THE INFLUENCE OF ADDED FAT AND PROTEIN IN BROILER RATIONS ON GROWTH RATE, DRESSING PERCENTAGES, AND OTHER CARCASS CHARACTERISTICS

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ABSTRACT

THE INFLUENCE OF ADDED FAT AND PROTEIN
IN BROILER RATIONS ON GROWTH RATE, DRESSING
PERCENTAGES, AND OTHER CARCASS CHARACTERISTICS

by Eskel Oren Essary

Twelve White Cornish Cross chicks of each sex were randomly sorted into five lots in each of 6 experiments. These chicks were used to study the influence of different levels of fat with different levels of protein in the diet on areas of fat deposition and many factors associated with the production and utilization of fryers.

Experiments 4, 5 and 6 were designed to replicate Experiments 1, 2 and 3, respectively. However, a different strain of White Cornish Cross chicks were used for each group of three experiments. The level of stabilized fat in the diets in Experiments 1 and 4 was increased by two per cent for each succeeding lot from 0 per cent for Lot 1 to eight per cent for Lot 5. Protein was approximately 20.2 per cent for all lots. In Experiments 2 and 5 the level of fat was the same as used in Experiments 1 and 4. Protein levels were 20.77, 21.35, 21.93, 22.91, and 23.09 per cent for Lots 1 to 5, respectively. In Experiments 3 and 6 fat was increased by one per cent for each succeeding lot from 0 per cent for Lot 1 to four per cent for Lot 5. Protein was added at levels of 20.77, 21.80, 22.83, 23.86, and 24.89 per cent, respectively.

Results show that the different levels of fat and protein did not influence growth rate or 10 week weights between lots

except in Experiments 1 and 3. Growth rate was higher for males than for females indicating a difference in the nutritional requirements for males and females. Feed efficiency was improved with supplemental fat added to the diet. Rations which resulted in lowest feed conversions did not necessarily produce the most economical fryers.

There was no significant difference in warm eviscerated yield or percentage moisture pick-up from chilling between lots. Specific gravity of the eviscerated carcasses was lower for birds which received higher levels of fat in the diet. With the abdominal fat removed from the carcasses no difference in cooking yields was found between lots in any experiment.

A higher percentage of fat was found in the abdominal area of females than in the males. There was no significant difference in the percentage heart between lots. Birds fed high levels of fat and protein showed a significantly higher percentage liver, deposited more fat on the gizzards and showed a higher percentage skin. Birds fed high levels of fat and protein together or high levels of protein in combination with low levels of fat in the diet had significantly smaller gizzards.

Fat composition was higher in the breast, thigh, drumstick, wing, and skin of birds fed high levels of fat than in those fed low levels. An inverse relationship existed between the percentage fat and moisture in these tissues. Percentage protein was fairly constant for the same tissue between lots but tissues from males contained about two per cent more protein than did that from the females.

Fat composition was lower in the skin of birds which received either high levels of fat with the same level of protein or high levels of protein with low levels of fat. Birds fed high levels of fat and protein together in the diet showed a higher percentage fat in the skin.

Birds on high levels of fat deposited more fat in the abdominal and gizzard areas, and muscle tissues than in the skin. Those on low levels of fat with high levels of protein deposited a lower percentage of fat in the different tissues and in the abdominal and gizzard areas. Strain and sex differences were noted in the amount and areas of fat deposited.

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ESKEL OREN ESSARY

A THESIS

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V. INTRODUCTION

In 1947, Scott, Matterson, and Singsen demonstrated that high levels of energy are desirable in broiler rations. Since their discovery an extensive amount of research has been conducted with poultry to determine the influence of high energy feeds on growth rate, feed efficiency, and the relationship between added fats in feeds and other feed nutrients. However, little research has been conducted to study the effect of using different levels of added fat with varying levels of protein on cost of broiler production, based on feed cost and feed efficiency, dressing percentage, areas of fat deposition in the broiler, water pick-up during chilling, cooking yields, chemical analysis of the carcass, and other factors which are important in evaluating a broiler ration.

These factors seem especially important since the cost of broiler production is of great concern to the poultry industry. Broiler production has increased at an enormous rate and has been associated with a decrease in selling price. In many areas of the United States the different segments of broiler production have been integrated and an increased interest in the over-all cost of production has resulted.

In both an integrated and a nonintegrated poultry industry, the cost of the finished product offered to the consumer can be altered by one or more steps within the entire operation. Cost of production is a major factor in determining whether a company makes or loses money in its' operation and what percentage of the consumer's dollar will be spent for poultry products instead of for competitive meat products.

