHLEGEL, MICHAEL L.
ANIMAL SCIENCE
233 ANTHONY HALL

a.T. Evans DVM

FROM: A. Thomas Evans, Chairperson
All-University Committee on Animal Use and Care

DATE: 06/24/94

SUBJECT: APPROVAL OF APPLICATION TO USE VERTEBRATE ANIMALS IN RESEARCH

This is to notify you that your recent application to use animals in research or teaching has been approved by the All-University Committee on Animal Use and Care. This approval is for a one-year period, beginning on the date of approval by the committee. *** For external funding agencies, if the Office of the Vice President for Research and Graduate Studies, or the Dean's Office notifies us of a funding date, your approval will be extended for one year following the funding date. ***

Should your project extend beyond one year, you should resubmit your request to the committee. For your convenience, the new Yearly Renewal Form is designed so that resubmissions maybe accomplished by merely identifying the earlier proposal and assuring that the proposal is being resubmitted with revisions.

The title of your approved proposal, the date of approval and the tracking numbers assigned (both ORD and AUF numbers) are given below. You should retain this information for future use. Please note that, according to University policy, no significant changes may be made to your animal-use plan without prior approval from the AUCAUC. Requests for review of proposed revisions may be made by submitting a new Animal Use Form or by sending a letter to the AUCAUC, C103 Clinical Center.

Title UNDERSTANDING CHANGES IN LIPOGENESIS AND LIPOLYSIS IN HOLSTEIN STEERS TREATED WITH BOVINE SOMATOTROPIN THROUGHOUT THE FINISHING PERIOD

AUF Number: 06/94-141-01 ORD Number: N/A

Funded By: DEPARTMENT

Approved: 06/24/94 Expires: 06/24/95

ATE/cjf

CC: Dr. Maynard G. Hogberg, Chairperson
ANIMAL SCIENCE
102 ANTHONY HALL

# LITERATURE CITED

## LITERATURE CITED


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