EFFECT OF TESTOSTERONE AND CASTRATION ON THE GROWTH AND CARCASS CHARACTERISTICS OF SWINE

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EFFECT OF TESTOSTERONE AND CASTRATION ON THE GROWTH AND CARCASS CHARACTERISTICS OF SWINE

By

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TABLE OF CONTENTS

INDEX TO FIGURES, ILLUSTRATIONS AND TABLES

INTRODUCTION

Removal of testes and ovaries has been practiced by man since ancient times. The Emperors and Empresses of China in the Han's dynasty castrated men for punishment as well as servants in the courts. In ancient times, men destined for the priesthood were castrated, while others were castrated to preserve high pitched soprano voices for choral purposes. Historians attribute one of the causes of the fall of the Holy Roman Empire to the fact that castration of man was practiced and the eunuchs were in power. Man early realized that castration of animals improved their ability to fatten and also the quality of meat. He also recognized that castration of the male bovine produced a better beast of burden; namely, the ox. Castration of animals is still practiced. Man caponizes the male fowl, castrates male calves, pigs, lambs and colts. Castration greatly enhances the market value of steers, lambs and pigs as it reduces restlessness and sexual activity, facilitating the fattening and increasing the palatability of the meat as well as producing a higher dressing percentage. Castration of the male foal inhibits the sexual libido and thus improves the gelding's performance under harness.

As science progresses, it is being recognized more and more that greater coordination among the various fields of both the pure and applied sciences will produce greater

results. The time has come when the animal husbandman can no longer isolate himself from the chemist, nutritionist, physiologist and the other scientists. The feed the animal consumes, the functions of the exocrine and endocrine glands, the metabolism as well as the management practices, are all interrelated in the growth and efficiency of the farm animal.

Swine have gone through many evolutionary changes since the time of the wild boar hunts of pre-historic and medieval times. In the United States, from pre-revolutionary days to the present, the type of hog has varied. At one time, the short, chuffy lard type hog was popular and profitable for the farmer to raise. The consumer accepted the fat as lard and seemed to enjoy the fat cuts of pork, such as fresh side and salt pork. Today the swine raiser finds that a lower price is received for his 300 and 400 pound hogs. The consumer buys vegetable oil shortening and other lard substitutes which are in strong competition with lard. Consequently, lard is nothing more than another by-product of the hog and is relatively cheap. The consumer wants leaner cuts and refuses salt pork and fresh side pork. Therefore, the producer must raise a lighter weight hog and one which will yield a greater proportion of lean cuts.

OBJECT OF THE STUDY

The lack of consumer demand for lard and its resultant low price has materially increased the price of the leaner and more desirable pork cuts. Both the producer and consumer would benefit materially from hogs that yield a higher percentage of the lean or muscled cuts. The commercial practice of discounting boars and stags on the livestock market is based upon the assumption that a certain percentage of the individuals will produce an objectionable or strong flavored product which cannot be sold as fresh or cured pork. There is no clear cut explanation as to the cause of this odor in pork. There is very little literature as to an explanation of the results of castration and testosterone administration as there are many fundamental problems concerning the function, behavior and interrelationship of the various endocrine glands. It was the purpose of this study to find the effect of testosterone administration and/or delayed castration on the sex accessory organs, muscle development, carcass measurements and flavor of the pork.

REVIEW OF LITERATURE

Although castration of male animals has been practiced by man for centuries, it was not until the beginning of the twentieth century that his curiosity was aroused to such a degree that he asked himself, "what are the basic physiological effects of castration?". Since that time, many researchers have published their findings of the effects of castration and the subsequent administration of the sex hormone. One can find very little work that has been done with swine. However, there is much literature on experiments with the classical laboratory animals as well as clinical work with human subjects.

Brown-Sequard, cited by Turner (57) in 1889, at the age of 72, injected testicular extracts into himself and claimed to have elicited striking rejuvenating effects in himself. In 1911, Pezard (2) reported that he obtained stimulation of the growth of the capon by injecting a relatively small amount of cryptorchid pig testes. It is general knowledge that the androgens have the capacity to prevent atrophy of the secondary sex structures - prostates, seminal vesicles, Cowper's glands and also in the case of the hog, the prepuce. The restoration of the sex accessory glands of a castrated rat is used as an assay method for testosterone. Moore, et al (39) rebuilt the seminal vesicles to normal from castrated rats at different ages of castration

by testosterone injections from bull testes. They found that the effectiveness of the potent factor in the injection extract was merely temporary and that in order to overcome castration effects for any length of time, injections have to be made without intermission.

Eidelsberg and Ornstein (10) support this view of continuous treatment. They observed the long time treatment of testosterone propionate. Subcutaneous injections for two years, in addition to 200 mg. pellets of testosterone propionate implanted under the skin gave no ill effects or untoward symptoms in treating patients who failed to develop male characteristics upon puberty. They found however, that treatment must be continued. Certain workers claim that high doses of testosterone propionate exert a growth depressing effect.

Rubinstein, et al (46) found that testosterone propionate given in doses of one mg. intraperitoneally daily except Sunday from 26 to 80 days significantly depresses body weight and length of the male albino rat. They stated that the growth curve approached that of castration. Dosages and time were important factors in the production of the observed effects. They believed that high dosage of testosterone propionate exerted its growth depressing effect by inhibiting the growth hormone production of the pituitary gland.

Ludwig (33) studied the effect of androgens on spermatogenesis. His results showed that low doses of

testosterone propionate suppressed the secretion of gonadotrophin by the pituitary and thus indirectly injured the testes, producing loss of weight and inhibition of sperm production. High doses, which likewise inhibit the pituitary, resulted in a level of androgen which stimulated the seminiferous tubules directly. Thus, testicular weight was maintained and spermatogenesis proceeded in a normal manner even in the face of a diminished supply of gonadotrophin.

Turner, et al (56) found in their experiment that prolonged injection of large amounts of testosterone propionate did not significantly alter the skeletal maturation or body growth in rats.

Several workers have studied the effects of animals castrated before puberty. Richter (44) noticed that rats spayed or castrated before puberty showed a constant low level of activity throughout life. Removal of sex glands produced about a 4/5 decrease in daily running activity. Why there was a decrease was not clearly understood by Richter. However, he showed that adrenalectomy, hypophysectomy and thyroidectomy can reduce the activity as much as gonadectomy.

Rubenstein, et al (45) castrated immature white rats and obtained a suppression of somatic growth as determined by body weight and length, both of which were significantly inhibited. Sanberg (48) found somewhat different results. He found that the food intake and weight curves of male and female rats which had been castrated before puberty were similar to

that of normal animals. The weight curves of male rats which had been castrated after puberty were similar to those of normal animals up to the age of 30 weeks. Then the curve of castration flattened out and at 40 weeks of age controls weighed 10 per cent more.

There seem to be conflicting views as to whether testosterone administration can cause an increase in body weight. Overbeek and Tausk (42), working with female monkeys, injected testosterone propionate daily and received regular increase in body weight. Rubinstein and Solomon (49) administered testosterone propionate to albino male rats which led to a significant increase in body weight and length. Korenchevsky (25) found that castration and cryptorchidism produced a decrease in body weight but an increase in fat deposition. Kenyon (19) treated 4 eunuchoids with daily testosterone propionate injections. Results revealed an increase in body weight. The authors cited gave no definite explanation as to why there was an increase or decrease in body weight in their experiments.

Papanicolaou and Falk (43) studied the general muscular hypertrophy induced by the androgenic hormone. The temporal muscles of adult male guinea pigs castrated before sexual maturity remained small and flat as in adult females. The muscles of such castrated males did not respond to treatment with gonadotrophic hormone. This treatment was likewise ineffective in spayed females. These observations indicated that the presence of the gonads was necessary for the production of muscular hypertrophy. Various experiments were

then performed in order to determine particularly the effect of the androgenic hormone. Castrated immature males and spayed females as well as normal females were treated with testosterone propionate and a definite hypertrophy of the temporal and other muscles of the body resulted. Progesterone and estrogen did not produce this effect.

Gonadectomy and testosterone propionate administration can cause a decrease or increase in the size of glands and organs other than the sex accessory glands. Leathem (28) observed an increase in the weight of kidney, spleen and liver in the castrated rat with small doses of testosterone propionate. Kochakian (22) showed that androgen therapy returned the castration - hypertrophied adrenals to normal. Moore (38) found that gonadectomy of both male and female is followed by a relative decrease in the size of the adrenals but only slightly so in males. Korenchevsky (22) cited Bauer and Bollinger as having found a slight increase in the heart weight of bulls and stallions compared with those of oxen and geldings.

Korenchevsky (22) studied the increase in size of the pituitary after castration. He concluded from his results that the greater activity of extracts from the pituitary glands of castrated animals in gonad stimulating properties constituted evidence that castration definitely influences the gonadotrophic properties of the pituitary.

Lewis, et al (31), while studying the effect of steroids

on the incidence of diabetes in castrated and 95 per cent pancreaectomized rats, found that 500 micrograms daily of testosterone propionate increased the body weight, liver, kidneys, seminal vesicles and prostate. These workers gave three possibilities as to how the mechanism by which the androgens and estrogens exert their influence:

1. Hormones act through the hypophysis, adrenals or liver.
2. They act directly on the pancreas.
3. They act on the peripheral tissues e.g. the muscle fiber.

Korenchevsky (25) found that castration produced an atrophy of the thyroid while the adrenals and hypophysis were hypertrophied. He explained that the sex hormone production of the seminiferous (Sertoli) cells stimulate metabolism and the thyroids, while the interstitial (Leydig's) cells produce hormones necessary for the normal growth of and development of the adrenals and hypophysis.

The review of literature of the effects of castration and androgenic administration with farm animals is limited. Some work has been done with sheep. Hunt, et al (18) studied the effect of castration of lambs on their development and quality of meat. Their results showed that rams carried a higher percentage of lean in rib cuts than did wethers. The wethers produced a greater weight of fat and a higher percentage of fat in rib and shoulder cuts than did rams, especially at older ages.

Andrews, et al (3) administered sex hormones to ten lots of blackface wether lambs. Five treatments were used in duplicate. One of the treatments consisted of a 10 mg. pellet of testosterone implanted subcutaneously. Another treatment consisted of a 10 mg. pellet of testosterone implanted at the start of the experiment and 10 mg. 43 days later. The wethers gained 0.43 and 0.41 pounds respectively against 0.35 pounds for the controls. The feed required per pound of gain in treated lots was significantly less than that required by the controls. Carcass quality appeared to be improved by the administration of testosterone.

A few workers have made studies comparing boars and barrows. Winters, et al (59) took live body measurements of boars and barrows. Measurements were made on the length, heart and flank girth, depth back of shoulders, width of loin and height at shoulders. At 12 weeks, the boars were significantly heavier. At 24 weeks, the barrows were significantly heavier. No true sex differences in measurements were noticed at 8 and 12 weeks. At 20 weeks, one breed of boars showed a significantly taller measurement than the barrows of the same breed. In another breed, the boars were significantly deeper. At 24 weeks, the length of the boars was the only significant difference in the measurements over the barrows. Winters (59) explained that the measurements indicated that the differences in growth between boars and barrows was due largely to differences in the skeleton and deposition of fat, the former being in favor of the boars

and the latter in favor of the barrows. He further stated that the testes first accelerate increased weight but that at puberty some other factor entered in and had a depressing effect.

Hammond and Murray (15) made a study of the body proportions of different breeds of bacon pigs. Their results will be reviewed in the discussion on back fat thickness. Baker (4) studied the influence of age at castration on the size of various organs of pigs. Six pigs were castrated at approximately 50 days of age, 7 pigs castrated at approximately 100 days, 2 pigs castrated at approximately 200 days and 2 left as boars. He weighed the seminal vesicles, Cowper's glands, adrenals, thyroid, pineal and pituitary. All of the pigs were slaughtered at 300 days from birth. His summary was as follows:

1. Seminal vesicles, Cowper's glands and adrenals are smaller when castration is performed at 100 days than when performed at 200 days.
2. There is much less difference, if any at all, according to whether castration is performed at 50 or 100 days.
3. Thyroid, pineal and pituitary are not significantly affected.

Norby and Gildow (40) studied the modifying effect of cryptorchid testes on the swine accessory sex glands. They found that accessory glands of cryptorchid pigs did not

make as rapid a growth as those that had normally developed testes in the scrotum. Testes were twice as large in boars as they were in cryptorchids. McMeekan (37), who has done extensive work with the growth and development of swine with reference to carcass quality characteristics, made this statement, "while little definite evidence is available, it is a matter of common observation that the entire male pig has heavier bones and less fat than entire females."