It is important to determine whether a ration containing all of the known essential nutrients at their proper levels and relationship to each other will produce a broiler more economically, without sacrifice to quality, than will another less expensive but nutritionally adequate ration. Such a determination would help to establish at what age the bird should be marketed to give the greatest return to the grower. However, the cost of feed is only one of several factors which needs to be considered in evaluating a broiler ration.

The influence of added fat in broiler rations on carcass composition is also important since consumers are concerned about the presence of fat in their diets.

If the addition of fat results in a large amount of fat being deposited in the edible parts of the carcass, then these broilers might be discriminated against by the housewives thereby resulting in lower broiler consumption.

It is essential to the processor to know whether the dressed yield of broilers is altered by fat deposition since yield is one of the many factors which determines the selling price of the dressed bird as well as the margin of profit. It is also important to know whether the fat is deposited mainly in the muscle tissues, in the abdominal cavity, or attached to the intestional tract. If a large percentage of the deposited fat is attached to the intestines and gizzard the dressing percentage would be reduced. This loss in yield would be reflected in the selling price of the dressed broilers or in the profit received by the processor. He should know if fat deposition influences the percentage of water pick-up during the chilling operation since this not only helps to determine the packed-out yield of the processed birds but also the percentage weight loss of the carcasses from the time they are packaged until they reach the consumer.

If added fat in the broiler ration results in greater fat deposition in the muscle tissues as well as the abdominal cavity, such birds would be expected to have a greater shrink from cooking. To food manufacturers using poultry meat it is important to know what cooking yields to expect from a product since this factor, in addition to others helps to determine the selling price, consumer acceptance, and quality standardization of the prepared food product.

It is essential to determine the possible alteration in the percentage protein, fat, and moisture of broilers fed rations containing different levels of added fat since consumers are becoming more conscious of the nutritive value of food items.

Published data do not furnish adequate information on the influence of diet on the carcass composition and characteristics. This study was therefore undertaken in 1956 to study the influence of different levels of added fat with different levels of protein on the many factors mentioned.

VI. LITERATURE REVIEW

Fats and oils began to be used extensively in livestock and poultry feeds when detergents replaced soaps as a cleaning agent. Kraybill (1953) reported that there were approximately one billion pounds of surplus fat on the market at the end of 1953.

The low price and enormous supply of fats provided the incentive for using fat as a source of energy in poultry feeds. Fat was found to be a valuable source of energy, Bird (1954). In addition to the increase in energy, fats improve the texture and color of feed ingredients, and control the dustiness of finely ground feeds. Lewis, Bray, and Sanford (1955) reported that on the basis of palatability preference, as evaluated by feed consumption, chicks preferred diets supplemented with 2 per cent lard and corn oil over basal diets.

Reiser and Couch (1949), using chicks which had the residual yolks removed, fed chicks on a practical and a purified fat-free diet plus 4 per cent Wesson Oil. The group on a purified fat-free ration gained at a slower rate than those on the purified diet plus 4 per cent oil. Arscott and Sather (1958) reported that the addition of 3 and 6 per cent fat to a corn

type ration resulted in a significant improvement in broiler growth. However, growth was adversely affected with an addition of 9 per cent fat to the same type ration.

Bird (1954), Aitken, Lindblad, and Hunsaker (1954), Yacowitz and Chamberlin (1954), Runnels (1955), Rosenberg et al. (1955), Curtin and Raper (1956), and Beilharz and McDonald (1959) showed that the addition of fat to broiler rations improved feed efficiency but failed to produce a significant increase in growth. Similar results were reported by Yacowitz, Carter, Wyne, and McCartney (1956) who conducted feeding trials using turkey broilers. Beilharz and McDonald (1959) reported that stabilization of the fat had no effect on body weight or feed efficiency.

Fox and Bohren (1954) reported inter- and intra-strain differences in poultry in their ability to utilize feed efficiently. Slinger, McConachie, and Pepper (1955) indicated that the difference in weights of 10 week old birds was due to the highly significant effects of strain, sex, and diet. Interactions between strain X diet and sex X diet were not statistically significant indicating that two among the 10 strains tested showed no weight response to added fat. Males showed a greater response to fat in the diet than females in all but two of the 10 strains studied.

Bigbee (1956) reported that fat increased growth rate as well as feed efficiency in cool weather, but only increased feed efficiency in summer. Dunkelgod, Gleaves, Tonkinson, and Thayer (1959) conducting tests with Broad Breasted Bronze poults, noted that poults developed deficiency symptoms which resembled those of biotin, pyridoxine, and thiamine when fed a high-energy diet under summer environmental conditions. Mortality was high and survivors had lesions in the mouth, a high percentage of deformed beaks, and a high incidence of perosis. The same diet was fed in the winter with no adverse effects.

Bigbee (1956) pointed out that feed conversion was improved by each 5 per cent increase in added fat to the diet. However, there was a reduction in growth rate when the level of added fat and protein were out of proportion to each other. Biely and March (1954), Aitken *et al*. (1954), Leong *et al*. (1955), Donaldson *et al*. (1955), Sunde (1956), Potter, Matterson, Carlson, and Singsen (1956), Biely and March (1957), and Vondell and Ringrose (1958) reported that there was a relationship between calorie and protein, and the growth rate and feed conversion of chicks.

Combs and Romoser (1955) suggested that broiler starting diets should contain about 42 calories per one per cent protein in each pound of feed. Richardson, Watts, and Epps (1956) reported that in broiler rations containing a protein level of 21.5 to 23.5 per cent, the optimum calorie-protein[1] ratio lies between 41 and 43 to 1. They further observed that a fat x fiber interaction existed and that the addition of vegetable fat to the diet counteracted all or part of the performance depressing effect of the fibrous feedstuffs. In 1958 these authors, using gain in weight and feed conversion as a criterion of performance, found that different fibers gave different growth responses. The addition of fat in broiler rations improved feed conversion in all instances but the magnitude of improvement was influenced by the source of fiber.

Reiser and Pearson (1949) reported that chick starter diets,high in refined cottonseed oil but low in riboflavin caused chicks to stop growing much sooner than those on similar diets which contained no added fat. When 4 grams of riboflavin per gram of feed

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1 Calorie-protein ratio hereafter referred to as C-P ratio.

were added to the diet, the growth response was essentially the same irrespective of whether the diet contained fat. Lard and hydrogenated vegetable fat did not retard the rate of growth. It was suggested that the difference in growth response from cottonseed oil, lard, and hydrogenated vegetable fat was due to the unsaturated acids in cottonseed oil which interfered with the intestinal synthesis of riboflavin.

Thayer and Davis (1953), Rice et al. (1954), and Peterson, Grau, and Peek (1954) showed that high energy diets can show up deficiencies of marginal nutrients by the reduced volume of feed intake which reduces the amount of each nutrient consumed unless the nutrients are suitably more concentrated in the diet. Donaldson et al. (1956), using 4-week assay experiments, showed that 30 per cent animal grease or corn oil in broiler diets gave satisfactory results when adequately supplemented with protein (amino acids), minerals, and vitamins.

Kummerow, Weaver, and Honstead (1949) showed that the choline requirement of the chick was increased by the addition of high levels of fat in the ration. Donaldson, Combs, and Romoser (1954) reported that the amount of feed required per pound of gain in broilers was consistently reduced by approximately 0.1 to 0.2 pounds when 2.5 to 15.0 per cent fat was added to rations containing 785 milligrams of choline per pound of feed. On the other hand, levels of added fat above 5 per cent did not improve the feed efficiency when the ration contained 685 milligrams of choline per pound. Siedler and Schweigert (1953) studied the influence of different levels of fat with and without choline and antibiotic plus B_{12} supplements on rate of gain. They reported an increase in growth rate from these supplements during the early phases of the experiments, but this response was not observed in the female broilers at 9 weeks of age.

Carver, Rice, Gray, and Mone (1955) reported that neither hydrogenated tallow nor fatty acids from hydrogenated tallow are efficiently utilized as fat supplements in broiler feed. Hydrogenated fat and fatty acids did not improve 4-week feed conversions while tallow improved feed conversions and was absorbed to the extent of 82 to 100 per cent. Biely and March (1957) concluded that not only is fat utilization affected by the protein content in the diet, but that the degree to which utilization is affected depends upon the nature of the fat.

Whitson, Carrick, Roberts, and Hauge (1943) demonstrated that chicks receiving a low fat diet (2.7 to 2.9 per cent) utilized a significantly smaller percentage of the fat than chicks receiving medium amounts (8.6 to 9.0 per cent), or high levels (20.2 to 20.7 per cent) of fat in the diets. The fat in the low fat diet was typical of that present in poultry diets while the oil added to the medium and high fat diets was an unsaturated fat, typical of many vegetable oils. It was noted that more fat was excreted in the feces of chicks receiving diets high in fat than by chicks receiving diets low in fat.