German investigators have been concerned with the sexual odor of meat from boars and cryptorchid boars. Lerche (30), at the institute of Food Hygiene of the University of Berlin, made this comment, "As soon as the male hog is sexually mature and the testes become capable of functioning, there seems to be a specific sexual odor, which is onion like or unpleasantly perspirative, occuring in all boars with normally developed testes. It is also present in the case of cryptorchids unless the testes lying in the abdominal cavity are atrophied." He stated that the views of butchers asserting that the odor of the meat can be avoided if the animals had no opportunity to become sexually excited before slaughtering are erroneous. He also investigated the meat, fat, and parotid glands of 32 boars at different time intervals after castration. Boars ranging between 3/4 and 3½ years of age were castrated and went through a rest period of 8 to 75 days before slaughtering. He described his cooking determination as follows: "The cooking samples as well as the roasting samples were put into an Erlenmeyer flask where small cubed pieces were boiled in

a little water." He claimed excellent results with this method as the odors do not disperse into space as in the case of rendering fat in an open container or during the rubbing of bacon in a hot pan. The results of his experiments showed that in the case of castrated boars, the sexual odor during the first weeks after castration is always perceptible and is attached particularly to the fat. After 33 days, a considerable lessening of the odor took place so that only a weak odor was present. After 57 days, the situation was similar. The first completely negative results on pieces of fat were obtained 68 days after castration. However, extremely slight off odor in the fat was detected in some animals 75 days after castration. Positive tests of the lean were detectable only up to the tenth day after castration. Results were different in the case of the parotid gland. It produced a definite sexual odor even though the meat and fat gave negative results.

Lerche (30) recommended that with all late castrated boars, a cooking test be made using the salivary gland below the external ear (parotid). If the parotid alone shows a sexual odor, the carcass should be removed.

Dr. Kunze (27), a local veterinarian at the Meizen Packing Plant, mentioned the fact that in 20 cases of sexual odor in cryptorchid boars, pickling for a period of 3 weeks eliminates the odor. He further mentioned that the odor in the pickling process is bound by the salt.

Dr. Heydt (16), municipal veterinarian at Stuttgart, commented on the dissertation of Gereke (13). Gereke (13) furnished the surprising proof that the carrier of the sexual odor of boars is to be found in the parotid gland. He stated that there must exist a connection between the testes and the salivary glands located below the external ear. He substantiated this fact on the basis of "parotitis epidemica" when a frequent swelling of the testes also occurs. Hypertrophy of the parotid gland in man (mumps) is accompanied by a hypertrophy of the testes. Gereke (13) pointed toward the observation that the sex smell on the living animal occurs particularly during excitement when much saliva is produced. Heydt (16) further cited cases where boar carcasses were hung for 2, 3 and 5 weeks without a disappearance of the odor.

METHODS OF PROCEDURE

A total of 24 boar pigs of a Poland China-Hampshire-Duroc cross averaging 40.4 pounds were used in the experiment. The pigs were farrowed between May 1st and 15th and were put on experiment July 19. They were divided into six lots of four pigs each. The pigs were ear notched according to the Michigan State College system.

Lots 1 and 2 were castrated at approximately 40 pounds. Lot 1 was left as normal barrow controls. Lot 2 was implanted with pellets of testosterone propionate. One pellet weighing approximately 193 milligrams was implanted in muscular tissue at the base of the ham. Lots 3, 4 and 5 were castrated as nearly as possible at weights of 100, 140 and 180 pounds, respectively. Lot 6 was left as normal boar controls. (See Table 1).

TABLE I

CASTRATION WEIGHT AND AGE

Lot No.	Hog No.	Initial Weight	Castration Weight	Approx. Age at Castration in Days	Implanted Pellet Weight (Milligram)*
1	11	40	40	70	
	12	47	47	70	
	13	36	36	70	
	14	43	43	70	
Average		41.50	41.50	70	
2	21	39	39	70	193.1
	22	36	36	70	190.4
	23	39	39	70	198.2
	24	47	47	70	192.0
Average		40.25	40.25	70	193.4
3	31	43	100	125	
	32	43	106	133	
	33	43	110	119	
	34	37	106	125	
Average		41.50	105.50	125.5	
4	41	37	136	140	
	42	37	137	153	
	43	46	144	140	
	44	42	154	140	
Average		40.50	142.27	143.2	
5	51	46	187	153	
	52	38	181	197	
	53	34	173	153	
	54	39	180	197	
Average		39.25	180.25	175.0	
6	61	43			
	62	38	Left as Boar Controls		
	63	35			
	64	43			
Average		39.75			

* Implanted at time of castration.

All lots were self fed on rape pasture and had access to an automatic waterer. The ration fed was as follows:

Ground Corn.....60%

Ground Oats.....20%

Soybean Oil Meal (41%).....12%

Meat Scraps..... 6%

Mineral..... 2%

Mineral Mixture consisted of:

Iodized Salt.....30.5%

Ground Limestone.....31.5%

Bonemeal.....31.5%

Magnesium Carbonate..... 3.0%

Trace mineral quantity sufficient for 100 pounds of mineral mixture.

After one month on experiment, Vitamin B was added to the ration as follows:

Niacin.....15mg per pound of feed

Calcium Pantothenate.....10mg " " " "

Riboflavin..... 2mg " " " "

Individual weights and feed consumption were recorded every two weeks. All boars and barrows were taken off feed when they reached a weight of 210 to 220 pounds or as near this as possible. They were tattooed and held for 24 hours before slaughter. Immediately after bleeding and dehairing the hogs, the sex accessory glands were removed. The seminal vesicles (vesiculae seminales) were tied off at the excretory

ducts to lessen the loss of fluid. The body of the prostate was weighed with the seminal vesicles plus the vesiculae fluid as the prostate body, being concealed by the seminal vesicles, was difficult to dissect without loss of fluid. The Cowper's glands (bulbo-uretheral) and fluid contents were weighed after removing the layer of striated muscle (M. bulbo-glandularis). The prepuce was removed to examine the condition due to the various stages of castration. The weights of the testicles were also recorded in the case of the boar controls.

All hogs were dressed packer style and the cold weights recorded (leaf fat out) after 24 hours in the chill room. At this time, carcass measurements were taken from the hanging carcass and recorded in millimeters. The length of the body was measured from the junction of the last cervical and first thoracic vertabrae to the anterior edge of the symphysis pubis. The leg length was measured from the anterior edge of the symphysis pubis to the coronary band. Back fat measurements were taken over the 1st rib at the junction of the last cervical and first thoracic vertebrae; over the 7th rib at the junction of the 6th and 7th thoracic vertebrae, over the last rib at the junction of the last thoracic and 1st lumbar vertebrae; and over the center of the last lumbar vertebra. The back fat thickness for each carcass was calculated by averaging the measurements of the 1st and last rib and last lumbar.

Both sides of the carcass were cut and primal cut weights recorded. A 2½ rib shoulder was removed. The jowl, breast flap, neck bones, clear plate and front foot just above the knee were removed. The New York Style shoulder was weighed as the first primal cut.

The ham was separated between the 2nd and 3rd sacral vertebrae on a line perpendicular to the hind leg. The tail, flank, surplus fat and shank at the hock were removed. A skinned ham was made leaving about 3/8 of an inch of fat on the skinned portion. The skinned ham was weighed as the second primal cut. The pellets from two of the lot 2 carcasses were recovered.

The loin plus fat back and belly were separated along a line about an inch from the tenderloin muscle at the posterior surface to about an inch from the end of the backbone on the blade end of the loin. At this time, tracings were made of the eye muscle and fat at the last rib on the right side of each carcass. The total area of lean and fat were measured using a planimeter. The fat back was removed from the loin, leaving about 3/8 of an inch covering of fat. The trimmed loin was weighed as the third primal cut. The spare ribs were lifted from the belly which was trimmed "barrow style" and weighed as the fourth primal cut.

Eight chops from each of the 24 carcasses were sent to the Foods and Nutrition Department where cooking and

palatability tests were made. Each lot of eight chops was divided to give duplicate tests. The chops were browned in a hot pan, then a small amount of water added, the pan covered and the cooking finished in a slow (250°F) oven. All samples were tested and scored while warm as to appearance, aroma, flavor of fat, flavor of lean, juiciness, tenderness and texture. The scoring scale was based on 1 to 7 points with the latter being excellent and 1 very poor. The cooking losses were determined. The panel tasting committee consisted of members of the Animal Husbandry and Foods and Nutrition Departments.

A statistical analysis of the data was made using the formulae shown in Table 2. A correlation analysis was made between the per cent live primal cut yield and per cent area of lean of the chops and between the per cent cold carcass cut yield and per cent area of lean of the chops for the six lots. An analysis of variance and t-test were calculated between the lots for carcass measurements, live and carcass primal cut yield, kidney weights, dressing per cent, per cent of lean of the chops, acceptability and daily rate of gain. Other data are presented in table form.

TABLE II

FORMULAE USED IN STATISTICAL ANALYSIS

Analysis of Variance:

$$SX^2 - \frac{(SX)^2}{N} =$$ Total sum of squares (54)

$$\frac{SX_1^2 + SX_2^2 \text{-----} SX_n^2}{n} - C.T. =$$ Sum of squares between Lots (54)

t-test

$$\sigma_{m_1} = \sqrt{\frac{\text{Error Variance}}{n}}$$

$$\sigma_{m_1 - m_2} = \sigma_{m_1} \sqrt{\frac{1}{n} - \frac{1}{n}}$$

$$\sigma_{m_1 - m_2)} \text{ (table for t)} =$$ Significant level between means (5)

Correlation Analysis:

$$r_{xy} = \frac{SXY - \frac{(SX)(SY)}{N}}{\sqrt{\left[SX^2 - \frac{(SX)^2}{N}\right]\left[SY^2 - \frac{(SY)^2}{N}\right]}}$$ (58)

$$\sigma_r = \frac{1 - r^2}{\sqrt{n - 2}}$$ (32)

$$\sigma_e = \sqrt{\frac{SY^2 - aSY - bSXY}{N - 2}}$$ (5)

$$Y = \bar{Y} - r \frac{\sigma_Y}{\sigma_X} (x - \bar{X})$$ Regression equation (58)

$$\sigma_X = \sqrt{\frac{SX^2 - \frac{(SX)^2}{N}}{N - 1}}$$ (58)

RESULTS AND DISCUSSION

Feed Consumption and Daily Gain

Comparisons of total feed consumed, feed consumed per 100 pounds of gain, pig days, initial and final weight and average daily rate of gain by lots are presented in Table III. Statistical treatment of the daily rate of gain between the lots did not show any significance. This is in agreement with Hunt, et al, (18) who found no significant difference in the average rates of gain made between rams and wethers.

Bratzler, et al, (6) in their study at the Michigan station could find no significant difference in the daily gain between boars and barrows. It was impossible to test for significance between the lots as to total feed consumed and feed consumed per 100 pounds of gain as the data were recorded by lots rather than by individuals within the lots. The mean for feed consumed per 100 pounds gain for all of the lots was 377.67 pounds. It is evident from Table III that none of the lots showed any appreciable increase or decrease from this mean.

Holt, et al (17) substantiate this somewhat while studying the effects of gonadectomy on the body structure and body weight in albino rats. They found no significant difference in food intake between castrated and normal males.

The 180 pound castrates (Lot 5) and the normal boar controls (Lot 6) were carried on the experiment for 133 and 139 days, respectively. This is longer than the mean of 124.67 for all lots. However, as can be seen in Table III, the final weight of Lots 5 and 6 were proportionately heavier than the other lots. See Appendix A for individual data on feed consumption and gain.

TABLE III

FEED CONSUMPTION AND DAILY GAIN BY LOTS

Lot No.	Initial Wt. (Average)	Final Wt. (Average)	Pig Days (Average)	Daily Gain (Average)	Total Feed Consumed	Pounds Feed Consumed/100 pound Gain (Average)
1	41.50	219.75	126	1.41	2714	381
2	40.25	220.25	118	1.52	2733	380
3	41.50	216.25	120	1.46	2768	396
4	40.50	217.25	112	1.57	2527	358
5	39.25	227.25	133	1.42	2768	367
6	39.75	224.25	139	1.31	2799	384

Dressing Per Cent

Analysis of variance of dressing per cent between the lots reveals that there is a highly significant difference as shown in Table IV. The t-test shows that the barrows, testosterone treated barrows and the 100 pound castrates of lots 1, 2 and 3 respectively had a significantly higher dressing per cent than the 140, 180 pound castrates and boar controls. However, in the case of the 180 pound castrates compared with the 140 pound castrates, the opposite is true. The general higher dressing per cent of the barrows of lots 1 and 2 and the 100 pound castrates would be expected since the boar controls and 140 and 180 pound castrates averaged a thinner back fat and a higher per cent of lean in the loin as will be discussed later. For a summary of the off feed weight, shrinkage, slaughter weight, cold carcass weight and dressing per cent, see Appensix B.