Duckworth, Naftalin, and Dalgarno (1950) studied the digestibility coefficient of added mutton fat at levels up to 12 per cent and found that growing chicks digested 88 per cent when 6 per cent fat was added to the diet but only 70 per cent when 12 per cent fat was added. They further noted that linseed oil was more digestible than mutton fat at levels of 6, 9, and 12 per cent. Siedler, Scheid, and Schweigert (1955) tested the effect of white grease, yellow grease, brown grease, prime tallow, No. 2 tallow, and fatty acids prepared from choice white grease on the performance of chicks. It was observed that the addition of 3 or 6 per cent stabilized feed-grade animal fats or 3 per cent stabilized free fatty acids to a high energy diet resulted in no significant difference in rates of gain even though the amount of fat ingested and the amount excreted showed excellent digestibility of the added fat.

Sunde (1956) attempted to determine the digestibility of white grease, oleic acid, and hydrogenated fat. It was noted that the addition of white grease in feeds increased the amount of fat in dry feces by 2 to 5 times over the control diet, depending upon the level fed. Five per cent oleic acid increased the fat in the feces about the same amount as did 5 per cent white grease. The amount of fat in the feces resulting from the feeding of the hydrogenated fat, however, increased about 8 to 9 times over that of the basal diet. It was found that the feces from the group fed the hydrogenated fat contained 82 per cent free fatty acids which suggested that the glycerol portion of the molecule was removed and the free fatty acids were not absorbed.

March and Biely (1957) noted that the coefficients of digestibility of fat were not as high as those reported in the literature because of the fatty acids excreted in the form of soaps. They concluded that fecal soaps must be considered in any estimation of digestibility of fat by the chicken. Fedde, Waibel, and Burger (1959) demonstrated that the digestion coefficients of fats are different for different fats and can be altered by the presence of calcium and other factors in the diet. Wilder, Cullen, and Rasmussen (1959) stated that the values for metabolizable energy of fats may be explained on a basis of the level of impurities in the sample. High values obtained for certain samples suggested that metabolizable energy values are inadequate to judge full contribution of these fats in nutrition.

Chicks require factors present in unsaturated fat for maximum growth as reported by Carver and Johnson (1953). These growth factors were found in crude corn oil, refined corn oil, soybean oil, wheat germ oil, and oleic acid concentrates.

In addition to the work cited showing that fat in diets influenced growth rate, feed efficiency, and other factors associated with growth, many authors have reported that high energy rations and rations containing certain other ingredients altered different carcass characteristics associated with the quality and composition of broilers.

Hammond and Harshaw (1941) and Culton and Bird (1941) found that fortified cod liver oils were potent sources of a pigmentation-suppressing factor. The latter authors also showed that certain samples of meat scraps, fish meal, and soybean oil meal also depressed pigmentation. Bird (1943) reported finding a pigmentation-suppressing factor in two or three samples of meat and bone meal but not in dried skimmed milk. Carver (1959) demonstrated that certain samples of yellow grease, No. 1 tallow, hydrolyzed animal and vegetable fat, and methyl esters of vegetable fat reduced pigmentation in broilers. Inasmuch as it was shown that this factor varied with the levels of fat supplements fed, it was concluded that some samples of yellow grease, hydrolyzed animal and vegetable fat did not depress pigmentation. The sample of methyl esters depressed growth, feed conversion, and pigmentation while certain samples of yellow grease, No. 1 tallow, and hydrolyzed fat which contained a pigmentation-and

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inhibiting compound had no adverse effects on growth and feed conversion.

Aitken, Lindblad, and Hunsaker (1954) fed a ration in which 10 per cent tallow was incorporated in a 25 per cent protein diet and reported that the male broilers after being dressed at 10 weeks of age were superior to broilers fed on rations not containing tallow. However, Yacowitz, Carter, Wyne, and McCartney (1956) noted that the feeding of 0, 3, and 6 per cent fat each with 20, 23, and 26 per cent protein in turkey finishing rations did not have any measurable effect on market quality of turkey broilers as judged by handling the live birds at 16 weeks of age.

Harshaw (1936, 1939), Fraps (1943), and Newell, Fry, and Thayer (1956) demonstrated that a relationship exists between the energy level of the ration and the fat composition of the carcass. Duckworth et al. (1950) showed that as the level of linseed oil in the diet was increased, fat deposition progressively increased in White Leghorn male chicks. McNally (1954) observed that the fat content of the edible meat of 12 week old cockerels was directly proportional to the fat content (1 to 19 per cent) of the diet. This condition was also found with linseed oil, corn oil, and tallow which show

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showed varying degrees of saturation. Breed differences were observed in the fat storage in the carcass on diets of the same percentage fat.

Renard (1949) noted a variation among different breeds and crosses in the percentage loss during dressing and evisceration of 10 week old cockerels. However, Morrison, Sauter, McLaren, and Stadelman (1954), using 8 breeds of broilers found no consistent differences between breeds with respect to eviscerated yields or yield of edible meat. Orr (1955) reported that there were no significant differences due to strain, sex, and diet as determined by the chilled dressed weights as a percentage of the live weight. However, on the basis of ready-to-cook weight, as a percentage of live weight, the effect of strain and sex was significant. Sullivan, Cherms, and Sunde (1958) observed differences in the dressing percentage of four different classes of poultry. The heavier classes of birds had the higher dressing percentages. Essary, Mountney, and Goff (1951) noted differences in eviscerated yields between meat type standardbred and crossbred broilers. Stotts and Darrow (1953) and Hathaway, Champagne, Watts, and Upp (1953) found that the introduction of Cornish breeding in pure form or in

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in crosses resulted in greater edible meat yield of the carcasses.

Jaap, Renard, and Buckingham (1950), reporting on the results obtained from dressing 44 different strains of 12-week fryers, concluded that rapid growth (size) appeared to be the major factor responsible for increasing both the percentage dressed and percentage eviscerated yields at this age. A linear relation was found between live weight and percentage yield. Similar results were reported by McNally and Spicknall (1949). Siegel and Essary (1959) found a highly positive genetic and phenotypic correlation between live and eviscerated weights in broilers.

Henderson (1946) reported that a significant correlation exists between meat type scores for both live and dressed birds and percentage of edible meat. Dawson, Davidson, Frang, and Walters (1957), using a Cornish-game miniature broiler at 6 weeks of age, observed a positive correlation between the apparent (visual) meat type and yield of edible cooked meat. Based on pound-sized, raw weight of broilers of meat-types rated 1 to 5 (1 superior), it was reported that for every pound of raw meat within the range of the weight and meat type studied, there was approximately 50 per cent edible meat, 22 per cent bone, 23 per cent loss due to cooking, and 5 per cent loss due to separating for boning.

May and Brunson (1955) starved male and female broilers for 24 hours and reported that significantly lower eviscerated yields resulted in these broilers than from similar broilers starved for 0, 3, 6, or 12 hours. Brunson (1957) reported that fasting periods of 12 and 24 hours resulted in significantly lower eviscerated yields in broilers, and that the moisture content of the carcasses varied directly with the eviscerated yields, indicating that the differences in the eviscerated yields were due to differences in the moisture content of the carcasses. Essary, Kramer, and Coles (1958) reported that not only was eviscerated yield decreased by the length of time fowl was held without feed but that shrink from starvation reduced the weight of the edible portion of the carcass. Essary (1958) showed that processing techniques can alter the degree of accuracy in obtaining processing data.

Harms, Hockreich, and Meyer (1957) demonstrated that the percentage of eviscerated yield increased in broiler-fryers as the energy level of the diet was increased. Stadelman, McCartan, Baum, and McLaren (1951) found that subcutaneous implantations of diethylstilbestrol in broilers improved general carcass appearance and increased fat deposition and dressing loss.

McNally and Spicknall (1950) reported a linear relationship between the specific gravity and the fat content of broiler legs. They concluded that specific gravity may be used as a fairly accurate rapid method for the determination of the fat content of whole carcasses and parts of the carcass. Newell *et al.* (1956) showed that specific gravity was significantly different between broilers fed different levels of fat. However, Thayer and Thompson (1950), using estrogen-fed poultry, found that specific gravity of muscle tissue samples was not an accurate measure of intra-muscular fat. Bigbee (1956) was unable to show significant improvement in carcass fat deposition as measured by specific gravity. It was noted, however, that broilers deposited slightly more carcass fat when fed rations containing 10 to 15 per cent added fat.

Koonz and Robinson (1946) demonstrated that the amount and distribution of connective tissue and of fat within the different sizes and arrangements of muscle

bundles in poultry differed between various muscles. Goertz, Vail, Harrison, and Sanford (1955) concluded from observing histological sections of turkey tissues that turkeys fed a high-density low fiber feed contained larger amounts of intra-muscular fat than those fed high fiber low-density feed. Lewis, Harrison, and Folse (1958) reported that the distribution as well as the quantity of fat in muscle tissue may be determined by employing a photomicrographic method which they developed.

It was reported by Asmundson, Jukes, Fyler, and Maxwell (1938) that the feeding of fats and/or oils had an effect on the stability of the deposited fats. Kummerow, Hite, and Kloxin (1948), and Chu and Kummerow (1950) observed that linolenic acid was deposited in the skin, gizzard, and liver of turkeys which had received supplements of linseed oil and that the resistance of poultry fat to rancidification was dependent on the amount of linolenic acid deposited in the skin tissue and the amount and nature of natural antioxidants. Barnes, Lundberg, Hanson, and Burr (1943) showed that alpha tocopherol helped to stabilize animal fats against oxidation.