TABLE IV

ANALYSIS OF VARIANCE OF DRESSING PER CENT ***

Source	D F	S S	M S	F
Total	23	37.25****		
Between Lots	5	20.80	4.16	4.65**
Within Lots	18	16.45	.916	

t-test - Difference between means to be highly significant .9736

$\bar{X}$ = Lot 1 74.05 Lot 2 73.66 Lot 3 73.86
Lot 4 71.61 Lot 5 72.92 Lot 6 72.12

Lot 1,2,3 dressing per cent significantly** higher than Lot 4,6
Lot 1 " " " " " " Lot 5
Lot 5 " " " " " " Lot 4

** Highly significant

*** Appendix J

**** Calculations coded by X-70

Carcass Measurements

An analysis of variance shows that there is a highly significant difference between the lots in body length. Individual lot differences were evaluated by the t-test. The boar controls had a longer length of body than any of the other lots, being significant at the 1 per cent level as shown in Table V. The same is true for the 140 and 180 pound castrates over the barrows and 100 pound castrates. These results are again similar to those of Bratzler, et al, (6) who found a greater body length of boars as compared with barrows. These results also agree with Moore (40) who found greater body length in normal male guinea pigs than in castrated males. Also Rubinstein, et al, (47) previously cited, castrated white immature male rats which led to a suppression of somatic growth as determined by body weight and body length, both of which were significantly inhibited.

The question of bone length was discussed by Novak (41) who cites Finkler, et al (1944). They made a roentgenological study of the effect of hormone therapy on bone growth of children. They showed that testosterone administration has a tendency to accelerate longitudinal bone growth without hastening epiphyseal union. Dorf (9) obtained similar results with an increase in length of children after chorionic gonadotropin administration.

Statistical analysis of the leg length gave similar results as shown in Table VI. Both the boar controls and 180 pound castrated boars were significantly longer in leg length. However, the leg length of the 100 pound castrates was significantly longer than the two lots of barrows and 140 pound castrates.

TABLE V

ANALYSIS OF VARIANCE OF LENGTH OF CARCASS*** (in mm.)

Source	D F	S S	M S	F
Total	23	11540		
Between Lots	5	9096	1819.20	13.40**
Within Lots	18	2444	135.78	

t-test - Difference between means to be highly significant 11.85

$\bar{X}$ = Lot 1 727.25 Lot 2 734.50 Lot 3 727.00

Lot 4 750.25 Lot 5 751.00 Lot 6 783.2

Lot 6 length of carcass significantly** greater than Lot 1,2,3,4,5

Lot 4,5 " " " " " " Lot 1,2,3

** Highly Significant

*** Appendix K

TABLE VI

ANALYSIS OF VARIANCE OF LEG LENGTH ***

Source	D F	S S	M S	F
Total	23	5838.62****		
Between Lots	5	3439.87	687.97	5.16**
Within Lots	18	2398.75	133.26	

t-test - Difference between means to be highly significant 11.74

$\bar{X}$ = Lot 1 541.50 Lot 2 535.75 Lot 3 550.00
Lot 4 538.00 Lot 5 562.50 Lot 6 567.00

Lot 5,6 leg length significantly** longer than Lots 1,2,3,4

Lot 3 " " " " " Lots 2,4

** Highly significant

*** Appendix V

**** Calculations coded by X-500

The longer body length and the leg length of the boar controls and 180 pound castrates may have some relationship to the male sex hormone through some inter-locking relationship with the growth hormone of the anterior pituitary. The growth hormone is still a controversial subject. However, Evans and Long, cited by Turner (57), prepared an extract of bovine pituitaries which was capable of augmenting growth in the rat. It was found that juvenile rats receiving daily injections of this extract exceeded the controls in body weight and in skeletal dimensions. Turner (57) also cited work done by Evans, et al, where they secured similar results with dachshunds. Smith (53) successfully hypophysectomized the immature rat which resulted in dwarfism. McCullagh and Rosmiller (35) had a case of dwarfism in which the boy grew approximately one inch a year between the ages of 12 and 19. Various forms of treatment had been tried. During nine and one half months of continuous therapy with oral methyl testosterone, (starting with 50 mg and building up to 300 mg per day), he increased in height at the rate of 3.9 inches in a year. Silberberg and Silberberg (50) found that estrogen and testosterone inhibits the proliferation of cartilage in rats and guinea pigs while gonadectomy inhibit temporarily the process of skeletal aging. The results of experiments on body growth both by androgenic and growth hormones are presented to show that there is a possible relationship between the actions of the gonads and hypophysis in their effective principles. The author has not been able to find any pertinent explanation as to why the growth hormone and the male sex hormone both produce greater skeletal dimensions.

The individual differences as evaluated by the t-test reveals that all lots had a significantly greater back fat thickness than the boar controls. Also, the two lots of barrows and the 100 pound castrates had a significantly greater back fat thickness than the 140 and 180 pound castrates as shown in Table VII. Bratzler, et al, (6) received similar results with barrows and boars. These results are also in accordance with those of Hammond and Murray (15) who studied the body proportions of different breeds of bacon pigs. They found in their work that castrated males and females had thicker back fat measurements than the corresponding entire animals while the entire female had more fat than the entire males. Their work on a number of experimental pigs produced these results as to back fat thickness:

Males.....28.5mm.

Barrows.....41.7mm.

Females.....34.3mm.

Castrated Females.....39.5mm.

Korenchevsky (25) did a very carefully controlled experiment studying the influence of cryptorchidism and castration on body weight, fat deposition and the sexual and endocrine organs of rats. His results showed a decrease in body weight but an increase in fat deposition in the castrates. He based this increase in obesity on the weight of the peritoneal fat. A summary of the data on carcass measurements will be found in Appendix C.

TABLE VII

ANALYSIS OF VARIANCE OF AVERAGE BACK FAT MEASUREMENTS*** (mm.)

Source	D F	S S	M S	F
Total	23	15317.33		
Between Lots	5	10397.33	2079.46	7.61**
Within Lots	18	4920.00	273.33	

t-test - Difference between means to be highly significant

16.81

$\bar{X}$ = Lot 1 133.2 Lot 2 128.2 Lot 3 132.2

Lot 4 108.8 Lot 5 109.0 Lot 6 73.5

Lot 1,2,3,4,5 back fat measurement significantly** greater than Lot 6

Lot 1,2,3 back fat measurement significantly** greater than Lot 4,5

** Highly significant

*** Appendix M

The results of the analysis of variance and t-test of the per cent of lean at the last rib of the rough loin between the lots are shown in Table VIII. The boar controls had a significantly higher percentage of lean than the other lots. The 180 pound castrates had a higher per cent of lean than the two lots of barrows and 100 pound castrates. Bratzler, et al, (6) found a significantly higher percentage of lean in the bellies of the boars compared with those of barrows. Illustration I shows a comparison of the eye muscle of boar No. 61 with that of the 100 pound castrate No. 31 and normal barrow control No. 13. It is evident that No. 61 had a larger eye muscle and less fat than Nos. 13 or 31. Illustration 2 shows a chop from boar No. 63 compared with chops from 2 of the 180 pound castrates. No. 63 had 5.22 square inches of lean, while Nos. 52 and 54 have 4.77 and 4.85 square inches respectively. It is interesting to note that two of the 180 pound castrates, 52 and 54, were castrated 44 days prior to slaughter. The eye muscle of the boars was of a poor quality due to a lack of marbling and firmness as well as having a darker color of lean. The fat was considerably soft. No doubt it takes somewhat more finish than that produced by the boars to produce a quality lean. A summary of data of the areas of fat and lean is presented in Appendix D.

TABLE VIII

ANALYSIS OF VARIANCE OF PER CENT OF LEAN ***

Source	D F	S S	M S	F
Total	21	2587.20		
Between Lots	5	1397.05	279.41	3.76*
Within Lots	16	1190.15	74.38	

t-test - Difference between means to be highly significant 8.83

$\bar{X}$ - Lot 1 40.91 Lot 2 39.80 Lot 3 41.60
Lot 4 45.73 Lot 5 51.20 Lot 6 61.74