Kummerow *et al*. (1947) noted that the degree of stability of deposited fat, as determined by comparing the acid, peroxide, and aldehyde values of the fat extracted from the skin, and by employing organoleptic tests, could be modified by the addition of certain supplements such as extracts of alfalfa leaf meal, carotene, cholesterol, ethanolamine, or choline. Work by Kummerow, Vail, Conrad, and Avery (1948) showed that a correlation probably exists between the organoleptic characteristics of the carcass and the peroxide and aldehyde values of the extracted skin fat. When the peroxide and aldehyde values were less than 10 and 25, respectively, the cooked carcass was acceptable to the taste panel.

Criddle and Morgan (1947) indicated that rather large additions of tocopherol to turkey diets are needed to influence markedly the amount of tocopherol deposited in the bird. Mecchi, Klose, and Lineweaver (1952) observed that the fatty acid composition was similar from chickens and turkeys receiving the same diet but the fat differed in the tocopherol content and stability. The difference in stability appeared to be related to the tocopherol content. Klose *et al*. (1952) reported that the tendency of fat to

deteriorate in frozen storage turkeys may be predicted in part from either the induction period or the fatty acid composition of the carcass fat. They further reported that the fatty acid composition of the dietary fat was reflected in the fatty acid composition of the carcass fat.

Siedler, Moline, Schweigert, and Riemenschneider (1957) reported that the A O M stabilities of the depot fat from broilers fed rations containing either no added fat, 6 per cent unstabilized fat, 6 per cent stabilized fat with an antioxidant, or 6 per cent stabilized fat with 0.02 per cent DPPD,[1] showed little or no increase in stability when stabilized or unstabilized animal fat was in the diets at the levels tested. Voth, Miller, and Lewis (1958) found that the intravenous injection of tocopherol at the amounts used did not significantly increase the amount of tocopherol in the depot fat. Subsequent resistance of the fat to oxidative rancidity was not increased by this injection.

Klose *et al*. (1952) fed turkeys for 17 weeks on a practical simplified low-fat basal diet and on a basal diet supplemented with 2 per cent beef fat, corn oil, linseed oil, sardine oil, and soybean oil.

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[1] Antioxidant, Diphenyl-p-phenylinediamine

Analysis of the feed fat and carcass fat for their fatty acid contents demonstrated significant correlation between diet fat and carcass depot fat for linoleic and linolenic acid contents. There were no significant differences, however, in fatty acid composition between three widely separated fat depots in the carcass. Cruickshank (1934) checked the iodine values of the mixed fatty acids of different fat depots in fowl and indicated that the superficial and internal fat reserves are more uniform in composition in fowl than in pigs and cattle. It was demonstrated that the ingestion of high percentages of saturated fatty acids in the form of palm kernel oil and mutton fat definitely decreased the degree of saturation of the mixed fatty acids of the depot fat, while the ingestion of unsaturated acids in hempseed resulted in a marked and rapid increase in unsaturation.

Hood, Wheeler, and McGlamery (1950) reported that birds receiving diethylstilbestrol deposited significantly higher percentages of fat which exhibited less change in Kreis and peroxide number during the two incubation periods than did the fat of the control birds. Kreis and peroxide values indicated that birds receiving diets containing 5 per cent crude peanut oil

as a natural source of tocopherol from 8 to 12 weeks of age deposited fat that was slightly less susceptible to oxidative changes than the fat of birds on diets containing 5 per cent peanut oil from which the tocopherols had been extracted by the use of ferric chloride.

Maw, Holcomb, Rodger, and Franklin (1936) and Harshaw (1938) found that the breast meat contained less fat than the dark or drumstick and thigh meat. Thayer and Thompson (1950) reported that the moisture content of the breast muscle was about the same for both control and estrogen-fed birds. There was no evidence to indicate that the estrogen-fed birds had more intra-muscular fat than the control birds. Fat levels in the muscles were not consistent with visual grades for the broilers. Dansky and Hill (1952) indicated that birds fed a high energy ration deposited more fat on the carcass than did birds on a ration of moderate amount of energy content. Females had a higher fat content than males on each of the rations. The fat content of the bone, leg muscle, gizzard, and skin varied directly with the fat content of the total carcass.

Waibel (1955) fed battery-reared chicks on 13, 16, 20, 25, and 31 per cent protein with 10 per cent stabilized bleachable fancy tallow and observed that the lots receiving the higher levels of protein contained higher percentages of protein based on moisture-free carcass. Fat content of the carcasses were correspondingly reduced as the protein content increased. Richardson, Brunson, and Watts (1957) reported that carcass fat content, on a dry matter basis, was increased as the calorie-protein ratio was increased from 34 to 1. With calorie-protein ratio held constant, an increase in protein level of the feed caused a decrease in fat content of the carcass. With protein level held constant, there seemed to be an increase in fat deposition as calorie-protein ratio increased.