Lot 6 per cent of lean significantly** higher than Lot 1,2,3,4,5

Lot 5 " " " " " " " Lot 1,2,3

* Significant

** Highly significant

*** Appendix N

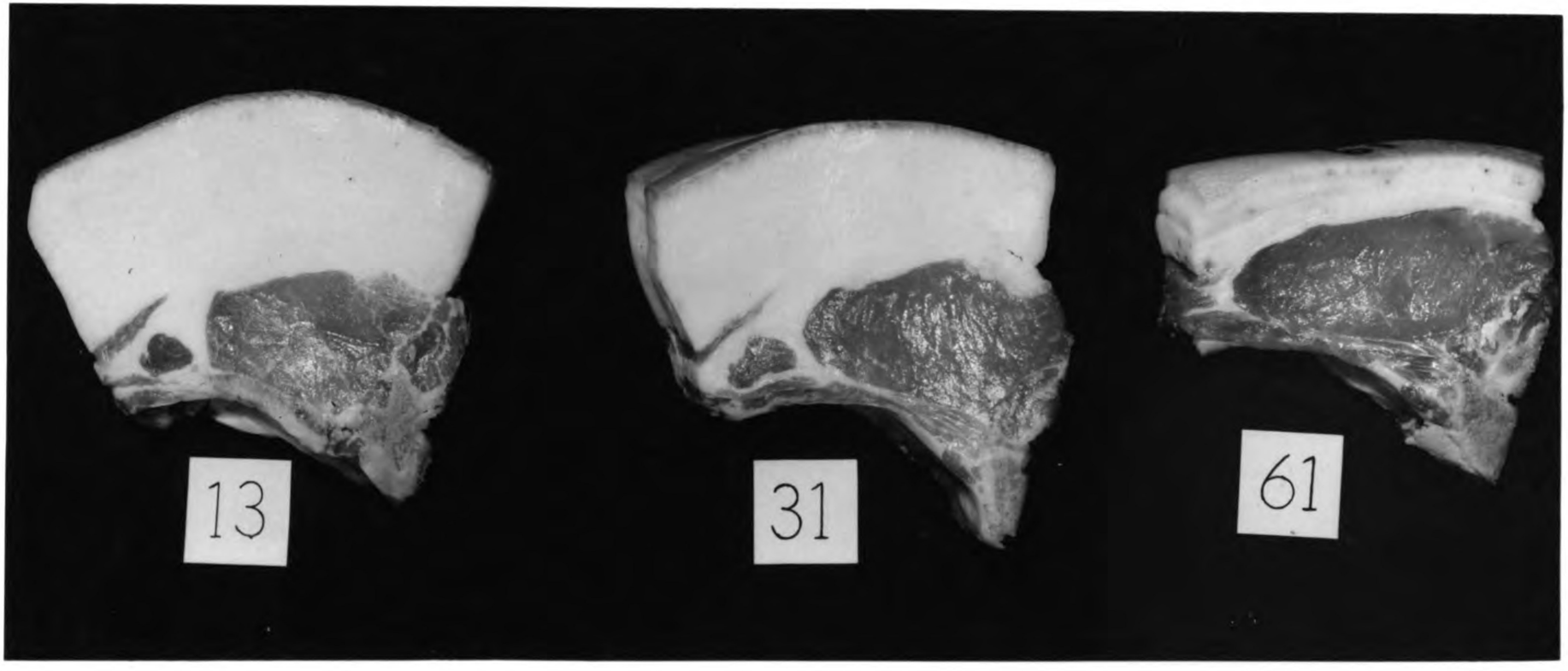


ILLUSTRATION I

No. 13 Barrow control
No. 31 100 pound castrate
No. 61 Boar control

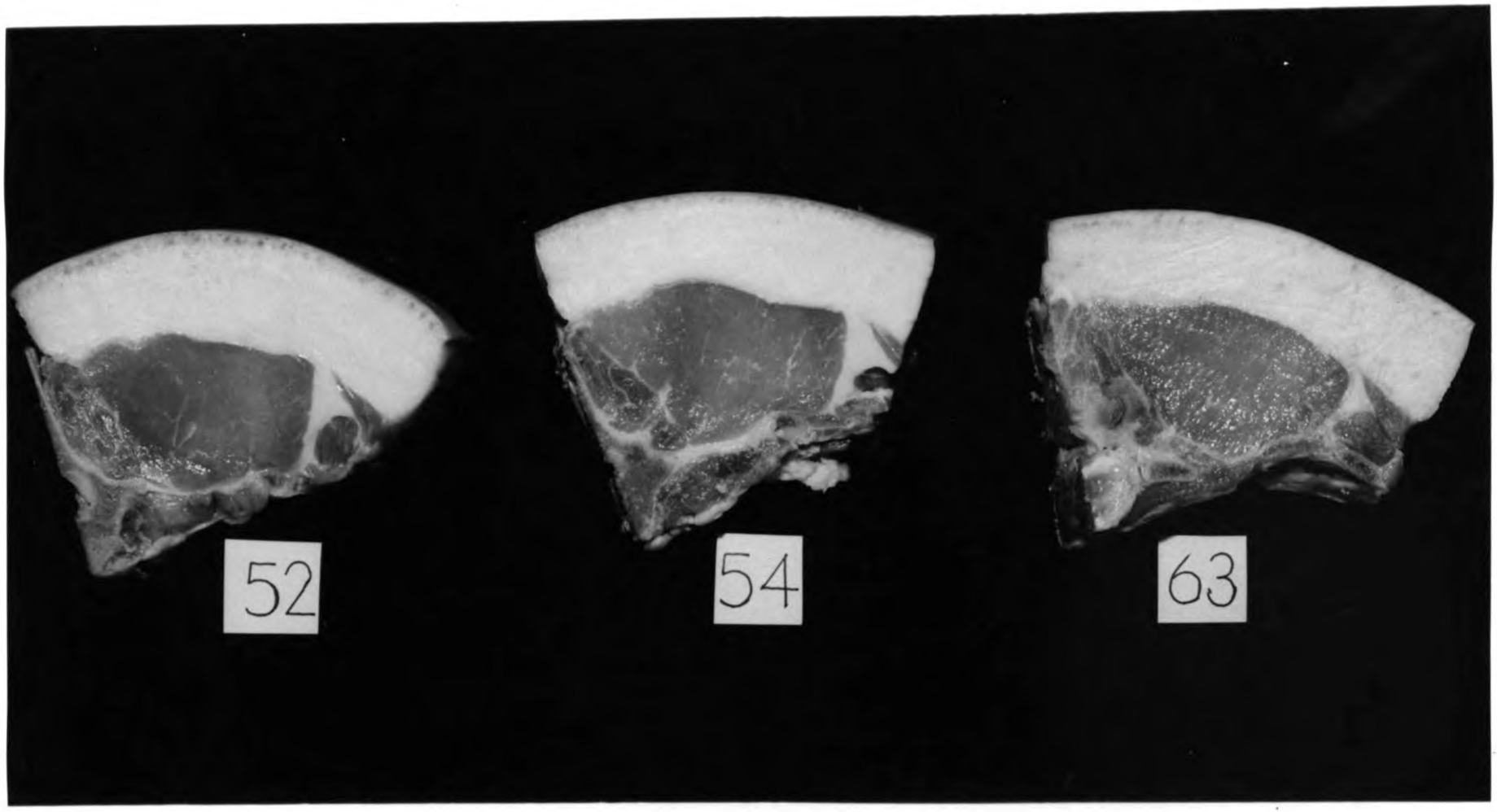


ILLUSTRATION II

No. 52 180 pound castrate
No. 54 180 pound castrate
No. 63 Normal Boar

The views by various experimentors explaining less fat and more muscle are rather diversified. However, there seems to be the general viewpoint that there is a definite protein anabolic effect by the androgens. Kochakian and Murlin (21) reported that male hormone extracts prepared from medical student urine produced a marked reduction in the urinary nitrogen excretion of thin and fat castrated dogs fed a constant diet. They assumed that the retained nitrogen had been incorporated into permanent tissue structures while the nitrogen lost had not been incorporated as yet into such tissue and probably was present in the body as a reserve protein. Kochakian and Stettner (24) administered both the growth hormone of the anterior pituitary and testosterone pellets to the mouse. Both hormones increased the total amount of protein and water in the carcass and organs but a decrease in fat. Each hormone separately produced the same results with the growth hormone showing slightly higher results.

The nitrogen and water retention can further be substantiated by Kenyon, et al, (20) who treated 4 eunuchoid patients with testosterone propionate and produced a decline in urinary nitrogen, urinary sodium and a gain in weight due largely to the water held in association with the sodium and nitrogen. Kenyon, et al, (20) called attention to the resemblances between the action of testosterone propionate on electrolyte excretion and that of certain of its chemical steroid relatives among the sex and adrenal hormones.

McKenzie, et al, (36) did an extensive study of the reproductive organs of the boar. They state "the large volume of semen, the extremely great number of sperm per ejaculate, the relatively long time required for ejaculation and the chemical composition of the semen give some indication of the heavy drain on the protein, mineral and energy supply of the boar during excessive sexual activity." Kochakian, et al, (23) made the statement that the nitrogen retained is much more than can be accounted for by the increase in size of the seminal vesicles and prostates who studied the effect of testosterone propionate on the recovery of fasting rats.

Viewing this fact, of less fat and more lean in the boars and late castrates, from another aspect, Abels, et al, (1) administered testosterone propionate to man and at first an absolute and relative hypoproteinemia resulted. The decrease in serum protein took place despite the fact that nitrogen was retained. They explain that nitrogen was diverted entirely to tissue-protein fabrication at the expense of serum protein. This is in line, more or less, with Leathem (29) who found that castration for 20 to 25 days increased total plasma protein concentration in adult rats due to an increase in plasma globulin. Testosterone propionate prevented the plasma protein increase induced by castration.

Papanicolau and Falk (43), previously cited, found that the androgenic hormone had a stimulating effect upon the muscle producing enlargement in guinea pigs. Sanford, et al and McCullagh, et al, cited by Novak (41), found an increase in basal metabolic rate on eunuchoids with testosterone propionate and methyl testosterone treatments. Bugbee and Simond (7) experimenting on dogs, failed to show that castration in itself reduced the basal metabolic rate. They believed that such factors as physic stimulation, lack of muscular exercise, adaptation of the nervous system and endocrine gland system call for less metabolism than active life.

The per cent primal cut out based on carcass and live weights was treated statistically for analysis of variance and t-test. It is evident from Table IX and X that the boars had a significantly higher live and carcass cut out than the other lots. The 180 pound castrates had a significantly higher live cut out than Lots 1, 2, 3 and 4 while the 180 and 140 pound castrates revealed a significantly higher carcass cut out than Lots 1, 2, and 3. This may be explained by the fact that the boars and 180 pound castrates had considerably less fat, thus proportionately yielding a higher per cent of primal cuts. A summary of the primal cut yield of each cut for all hogs is presented in Appendix E.

TABLE X

ANALYSIS OF VARIANCE OF PER CENT CARCASS CUT OUT ***

Source	D F	S S	M S	F
Total	23	249.026		
Between Lots	5	195.162	39.03	13.04**
Within Lots	18	53.864	2.99	

t-test - Difference between means to be highly significant 1.76

$\bar{X}$ - Lot 1 64.86 Lot 2 64.63 Lot 3 65.80
Lot 4 68.04 Lot 5 68.79 Lot 6 72.86

Lot 6 per cent carcass cut out is highly significantly greater than Lots 1,2,3,4 and 5.

Lot 4,5 per cent carcass cut out is highly significantly greater than Lots 1,2 and 3.

** Highly Significant

*** Appendix P

It was previously mentioned that both the producer and consumer would benefit materially from hogs that yield a higher percentage of the lean or muscled cuts. Therefore, an opportunity was given here to calculate the relationship between the area of lean in the loin at the last rib with the live and carcass primal cut yield, each being calculated separately.

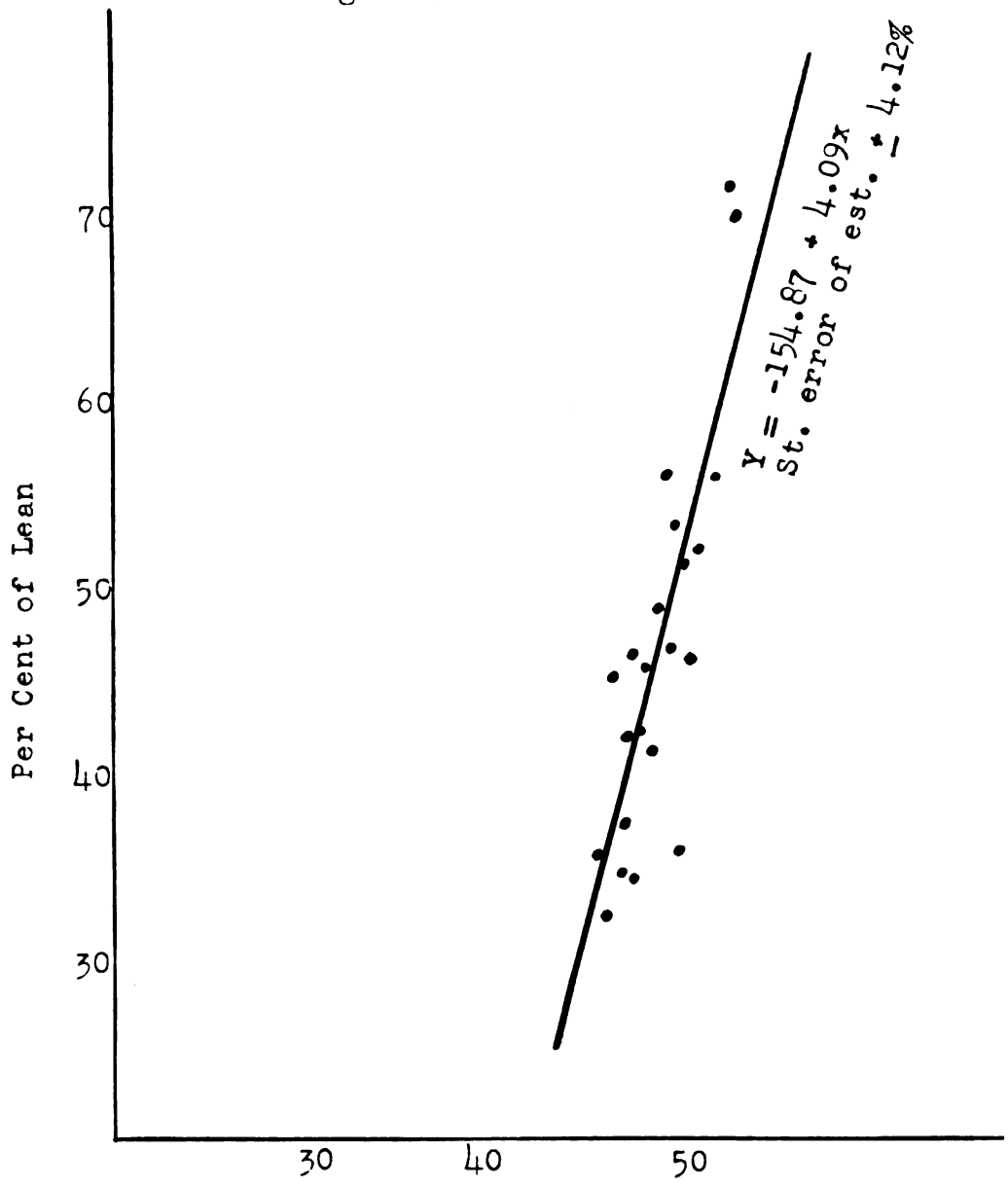
Figure 1 is a scatter diagram showing the relationship between the per cent of lean and live weight cut out. The correlation coefficient is + .8186 with a standard error of ± .0738. The equation for establishing the regression line is Y= -154.87 + 4.09 and the standard error of estimate for Y is 4.12 per cent.

Figure 2 is a scatter diagram showing the relationship between the per cent of lean and carcass cut out. The correlation coefficient is + .8550 with a standard error of ± .0602. The equation for establishing the regression line is Y= -131.44 + 2.64 and the standard error of estimate for Y is 5.27 per cent.

Lindquist's (32) table of correlation coefficient required for significance at 1 per cent level for a sample size of 22 requires a + .535 correlation coefficient. Therefore, it can be concluded that these values are highly significant.

Engleman, et al, (12) conducted a study on hog carcasses at the George A. Hormel and Company packing plant, Austin Minnesota, whereby they used various statistical analyses, combining percentage of the high value cuts and the fat trimmings and termed it the "index of lean".

Figure 1



Per Cent Live Weight Cut Out *

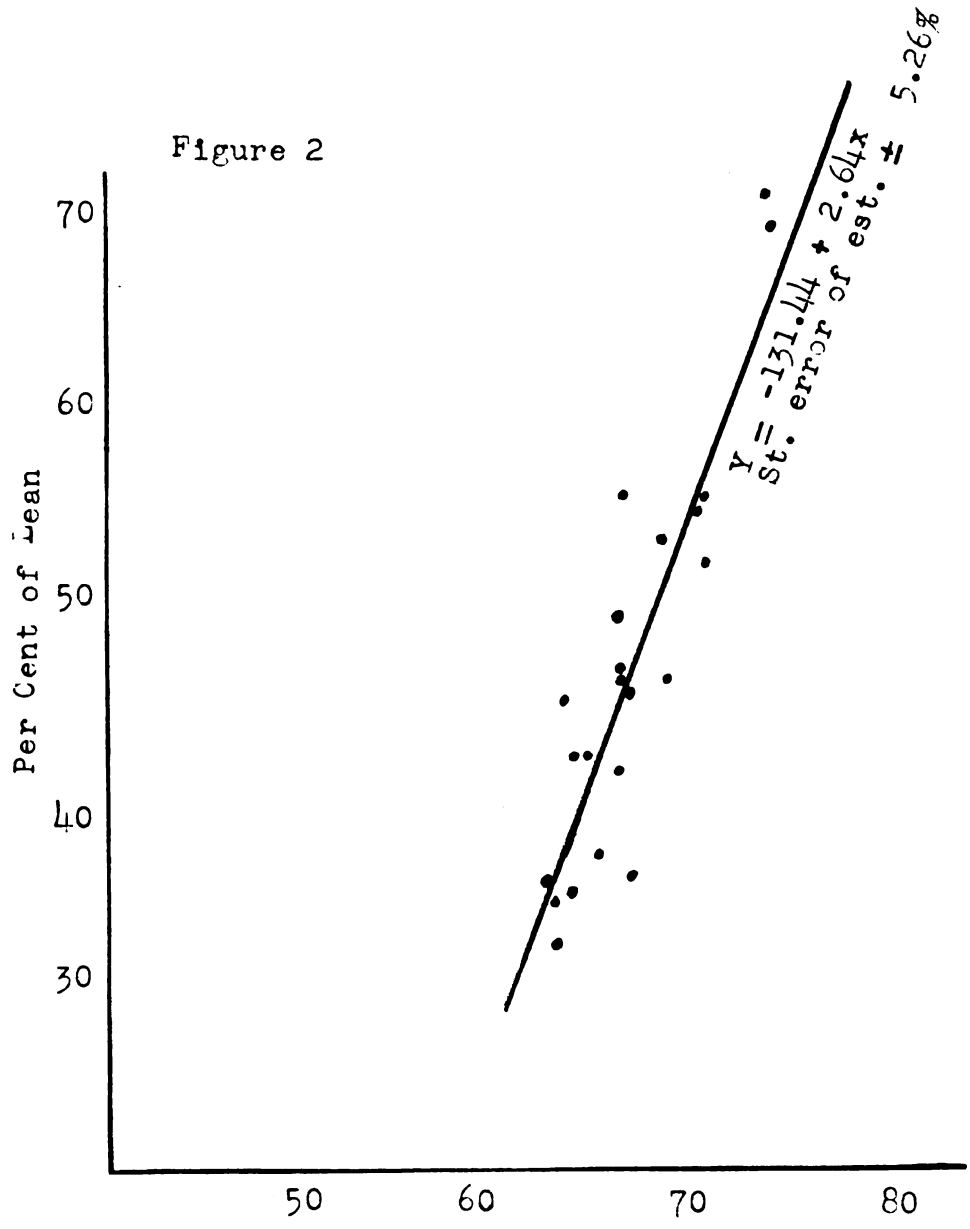
$\underline{N} = 22$
$\underline{X} = 49.23$
$\underline{Y} = 46.23$

ryx = + .8186

St. error of r = ± .0738

* Appendix H

Figure 2



N = 22
$\bar{X}$ = 67.30
$\bar{Y}$ = 46.23

ryx = + .855

St. error of r = ± .0602

* Appendix I

Acceptability and Cooking Tests

The acceptability and cooking tests were conducted by the Foods and Nutrition Department of Michigan State College. The methods used have been previously mentioned. Analysis of variance on the acceptability by the panel tasting committee revealed that there was a significant difference between the lots at the 5 per cent level only. However, the t-test using the table for t at 1 per cent level, Lindquist (32) showed that all the lots have a significantly better acceptability than the boar controls as shown by Table XI. Boar number 61 scored a low of 2 and had a decided "off-odor" throughout the cooking period and the odor carried over into the finished product. The same was true for boar 62. Members of the Animal Husbandry Department also found an "off-odor" or characteristic "boar odor" while cooking these chops at home. Pieces of fat from the boars which were cooked in the meats laboratory also produced this odor. See Appendix F for detailed results of acceptability tests.

The work of German investigators on the odor of boar meat has been reviewed. Gereke (13) reported that the parotid gland is the carrier of the odor and is in relationship with the sex hormone. Other workers have studied the sex endocrine relationship with that of the submaxillary gland on mice. The parotid gland covers the submaxillary gland in the pig in front and below the external ear,

Sisson and Grossman (52), and both function as a salivary gland. It may be pertinent here to review the work done on rats.

Lacassagne, cited by Grad and LeBond, (14) found that the serous tubules (in addition with the mucous acini constitute the secreting part of submaxillary gland) were far better developed in male than in female mice. Later he showed that extirpation of the testes produced the atrophy of these tubules while testosterone injections restored them to a normal condition. Frantz and Kirschbaum, also cited by Grad and LeBond, (14) went so far as to consider the serous tubules as a more sensitive indicator than the seminal vesicles as an assay method for testosterone. Grad and LeBond (14) in their experiment on rats found that both the thyroid and testes were involved in the control of the submaxillary gland. Treatment of the atrophied submaxillary gland with either testosterone propionate or thyroxine had little or no effect on the gland. However, injection of both hormones simultaneously restored the gland to normal. Korenchevsky (25) found that the thyroids atrophy due to castration.

The results of the cooking losses are presented in Appendix G. The National Live Stock and Meat Board (8) did studies on cooking losses in bacon. They found that lean bacon, 60 per cent lean and 40 per cent fat, lost 65 per cent of its weight in frying. Fat bacon, 40 per cent

lean and 60 per cent fat, lost 79 per cent of its weight in frying. There seemed to be no appreciable difference between the greater lean chops of the boars and the fatter chops of the barrows and various weight castrates in the results of this study.

TABLE XI

ANALYSIS OF VARIANCE OF ACCEPTABILITY OF PORK CHOPS ***

Source	D F	S S	M S	F
Total	23	10.40		
Between Lots	5	5.26	1.052	3.678*
Within Lots	18	5.14	.286	

t-test - Difference between means to be highly significant .54

$\bar{X}$ = Lot 1 4.68 Lot 2 4.50 Lot 3 4.52
Lot 4 4.75 Lot 5 4.68 Lot 6 3.28

Lot 1,2,3,4,5 acceptability significantly** better than Lot 6.

* Significant

** Highly Significant

*** Appendix Q

Accessory Sex Glands and Kidney Weights

An analysis of the kidney weights revealed that the boar controls had a significantly heavier kidney than any of the other lots. It is interesting to note that the 180 pound castrates had a significantly heavier kidney weight than either the barrows or 100 pound castrates as shown in Table XII. These results have not been explained in any of the literature. Leathem (29) found that testosterone propionate increased the kidney weight of rats in which the food intake was restricted, and equally effective in thiourea-fed and normal rats. Kochakian and Settner, (24) experimenting with castrated mice, showed an increase in kidney weight with the growth hormone but a much greater increase with androgen administration. Selye (49) showed similar results; however, Wrete (60) found no increase in the kidney size of androgen-treated rabbits.

TABLE XII

ANALYSIS OF VARIANCE OF KIDNEY WEIGHTS ***

Source	D F	S S	M S	F
Total	23	32804		
Between Lots	5	18382	3676.4	4.59**
Within Lots	18	14422	801.2	

t-test - Difference between means to be highly significant 28.82

$\bar{X}$ - Lot 1 257.0 Lot 2 268.2 Lot 3 274.0
Lot 4 282.7 Lot 5 308.5 Lot 6 339.0

Lot 6 kidney wt. significantly** heavier than Lots 1,2,3,4,5.

Lot 5 " " " " " Lots 1,2,3.

** Highly Significant

*** Appendix R

It is evident from Table XIII that there is a significant difference between the lots of the weights of the seminal vesicles and Cowper's glands. The boars were by far the heaviest and the weight decreases as the weight of castration decreases. Illustration III shows a comparison of the seminal vesicles and Cowper's gland from a normal boar control and a 180 pound castrate which was castrated 44 days prior to slaughter. Baker (4) studying the influence of age on castration of pigs observed that the seminal vesicles and Cowper's glands were much larger in pigs castrated at 200 days than those at 100 days. There was little or no difference in the size of these glands in pigs castrated at 50 and 100 days. He reasoned that there was a change at about 100 days of age, rendering the seminal vesicles and Cowper's glands progressively more and more sensitive to the male hormone. Boars slaughtered at the same time had much larger seminal vesicles and Cowper's glands. A summary of his results, which are comparable to this study, are presented in table form.

TABLE XIII

ACCESSORY SEX GLANDS AND KIDNEY WEIGHTS (in grams)

Lot No.	Hog No.	Seminal Vesicle Plus Prostate	Cowper's Gland	Kidney	Testes	No. Days Between Castration and Slaughter
	11	0.5	2.7	278		117
1	12	1.2	2.0	230		117
	13	1.5	3.5	282		135
	14	1.5	2.1	238		135
	21	1.1	3.2	305		117
	22	1.8	3.2	265		119
2	23	1.5	2.7	263		119
	24	2.4	3.3	240		117
	31	3.7	5.0	270		81
	32	5.9	13.1	270		57
3	33	5.5	10.0	290		62
	34	7.9	8.8	266		63
	41	15.4	18.5	275		41
	42	15.0	15.9	305		37
4	43	12.6	20.9	268		48
	44	7.2*	14.4	283		34
	51	9.3*	57.6	287		21
	52	24.7	61.0	294		44
5	53	9.1*	13.7*	307		27
	54	31.8	49.2	346		44
	61	380	210	320	575	
	62	443	259	403	345	Boar
6	63	437	135.1	343	475	Controls
	64	85*	112	290	357	

* Loss of fluid.

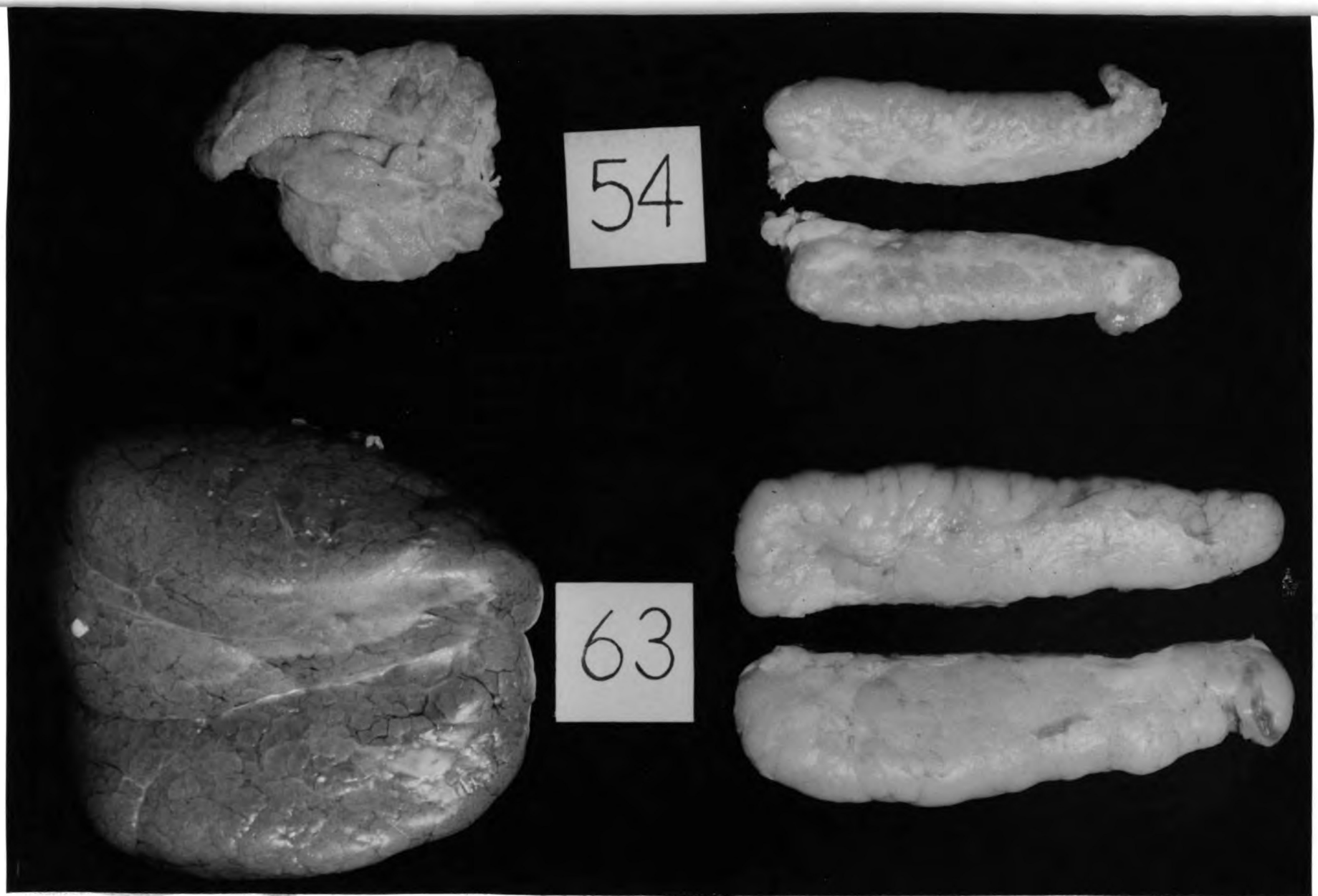


ILLUSTRATION III
No. 54 180 pound castrate
No. 63 Boar control

TABLE XIV

WEIGHT OF SEMINAL VESICLES AND COWPER'S GLANDS

OF PIGS CASTRATED AT DIFFERENT AGES *

Age at Castration (days)	Age When Slaughtered (days)	Body Weight (pounds)	Wt. of Sem. Ves. (gram)	Wt. of Cowper's Gl. (gram)
50	302	97.2	1.44	2.53
100	301	85.5	1.46	2.95
200	301	85.0	9.00	12.60
Not Castrated	302	89.0	317.00	117.00

* Baker's Data (4)

Phillips and Andrews cited by McKenzie (36) found that the first marked development of the germinal epithelium occurred at about 84 days of age in the boar while spermatozoa were found at 174 days. At this age, the male sex hormone is secreted in sufficient quantity to render a marked growth of the accessory glands, or they are sensitized to the androgenic substance simultaneously with the initiation of spermatogenesis. In this study the boars were observed to be rutting and practising pederasty at about four months of age.