Rice <u>et al</u>. (1954) found no gross indications that carcass quality or composition were altered although 5 per cent or more hydrolyzed cottonseed foots were used in the ration. Rand, Kummerow, and Scott (1957) showed that increased protein consumption reduced the percentage of fat in the carcass and was the main factor controlling the latter.

Spring and Wilkinson (1957) conducted a study in which protein levels of 22, 25, and 28 per cent were each paired with 1200, 1350, and 1500 calories of metabolizable energy per pound of feed. The body composition of broilers were analyzed at 2, 4, 6, and 8 weeks of age after grinding the entire body immediately after the birds were killed. At 2 weeks of age, increasing dietary protein from 22 to 28 per cent, increased body protein from 18.3 to 18.8 per cent, water 71.5 to 73.6 per cent, and decreased body fat from 6.7 to 5.0 per cent. Increasing dietary energy from 1200 to 1500 calories per pound, decreased body protein from 18.8 to 18.1 per cent, water from 73.7 to 71.2 per cent, and increased body fat from 4.4 to 7.8 per cent. At 8 weeks of age, increasing dietary energy caused an increase in body fat from 6.0 to 9.1 per cent but decreased body protein from 22.1 to 21.2 per cent and water from 69.6 to 67.8 per cent. Increasing dietary protein level decreased body fat from 8.6 to 5.9 per cent and increased body protein from 21.3 to 21.8 per cent and water from 68.0 to 69.6 per cent.

McNally (1955) reported that the moisture and protein content of poultry meat on a fat-free basis are fairly constant. The fat as a component of the

tissue reduced the moisture and protein contents in proportion to their quantity in the fat-free material. Donaldson, Combs, and Romoser (1956) determined that as the ratio of energy to protein in the broiler ration was widened the energy intake and carcass fat deposition were increased and the water content of the carcass was decreased.

Leong et al. (1955), Donaldson, Combs, Romoser, and Supplee (1955), Donaldson, Combs, and Romoser (1956), Baldini and Rosenberg (1957), and Rand, Scott, and Kummerow (1957) reported that as the ratio of energy to protein in the ration was widened, the energy intake and carcass fat deposition were increased and the water content of the carcass was decreased. Lewis et al. (1955), and Lewis, Sanford, Ericson, and Clegg (1956) showed that the muscles from birds fed low-fat purified-type diets deposited more ether-extractibles in their light and dark muscles than those fed diets of higher fat content which contained natural ingredients. Carcasses of birds in which more external fat was evident, were found to contain the least muscular ether-extract.

Thomas, Glazener, and Blow (1958) reported on the differences observed in percentage ether-extract between sex of New Hampshire broilers to 10 weeks of age and between birds of the same sex and strains with relatively good and poor feed conversion. In both males and females the relatively efficient group contained a lower percentage ether-extract than did the relatively inefficient group. The males of both groups, however, had a lower percentage ether-extract than did the two groups of females.

Brunson (1958) analyzed broilers fed thiouracil and thyroprotein with and without diethylstilbestrol injections. It was found that the fat content, expressed as percentages of the dry weights of the carcasses, ranged from 11 to 48 per cent.

Lowe and Vernon (1927) reported that excessively fat birds have a very high cooking loss. It was demonstrated by Maw, Holcomb, Rodger, and Franklin (1936) that lower grade poultry, determined by the lack of body fat and finish, showed greater cooking losses than higher grade poultry. Alexander and Schopmeyer (1949) found that cooked yield of stewing hens was increased by cooling the birds in the broth in which they were cooked. Maw, Nikolaiczuk, and Johnston (1950) cooked broilers which had been fed high and low efficiency broiler rations. One-half of each broiler was cooked at high temperature (fast cooking) and the other one-half at low temperature (slow cooking). They concluded that contrary to general opinion, the high energy ration-fed stock yielded higher weight returns in cooked form with both the fast-cooking and slow-cooking methods.

Hood, Wheeler, and McGlamery (1950) reported that dripping losses during cooking were in direct relationship to the percentage of body fat and that evaporation losses were in inverse relationship to the percentage of body fat.

Klose, Pool, and De Fremery (1959) showed that cooking shrink increased with the increase in water uptake during chilling, but yield of cooked carcass calculated as percentage of freshly eviscerated, unchilled weight was essentially the same for all types of chilling and resulting water uptakes. Arscott and Sather (1958) showed that broilers fed an all-corn ration with 3 per cent fat had significantly less eviscerated losses that were reflected in greater oven-ready and cooked weights.