At the time of slaughter, the prepuce was examined. In the case of the barrows of Lot 1, the preputial sac had atrophied with very little necrotic tissue present. Two barrows of Lot 2 showed a little bloody fluid indicating involution was almost complete. The 100 and 140 pound castrates had some bloody fluid and necrotic tissue indicating partial involution. Upon examining two of the 180 pound castrates slaughtered 3 and 4 weeks after castration, much bloody fluid and free epithelial tissue were observed and was in the process of involution. The preputial sac of the boar controls showed healthy epithelial tissue lining the sac and the lumen contained a milky fluid. The 180 pound castrates and the boar controls produced a "strong pig pen odor" while the other lots had a "strong urine odor". McKenzie (36) stated that fresh semen has no odor except when contaminated with urine or contents of the preputial

pouch. He further mentioned that the preputial pouch contained decomposing urine and cellular debris which have a disagreeable odor and constitute the characteristic sexual odor of the boar.

Lot 2 barrows were implanted with one testosterone propionate pellet each at the time of castration. See Table I. Recovery was successful in the case of barrows 21 and 22, and had a total absorption of 60.1 and 57.4 mg. respectively. The results of this study do not reveal any significant difference between these testosterone propionate implanted barrows compared with the barrow controls. Apparently, the absorption was not great enough. Other workers have been successful with this method. Kochakian (22) studied the rate of absorption and effect of testosterone propionate pellets implanted in mice. In his results, he stated that the testosterone propionate pellet is an effective means of providing a continuous excess supply of the androgen to the mouse which produces a substantial increase in size of seminal vesicle, prostate and kidney weight. Mark and Biskind (34) in working with implanted testosterone propionate pellets reported that about 59 micrograms of testosterone propionate were absorbed per day and the rate was not effected by the site of introduction or the physiological need of the animal. Eidelsberg, et al, (11) in studying the metabolic effects of implants stated that the "life" of

testosterone propionate pellets may be demonstrated by the urinary excretion of nitrogen, chlorides and phosphates. Bratzler, et al, (6) administered testosterone propionate dissolved in corn oil by intramuscular injections to three barrows averaging 257 pounds. They used the jowl as the site of injection in two of the barrows and the fore leg in the case of the other. Fifty mgs. were administered twice weekly to each pig. After a total dose of 350 mgs., the pigs were slaughtered and the accessory organs removed and weighed. The results produced a significant increase in these atrophied glands. Probably this would have been a more effective method in this study. If it were not so expensive, methyl testosterone could have been administered orally and possibly would have produced more accurate results.

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CONCLUSIONS

1. Carcass comparisons of the boars and barrows of different castration weights showed that the boars had a higher per cent of lean in the loin, had a thinner back fat, longer body and leg length and a higher live and carcass primal cut yield. There was no significant difference in the daily gain.

2. Acceptability tests showed that the boars had a definite "off flavor". Cooking loss showed no conclusive difference between the boars and different castration weights.

3. A correlation coefficient of + .818 ± .0602 and + .855 ± .0738 was obtained between the per cent area of lean and live and carcass primal cut yield respectively.

4. The accessory sex glands and kidney weight of the boars were heavier and the weights decreased as the different weights of castration decreased.

5. There was no significant difference in sex accessory gland and kidney weights between normal and testosterone propionate pellet implanted barrows due to poor absorption.

6. Results of this experiment were compared with other investigators showing evidence of the anabolic actions of androgenic substances and the interrelationships among the various endocrine glands.

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APPENDIX

APPENDIX A

SUMMARY OF DATA - FEED CONSUMED, GAIN, WEIGHT AT CASTRATION AND WEIGHT OF TESTOSTERONE PROPIONATE PELLETS

Lot No.	Hog No.	Initial Wt. (lbs.)	Final Wt. (lbs.)	Total Gain (lbs.)	Total Pig Days	Gain Per Day (lbs.)
	11	40	226	186	117	1.59
1	12	47	220	173	117	1.48
	13	36	221	185	135	1.37
	14	43	212	169	135	1.25
Average		41.50	219.75	178.25	126	1.41
	21	39	222	183	117	1.56
2	22	36	212	176	119	1.48
	23	39	217	178	119	1.50
	24	47	230	183	117	1.56
Average		40.25	220.25	180.0	118	1.52
	31	43	215	172	135	1.27
3	32	43	212	169	119	1.42
	33	43	215	172	110	1.56
	34	37	223	186	117	1.59
Average		41.50	216.25	174.75	120	1.46
	41	37	213	176	110	1.60
4	42	37	210	173	119	1.45
	43	46	230	184	117	1.57
	44	42	216	172	103	1.67
Average		40.50	217.25	176.25	112	1.57
	51	46	224	178	103	1.73
5	52	38	238	200	160	1.25
	53	34	218	184	110	1.67
	54	39	231	192	160	1.20
Average		39.25	227.25	188.5	133	1.42
	61	43	213	170	135	1.26
6	62	38	224	186	143	1.30
	63	35	235	200	160	1.25
	64	43	216	173	119	1.45
Average		39.75	224.25	182.25	139	1.31

APPENDIX A - Continued

SUMMARY OF DATA - FEED CONSUMED, GAIN, WEIGHT AT CASTRATION AND WEIGHT OF TESTOSTERONE PROPIONATE PELLETS

Lot No.	Hog No.	Wt. At Castration (lbs.)	Total Feed Consumed By Lots (lbs.)	Pounds of Feed Per 100 Pounds of Gain	Wt. of Testosterone Pellets Implanted (mgs.)	Wt. of Testosterone Pellets Recovered (mgs.)
	11	40				
1	12	47	2714	381		
	13	36				
	14	43				
Average		41.50				
	21	39			193.1	133.0
2	22	36	2733	380	190.4	133.0
	23	39			198.2	-
	24	47			192.0	-
Average		40.25			193.4	133.0
	31	100				
3	32	106	2768	396		
	33	110				
	34	106				
Average		105.50				
	41	136				
4	42	137	2527	358		
	43	144				
	44	154				
Average		142.27				
	51	187				
5	52	181	2768	367		
	53	173				
	54	180				
Average		180.25				
	61					
6	62	Boar	2799	384		
	63	Controls				
	64					
Average						

APPENDIX B

SUMMARY OF DATA OF DRESSING PER CENT

Lot No.	Hog No.	Off Feed Wt. (lbs.)	Slaughter Wt. (lbs.)	Shrinkage (lbs.)	Per Cent Shrinkage	Cold Carcass Wt. (lbs.)	Dressing Per Cent
	11	226	209	17	7.5	155.4	73.35
1	12	220	212	8	3.6	155.2	73.21
	13	221	209	12	5.4	154.4	74.35
	14	212	204	8	3.8	151.7	74.36
Average		219.75	208.50	11.25	5.08	154.18	73.95
	21	222	205	17	7.6	150.8	73.56
2	22	212	197	13	6.1	148.4	74.57
	23	217	203	14	6.4	149.0	73.40
	24	230	215	15	6.5	157.2	73.12
Average		220.25	205.50	14.75	6.65	151.35	73.65
	31	215	207	8	3.7	155.3	75.02
3	32	212	202	10	4.7	145.9	72.23
	33	215	206	9	4.2	151.3	73.40
	34	223	205	18	8.1	153.4	74.80
Average		216.25	205.00	11.25	5.00	151.47	73.98
	41	213	202	11	5.2	144.0	71.29
4	42	210	200	10	4.8	143.1	71.55
	43	230	216	14	6.1	156.4	72.41
	44	216	200	16	7.4	142.5	71.20
Average		217.25	204.50	12.75	5.88	151.48	71.63
	51	224	206	18	8.0	149.5	72.57
5	52	238	216	22	9.2	158.5	73.38
	53	218	204	14	6.4	151.8	74.41
	54	231	216	15	6.5	154.0	71.30
Average		227.25	210.50	17.25	7.53	153.45	72.90
	61	213	201	12	5.6	143.3	71.29
6	62	224	214	10	4.5	153.0	71.49
	63	235	221	14	5.9	163.0	73.76
	64	216	206	10	4.6	148.2	71.94
Average		224.25	210.50	11.50	5.15	151.88	72.15

APPENDIX C

SUMMARY OF DATA OF CARCASS MEASUREMENTS (in mm.)

Lot No.	Hog No.	Carcass Length	Leg Length	Back Fat 1st Rib	Back Fat 7th Rib	Back Fat Last Rib	Back Fat Last Lumbar	Average Back Fat
	11	715	530	58	47	38	44	46.7
1	12	716	539	59	48	31	39	43.0
	13	733	538	53	45	37	46	45.3
	14	745	559	56	45	33	39	42.7
Average		727.25	541.5	56.5	46.25	34.75	42	44.41
	21	729	528	66	41	34	39	46.3
2	22	761	552	52	39	31	30	37.7
	23	717	545	47	44	30	39	38.7
	24	731	518	63	53	39	43	48.3
Average		734.40	535.75	57.0	44.25	33.50	37.75	42.75
	31	729	554	53	49	38	40	43.7
3	32	728	555	48	41	28	33	36.3
	33	715	551	68	59	43	44	51.7
	34	736	540	60	54	35	39	44.7
Average		727.00	550.00	57.25	50.75	36.0	39.00	44.08
	41	749	538	47	36	30	28	35.0
4	42	755	550	51	35	26	32	36.3
	43	755	534	48	48	33	37	39.3
	44	742	530	48	38	25	30	34.3
Average		750.25	538.00	48.5	39.25	28.50	31.75	36.25
	51	740	578	55	45	33	29	39.0
5	52	758	569	46	34	24	30	33.3
	53	751	543	56	41	34	35	41.7
	54	755	560	44	36	27	23	31.3
Average		751.00	562.50	50.2	39.0	29.50	29.25	36.33
	61	769	578	43	24	17	17	25.7
6	62	793	562	37	21	13	14	11.3
	63	783	567	45	34	25	22	30.7
	64	788	561	43	30	21	27	30.3
Average		783.25	567.00	42.0	27.25	19.0	20.0	24.5

APPENDIX D

SUMMARY OF DATA OF AREAS OF FAT AND LEAN IN PORK CHOP (sq. in.)

Lot No.	Hog No.	Total Lean	Total Fat	Total Area Fat & Lean	Per Cent Lean
	11	3.61	5.00	8.61	41.93
1	12	3.26	7.00	10.26	31.77
	13	4.33	6.09	10.42	41.55
	14	4.23	5.51	8.74	48.40
Average		3.86	5.65	9.51	40.73
	21	3.35	6.47	9.82	34.11
2	22	4.86	5.83	10.69	45.46
	23	4.05	5.03	9.08	44.60
	24	3.36	6.23	9.59	35.04
Average		3.91	5.89	9.80	39.87
	31	4.35	5.07	9.42	46.18
3	32	4.29	5.23	9.52	45.06
	33	3.87	5.59	9.46	40.91
	34	3.10	5.95	9.05	34.25
Average		3.90	5.46	9.36	41.68
	41	4.39	3.65	8.04	54.60
4	42	4.02	4.73	8.75	45.94
	43	3.65	6.31	9.96	36.65
	44	-	-	-	-
Average		4.02	4.90	8.92	45.08
	51	-	-	-	-
5	52	4.77	4.29	9.06	52.65
	53	4.17	4.99	9.16	45.52
	54	4.85	3.90	8.75	55.43
Average		4.60	4.39	8.99	51.13
	61	6.17	2.53	8.70	70.92
6	62	5.55	2.46	8.01	69.29
	63	5.22	4.23	9.45	55.24
	64	4.64	4.37	9.01	51.50
Average		5.40	3.40	8.79	61.36

APPENDIX E

SUMMARY OF DATA - PRIMAL CUT YIELD (in pounds)

Lot No.	Hog No.	Skinned Ham	Trimmed Belly	Trimmed Shoulder	Trimmed Loin	Total Wt.	% Live Wt. Cut Out	% Carcass Cut Out
	11	27.6	27.0	25.2	21.1	100.9	48.28	64.92
1	12	25.8	26.0	25.9	20.5	98.2	46.32	63.27
	13	26.4	27.5	25.3	20.8	100.0	47.84	64.76
	14	28.0	23.1	26.7	23.1	100.9	49.46	66.51
Average						100	47.96	64.86
	21	27.6	23.3	25.2	21.3	97.4	47.51	64.59
2	22	27.8	22.6	25.8	23.6	99.8	50.15	67.25
	23	25.9	24.2	23.9	21.2	95.2	46.90	63.89
	24	26.4	24.4	26.0	21.6	98.7	45.90	62.79
Average						97.78	47.57	64.60
	31	29.2	24.8	26.1	23.3	103.4	49.95	66.58
3	32	28.5	23.1	24.8	21.4	97.8	48.41	67.03
	33	26.5	26.8	25.3	21.9	100.5	48.79	66.42
	34	25.5	27.6	24.0	19.8	96.9	47.27	63.16
Average						99.60	48.61	65.78
	41	27.8	22.1	28.1	24.0	102.0	50.49	70.83
4	42	26.9	21.2	27.2	20.2	95.5	47.75	66.73
	43	29.1	23.9	27.4	21.8	102.2	47.31	65.34
	44	28.3	23.0	27.1	20.3	98.7	49.35	69.26
Average						99.60	48.70	67.98
	51	29.7	22.1	28.7	22.7	103.2	50.10	69.03
5	52	32.2	23.0	29.4	24.8	109.4	50.65	69.02
	53	27.7	24.2	26.2	23.6	101.7	49.85	66.99
	54	32.0	23.1	27.8	25.1	108.0	50.00	70.12
Average						105.58	50.15	68.80
	61	31.4	20.5	30.5	24.4	106.8	74.52	70.92
6	62	34.2	20.5	33.4	26.4	114.5	74.83	69.29
	63	31.1	25.3	32.8	26.5	115.7	70.98	55.24
	64	30.3	21.2	30.5	23.4	105.4	71.12	51.50
Average						110.60	72.54	72.82

APPENDIX F

ACCEPTABILITY TESTS ON PORK CHOPS

Lot No.	Hog No.	Appearance			Aroma			Flavor-Fat			Flavor-Lean		
		1	2	Av.	1	2	Av.	1	2	Av.	1	2	Av.
1	11	5.4	5.2	5.3	5.2	5.0	5.1	5.0	5.2	5.1	5.4	5.0	5.2
	12	5.2	5.2	5.2	4.8	5.0	4.9	4.6	5.6	5.1	5.0	5.0	5.0
	13	4.8	5.8	5.3	4.0	5.3	4.65	5.3	5.5	5.4	5.3	5.0	5.15
	14	4.8	4.8	4.8	3.8	4.5	4.15	4.8	5.3	5.05	5.0	4.8	4.9
2	21	3.5	*	3.5	1.8	*	1.8	2.0	*	2.0	2.5	*	2.5
	22	5.8	5.0	5.4	5.6	4.6	5.1	5.8	4.6	5.2	5.2	3.8	4.5
	23	5.2	5.8	5.5	5.0	4.3	4.65	4.8	5.3	5.05	5.4	4.8	5.1
	24	5.4	4.8	5.1	5.0	4.0	4.5	5.6	5.3	5.45	5.0	5.0	5.0
3	31	5.5	5.4	5.45	5.5	4.4	4.95	5.5	4.8	5.15	5.5	4.6	5.05
	32	4.8	3.5	4.15	4.0	4.0	4.0	4.8	3.8	4.3	4.8	4.0	4.4
	33	5.6	5.8	5.7	4.8	4.5	4.65	4.8	4.5	4.65	5.0	4.3	4.65
	34	5.4	5.0	5.2	4.7	4.0	4.35	5.4	4.6	5.0	5.9	4.6	5.25
4	41	4.8	5.0	4.9	4.8	5.0	4.9	5.8	5.2	5.5	5.0	5.0	5.0
	42	5.0	5.4	5.2	5.0	5.4	5.2	4.6	5.4	5.0	5.0	5.8	5.4
	43	5.4	4.6	5.0	5.0	4.8	4.9	4.8	5.2	5.0	5.4	4.8	5.1
	44	5.0	4.8	4.9	5.0	5.0	5.0	5.0	5.4	5.2	4.8	4.6	4.7
5	51	5.9	5.7	5.8	4.9	4.9	4.9	5.6	4.9	2.25	5.7	5.3	5.5
	52	6.0	6.0	6.0	3.9	4.9	4.4	4.4	5.4	4.9	5.1	5.4	5.25
	53	5.0	5.4	5.2	4.4	4.6	4.5	4.4	4.8	4.6	4.2	5.0	4.6
	54	5.6	5.2	5.4	4.6	4.6	4.6	5.3	5.0	5.15	5.9	5.4	5.65
6	61	3.0	4.2	3.6	2.0	3.6	2.8	2.3	4.4	3.85	3.0	4.6	3.8
	62	4.4	4.8	4.6	3.8	3.8	3.8	4.6	4.8	4.7	4.0	4.2	4.1
	63	4.6	5.4	5.0	3.4	4.0	3.7	4.2	4.8	4.5	3.8	4.6	4.2
	64	5.0	5.2	5.1	4.6	4.2	4.4	4.4	4.6	4.5	4.4	4.6	4.5

* Only one cooking.

APPENDIX F - Continued

ACCEPTABILITY TESTS ON PORK CHOPS

Lot No.	Hog No.	Juiciness			Tenderness			Texture			Gen'l. Conc.		
		1	2	Av.	1	2	Av.	1	2	Av.	1	2	Av.
	11	4.4	4.2	4.3	5.2	4.8	5.0	5.4	5.2	5.3	5.0	4.6	4.8
1	12	4.4	4.2	4.3	5.0	5.0	5.0	4.6	5.0	4.8	4.6	4.8	4.7
	13	4.5	3.3	4.4	4.5	3.8	4.15	5.0	4.5	4.75	5.0	4.8	4.9
	14	4.3	3.5	4.4	4.0	3.3	3.65	4.5	4.3	4.4	4.3	4.3	4.3
	21	3.5	*	3.5	4.0	*	4.0	4.0	*	4.0	2.0	*	2.0
2	22	4.6	4.0	4.3	4.8	5.4	5.1	5.0	4.4	4.7	5.2	4.0	4.6
	23	3.6	3.0	3.3	4.2	4.0	4.1	4.4	4.3	4.35	4.4	4.0	4.2
	24	3.2	4.3	3.75	4.2	5.0	4.6	4.6	5.3	4.95	4.6	4.3	4.45
	31	4.8	3.6	4.2	5.5	5.0	5.25	5.3	5.0	5.15	5.3	4.4	4.85
3	32	3.8	4.0	3.9	3.8	3.8	3.8	4.3	4.5	4.4	4.0	3.8	3.9
	33	3.8	3.8	3.8	4.8	5.3	5.05	4.4	4.8	4.6	4.8	4.5	4.65
	34	5.0	4.2	4.6	5.0	5.2	5.1	5.1	4.8	4.95	5.3	4.2	4.75
	41	5.0	3.6	4.3	5.3	5.0	5.15	5.3	4.8	5.05	4.8	4.8	4.8
4	42	3.9	3.8	3.85	4.6	4.8	4.7	4.3	5.0	4.65	4.0	4.8	4.4
	43	3.8	3.6	3.7	5.2	4.6	4.9	5.2	4.4	4.8	5.0	4.6	4.8
	44	4.0	4.2	4.1	5.0	5.4	5.2	4.5	4.8	4.65	4.8	4.6	4.7
	51	4.3	4.6	4.45	5.9	5.4	5.65	5.1	5.4	5.25	5.0	5.2	5.1
5	52	3.9	4.3	4.1	5.1	4.7	4.9	4.9	5.0	4.95	4.5	5.0	4.75
	53	3.8	3.6	3.7	3.6	4.0	3.8	3.8	4.6	4.2	4.0	4.4	4.2
	54	4.9	4.6	4.75	4.9	5.0	4.95	4.7	5.4	5.05	4.9	5.0	4.95
	61	3.0	3.8	3.4	3.0	3.2	3.1	3.5	4.0	3.75	2.3	4.0	3.15
6	62	4.2	4.4	4.3	4.4	5.0	4.7	4.4	4.8	4.6	4.0	4.2	4.1
	63	3.0	3.8	3.4	3.6	3.8	3.7	3.8	4.0	3.9	3.6	4.0	3.8
	64	3.8	4.8	4.3	4.2	4.8	4.5	4.4	5.2	4.8	4.6	4.8	4.7

* Only one cooking.

APPENDIX G

COOKING LOSSES IN PER CENT PORK CHOPS

Lot No.	Hog No.	1st Cooking	2nd Cooking	Average	Notations
1	11	35.33	30.55(1)	32.94%	(1) Frozen 12 days
	12	33.54	31.52(1)	32.53%	(1) Frozen 12 days
	13	29.26	28.05(1)	28.66%	(1) Frozen 7 days
	14	24.17	26.88(1)	25.53%	(1) Frozen 7 days
2	21	32.33	*	32.33%	*Only one cooking
	22	33.43	34.85(1)	34.14%	(1) Frozen 12 days
	23	32.96	30.81(1)	31.89%	(1) Frozen 17 days
	24	30.28	34.03(1)	32.16%	(1) Frozen 17 days
3	31	35.24	30.07(1)	32.66%	(1) Frozen 14 days
	32	30.88	28.76(1)	29.82%	(1) Frozen 7 days
	33	37.14	34.38(1)	35.76%	(1) Frozen 17 days
	34	35.03	35.38	35.21%	
4	41	32.32	30.67(1)	31.50%	(1) Frozen 14 days
	42	34.36	31.38	32.87%	
	43	32.64	31.56	32.10%	
	44	31.88	32.76(1)	32.32%	(1) Frozen 14 days
5	51	35.18	31.82	33.50%	
	52	31.70	32.77	32.24%	
	53	31.12(1)	35.42(2)	33.27%	(1) Frozen 6 days (2) Frozen 8 days
	54	37.44	34.26	35.85%	
6	61	30.93(1)	37.33(2)	34.13%	(1) Frozen 6 days (2) Frozen 8 days
	62	32.70	28.07(1)	30.39%	(1) Frozen 22 days
	63	28.48(1)	38.74(2)	33.61%	(1) Frozen 6 days (2) Frozen 8 days
	64	33.38	34.09	33.74%	

APPENDIX H

RELATIONSHIP BETWEEN PER CENT AREA OF LEAN (y) AND PER CENT LIVE WEIGHT PRIMAL CUT OUT (x)

Lot No.	Hog No.	Per Cent Area Lean (y)	Live Weight Cut Out (x)
1	11	41.93	48.28
	12	31.77	46.32
	13	41.55	47.84
	14	48.40	49.46
2	21	34.11	47.51
	22	35.46	50.15
	23	44.60	46.90
	24	35.04	45.90
3	31	46.18	49.95
	32	45.06	48.41
	33	40.91	48.79
	34	34.25	47.27
4	41	54.60	50.49
	42	45.94	47.75
	43	36.65	47.31
	44	-	-
5	51	52.65	50.10
	52	45.52	50.65
	53	55.43	49.85
	54	-	-
6	61	70.92	53.14
	62	69.29	53.50
	63	55.24	52.35
	64	51.50	51.17

$\bar{X}$ = 49.23

$\bar{Y}$ = 46.23

N = 22

SX = 1,083.09

SY = 1,017.00

SXY = 50,473.20

SX^2 = 53,416.54

SY^2 = 49,369.87

$(SX)^2$ = 1,173,083.95

$(SY)^2$ = 1,034,289.00

APPENDIX H - Continued

RELATIONSHIP BETWEEN PER CENT AREA OF LEAN (y)

AND PER CENT LIVE WEIGHT PRIMAL CUT OUT (x)

Method of Correlation Analysis:

$$\sigma X = \sqrt{\frac{53{,}416.5429 - \frac{1{,}173{,}083.9480}{22}}{22 - 1}} = + 2.122$$

$$\sigma Y = \sqrt{\frac{49{,}369.8742 - \frac{1{,}034{,}289.00}{22}}{22 - 1}} = + 10.59$$

$$rxy = \frac{50{,}473.1977 - \frac{1{,}101{,}502.53}{22}}{(2.122)\ (10.59)\ (22)} = + .8186 \quad (58)$$

$$\sigma e \text{ of } r = \frac{1 - (8186)^2}{\sqrt{20}} = \pm .0738 \quad (32)$$

$$Y = 46.23 + .8186 \frac{10.59}{2.12} (x - 49.23) \quad (58)$$

$$= - 154.87 + 4.09x$$

$$\sigma e = \sqrt{\frac{49{,}369.87 - (-154.87)(1017) - (4.09)(50{,}473.20)}{22 - 2}} \quad (5)$$

$$= 4.12 \text{ per cent.}$$

APPENDIX I

RELATIONSHIP BETWEEN PER CENT AREA OF LEAN (y) AND PER CENT CARCASS PRIMAL CUT OUT (x)

Lot No.	Hog No.	Per Cent Area Lean (y)	Per Cent Carcass Cut Out (x)
1	11	41.93	64.92
	12	31.77	63.27
	13	41.55	64.76
	14	48.40	66.51
2	21	34.11	64.59
	22	35.46	67.25
	23	44.60	63.89
	24	35.04	62.79
3	31	46.18	66.58
	32	45.06	67.03
	33	40.91	66.42
	34	34.25	63.16
4	41	54.60	70.83
	42	45.94	66.73
	43	36.65	65.34
	44	-	-
5	51	52.65	69.03
	52	45.52	69.02
	53	55.43	66.99
	54	-	-
6	61	70.92	74.52
	62	69.29	74.83
	63	55.24	70.98
	64	51.50	71.12

$\bar{X}$ = 67.30

$\bar{Y}$ = 46.23

N = 22

SX = 1,480.56

SY = 1,017.00

SXY = 69,125.68

SX^2 = 99,885.44

SY^2 = 49,369.87

$(SX)^2$ = 2,192,057.91

$(SY)^2$ = 1,034,289.00

APPENDIX I - Continued

RELATIONSHIP BETWEEN PER CENT AREA OF LEAN (y) AND PER CENT CARCASS PRIMAL CUT OUT(x)

Method of Correlation Analysis:

$$\sigma X = \sqrt{\frac{99,885.4360 - \frac{2,192,057.9136}{22}}{22 - 1}} = \pm 3.43$$

$$\sigma Y = \sqrt{\frac{49,369,8742 - \frac{1,034,289.00}{22}}{22 - 1}} = \pm 10.59$$

$$rxy = \frac{69,125.6845 - \frac{1,505,729.52}{22}}{(3.43)\ (10.59)\ (22)} = + .8550 \quad (58)$$

$$\sigma e \text{ of } r = \frac{1 - (8550)^2}{\sqrt{20}} = \pm .0602 \quad (32)$$

$$Y = 46.23 + .8550 \frac{10.59}{3.43} (x - 67.30) \quad (58)$$

$$= - 131.44 + 2.64x$$

$$\sigma e = \sqrt{\frac{49,369.87-(-131.44)(1,017)-(2.64)(69,125.68)}{22 - 2}} \quad (5)$$

$$= 5.27 \text{ per cent.}$$

APPENDIX J

ANALYSIS OF VARIANCE OF DRESSING PER CENT

Hog	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6
1	74.35	73.56	75.02	71.29	72.57	71.29
2	73.21	74.57	72.23	71.55	73.38	71.49
3	74.35	73.40	73.40	72.11	74.41	73.76
4	74.36	73.12	74.80	71.20	71.30	71.94
$\bar{X}$	74.07	73.66	73.86	71.61	72.92	72.12

Lot 1,2,3 dressing per cent significantly** higher than Lots 4,6.

Lot 1 " " " " " " Lot 5.

Lot 5 " " " " " " Lot 4.

$C.T. = \frac{(72.96)^2}{24} = 221.80$ ****

Total ss = 259.05 - C.T. = 37.25

ss Between Lots $\frac{967.51}{4}$ - C.T. = 20.08

t-test

$$\sigma_{m1} = \frac{\sqrt{.9155}}{\sqrt{4}} = .4784$$

$$\sigma_{m_1 - m_2} = .4784\sqrt{\tfrac{1}{4} - \tfrac{1}{4}} = .3383$$

.3383 x 2.878 *** = .9736 difference between means to be highly significant.

** Highly significant.

*** Table for t 18 d.f. at 1% level.(32)

**** Calculations coded by X - 70.

APPENDIX K

ANALYSIS OF VARIANCE OF LENGTH OF CARCASS (in mm.)

Hog	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6
1	715	729	729	749	740	769
2	716	761	728	755	758	793
3	733	717	715	755	751	783
4	745	731	736	742	755	788
$\bar{X}$	727.25	734.50	727.00	750.25	751.00	783.2

Lot 6 length of carcass significantly** greater than Lot 1,2,3,4,5.

Lot 4,5 " " " " " " Lot 1,2,3.

$C.T. = \frac{(1093)^2}{24} = 49777.0$ ****

Total ss = 61317.0 - C.T. = 11540.0

ss Between Lots $\frac{235495.0}{4}$ - C.T. = 9096.0

t-test

$$\sigma_{m_1} = \frac{\sqrt{135.78}}{\sqrt{4}} = 5.83$$

$$\sigma_{m_1 - m_2} = 5.83 \sqrt{\tfrac{1}{4} - \tfrac{1}{4}} = 4.12$$

4.12 x 2.878 *** = 11.85 difference between means to be highly significant.

** Highly Significant.

*** Table for t 18 d.f. at 1% level. (32)

**** Calculations coded by X - 700.

APPENDIX L

ANALYSIS OF VARIANCE OF LENGTH OF LEG (in mm.)

Hog	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6
1	530	528	554	538	578	578
2	539	552	555	550	569	562
3	538	545	551	534	543	567
4	559	518	540	530	560	561
$\bar{X}$	541.50	535.75	550.00	538.00	562.50	567.00

Lot 5,6 leg length significantly** longer than Lot 1,2,3,4.

Lot 3 " " " " " Lot 2,4.

$C.T. = \frac{(1179)^2}{24} = 57918.38$ ****

Total ss = 63757 - C.T. = 5838.62

ss Between Lots $\frac{245433.0}{4}$ - C.T. = 3439.87

t-test

$$\sigma_{m_1} = \frac{\sqrt{133.26}}{\sqrt{4}} = 5.77$$

$$\sigma_{m_1 - m_2} = 5.77 \sqrt{\tfrac{1}{4} - \tfrac{1}{4}} = 4.08$$

4.08 x 2.878 *** = 11.74 difference between means to be highly significant.

** Highly significant.

*** Table for t 18 d.f. at 1% level. (32)

**** Calculations coded by X - 500.

APPENDIX M

ANALYSIS OF VARIANCE OF BACK FAT MEASUREMENT (in mm.)

Hog	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6
1	140	139	131	105	117	77
2	129	113	109	109	100	34
3	136	116	155	118	125	92
4	128	145	134	103	94	91
$\bar{X}$	133.2	128.2	132.2	108.8	109.0	73.5

Lot 1,2,3,4,5 back fat measurement significantly** greater than Lot 6.

Lot 1,2,3 " " " " " than Lot 4,5.

$$C.T. = \frac{(2740)^2}{24} = 312816.67$$

Total ss = 328134.00 - C.T. = 15317.33

ss Petween Lots $\frac{1292856}{4}$ - C.T. = 10397.33

t-test

$$\sigma_{m_1} = \frac{\sqrt{273.33}}{\sqrt{4}} = 8.26$$

$$\sigma_{m_1 - m_2} = 8.26\sqrt{\tfrac{1}{4} - \tfrac{1}{4}} = 5.84$$

5.84 x 2.878 *** = 16.81 difference between means to be highly significant.

** Highly significant

*** Table for t 18 d.f. at 1% level (32)

APPENDIX N

ANALYSIS OF VARIANCE OF PER CENT AREA OF LEAN IN PORK CHOP (ROUGH LOIN)

Hog	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6
1	41.93	34.11	46.18	54.60	-	70.92
2	31.77	45.46	45.06	45.94	52.65	69.29
3	41.55	44.60	40.91	36.65	45.52	55.24
4	48.40	35.04	34.25	-	55.43	51.50
$\bar{X}$	40.91	39.80	41.60	45.73	51.20	61.74

Lot 6 per cent of lean significantly** higher than Lots 1,2,3,4,5.

Lot 5 " " " " " " " Lots 1,2,3.

$$C.T. = \frac{(1027.00)^2}{22} = 47942.27$$

Total ss = 50529.47 - C.T. = 2587.20

$$\text{ss Between Lots} = \frac{(163.65)^2}{4} + \frac{(159.21)^2}{4} + \frac{(166.40)^2}{4} + \frac{(137.19)^2}{3} + \frac{(153.60)^2}{3} + \frac{(246.95)^2}{4} - C.T. = 1397.1$$

t-test.

$$\sigma_{m_1} = \frac{\sqrt{73.38}}{\sqrt{4}} = 4.31$$

$$\sigma_{m_1 - m_2} = 4.31 \sqrt{\tfrac{1}{4} - \tfrac{1}{4}} = 3.05$$

3.05 x 2.898*** = 8.83 difference between means to be highly significant.

** Highly Significant

*** Table for t 16 d.f. at 1% level (32)

APPENDIX O

ANALYSIS OF VARIANCE OF PER CENT OF LIVE WEIGHT CUT OUT

Hog	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6
1	48.3	47.5	50.0	50.5	50.1	53.1
2	46.3	50.2	48.4	47.8	50.6	53.5
3	47.8	46.9	48.8	47.3	49.8	52.4
4	49.5	45.9	47.3	49.4	50.0	51.2
$\bar{X}$	47.98	47.62	48.62	48.75	50.12	52.55

Lot 6 per cent cut out significantly** higher than Lot 1,2,3,4,5.

Lot 5 " " " " " " " Lot 1,2,3,4.

$$C.T. = \frac{(1,182.6)^2}{24} = 58272.6$$

Total ss = 58,367.88 - C.T. = 95.28

ss Between Lots = $\frac{23335.54}{4}$ - C.T. = 66.2

t-test

$$\sigma_{m_1} = \frac{\sqrt{1.62}}{\sqrt{4}} = .6365$$

$$\sigma_{m_1 - m_2} = .6365 \sqrt{\tfrac{1}{4} - \tfrac{1}{4}} = .450$$

.450 x 2.878 *** = 1.295 difference between means to be highly significant.

** Highly significant

*** Table for t 18 d.f. at 1% level (32)

APPENDIX P

ANALYSIS OF VARIANCE OF PER CENT OF CARCASS CUT OUT

Hog	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6
1	64.92	64.59	66.58	70.83	69.03	74.52
2	63.27	67.25	67.03	66.73	69.02	74.83
3	64.76	63.89	66.42	65.34	66.99	70.98
4	66.51	62.79	63.16	69.26	70.12	71.12
$\bar{X}$	64.86	64.63	65.80	68.04	68.79	72.86

Lot 6 per cent cut out significantly** higher than Lot 1,2,3,4,5.

Lot 4,5 " " " " " " " Lot 1,2,3.

C.T. = $\frac{(179.94)^2}{24}$ = 1349.10 ****

Total ss = 1,598.13 - C.T. = 249.03

ss Between Lots = $\frac{6177.052}{4}$ - C.T. = 195.16

t-test

$$\sigma_{m_1} = \frac{\sqrt{2.9924}}{\sqrt{4}} = .865$$

$$\sigma_{m_1 - m_2} = .865 \sqrt{\tfrac{1}{4} \times \tfrac{1}{4}} = .6116$$

.6116 x 2.878 *** = 1.76 difference between means to be highly significant.

** Highly significant

*** Table for t for 18 d.f. at 1% level (32)

**** Calculations coded by X-60

APPENDIX Q

ANALYSIS OF VARIANCE OF ACCEPTABILITY TESTS OF PORK CHOPS****

Hog	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6
1	4.8	4.6	3.9	4.4	4.8	2.0
2	4.7	4.2	4.6	4.8	4.2	3.2
3	4.9	4.4	4.8	4.7	5.0	4.1
4	4.3	4.8	4.8	5.1	4.7	3.8
$\bar{X}$	4.68	4.50	4.52	4.75	4.68	3.28

Lot 1,2,3,4,5 acceptability significantly** better than Lot 6.

$$C.T. = \frac{(105.6)^2}{24} = 464.64$$

Total ss = 475.04 - C.T. = 10.40

ss Between Lots = $\frac{1883.60}{4}$ - C.T. = 5.26

t-test

$$\sigma_{m_1} = \frac{\sqrt{.286}}{\sqrt{4}} = .267$$

$$\sigma_{m_1 - m_2} = .267\sqrt{\tfrac{1}{4} - \tfrac{1}{4}} = .1888$$

.1888 x 2.878 *** = .54 difference between means to be highly significant.

** Highly significant

*** Table for t for 18 d.f. at 1% level (32)

**** Score range 1 very poor to 7 excellent

APPENDIX R

ANALYSIS OF VARIANCE OF KIDNEY WEIGHTS IN (gms.)

Hog	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6
1	278	305	270	275	287	320
2	230	265	270	305	294	403
3	282	263	390	268	307	343
4	238	240	266	283	346	290
$\bar{X}$	257.0	268.2	274.0	282.7	308.5	339.0

Lot 6 kidney wt. significantly** heavier than Lot 1,2,3,4,5.

Lot 5 " " " " " Lot 1,2,3.

$C.T. = \frac{(6918)^2}{24} = 1994113.5$

Total ss= 2026918.0 - C.T. = 32804.0

ss Between Lots = $\frac{8049982.0}{4}$ - C.T. = 18382.0

t-test

$$\sigma_{m_1} = \frac{\sqrt{801.2}}{\sqrt{4}} = 14.15$$

$$\sigma_{m_1 - m_2} = 14.15 \sqrt{\tfrac{1}{4} - \tfrac{1}{4}} = 10.00$$

10.00 x 2.878 *** - 28.80 difference between means to be highly significant.

** Highly significant

*** Table for t for 18 d.f. at 1% level (32)