Orr (1955) reported that differences exist in yields of edible cooked meat among different strains of birds. Fromm and Margolf (1956), using New

Hampshire broiler-fryers which had been treated with diethylstilbestrol, demonstrated that the treated birds showed higher eviscerated yields and cooking losses than the untreated ones. Harms, Hochreich, and Meyer (1957) reported that as the energy level of broiler rations was increased a significant increase was obtained in the eviscerated yield but a greater percentage loss resulted from the drippings of the cooked birds. Brunson (1958) concluded that there was a tendency for the cooking loss to increase as the carcass fat content increased but the differences were not significant. The length of cooking time was found to have a much greater effect on cooking loss than the fat content of the carcasses.

Dawson, Walters, and Davidson (1958) conducted tests in which 5 replications of both males and females from 4 strains of birds were evaluated for percentage cooked meat, bone, and cooking losses at 6 and 16 weeks of age. They found that birds which had more fat and a better finish lost this extra fat during cooking either through volatile loss or excessive drip.

The method of cooking was shown to influence cooked yields, Essary (1957). It was found that approximately 7 per cent greater cooked yield could be

obtained with quartered broilers cooked in an electronic oven than in an electrically heated type oven. Apgar, Cox, Downey, and Fenton (1959) cooked pork patties, roasts, and chops both electronically and conventionally. No significant difference was noted in cooking method as measured by total cooking loss of either patties or roasts. Cooking electronically, however, resulted in significantly less loss in chops.

Blaker, Newcomer, and Stafford (1959) cooked hams and beef roasts, wrapped in aluminum foil and unwrapped, in an electrically heated oven. The unwrapped meat was cooked in a 350 °F oven while the meat wrapped in foil was cooked in a 500 °F oven. They concluded that no distinct advantage was derived in cooking ham or beef wrapped in foil. Distinct disadvantages were noted, however, in terms of increased weight loss due to cooking, greater fuel consumption, and a steamed flavor of the meat. Aluminum foil acted as a thermal insulator equivalent to lowering the oven temperature approximately 75 °F. Winter and Clements (1957) cooked cut-up poultry parts in pieces of heavy aluminum foil in an autoclave at 15 pounds pressure (250 °F) for 20 minutes in the case of broilers. They found that the cooking loss of ready-to-cook poultry by this method varied from about 24 per cent for chicken broilers and young turkeys to 44.5 per cent for ducks.

Several research workers have reported that added fat in the diet had an influence on the organoleptic values of the carcass. Aitken et al. (1954) concluded from a consumer preference test involving comparisons by 45 individuals, that no difference in flavor existed between birds on 10 per cent tallow with 25 per cent protein and those without fat in the diet. There was a preference, however, on the basis of moistness of the cooked flesh, for the birds which had received tallow. Morrison, Sauter, McLaren, and Stadelman (1954) reported that there were no significant differences among 8 breeds or crosses of broilers as measured by tenderness and flavor score as determined by a sensory panel, or tenderness as measured by a tenderometer. Admundson et al. (1938) showed that 2 or 5 per cent levels of fish oils fed for six weeks prior to slaughter produced off-flavors in the cooked meat. Klose, Mecchi, Hanson, and Lineweaver (1951) reported that fishy flavors and odors in roasted turkey meat can also be present in the absence of fish products by including a highly unsaturated vegetable oil (5 per cent linseed oil) in the diet.

Carlson _et al_. (1957) tried to establish the amount of certain commonly used fats and fish oils that could be safely used without adverse effects on the flavor of broilers. It was found that the mean scores for chicken flavor of those fed the various levels of tallow, menhaden oil, or menhaden oil plus antioxidant were not significantly different from those of the corresponding control samples. However, there was a tendency for chickens fed the diets containing tallow to be scored higher for chicken flavor than those fed diets containing menhaden oil plus the antioxidant, and for the latter, particularly the dark meat, to be scored higher than chickens fed menhaden oil alone. In general, scores for chickens fed tallow at all levels tested indicated that these chickens had more full natural chicken flavor than the controls. Those fed 0.5 per cent menhaden fish oil, with or without DPPD, in addition to the 0.5 per cent in the basal diet were not significantly different from the control birds. Where 0.5, 1.0, or 2.0 per cent tallow was added to the diet, chickens had very slight or no observed off flavor. One or 2.0 per cent menhaden oil, with or without DPPD, resulted in fishy off flavors.

Lewis et al. (1955) conducted a series of tests in which corn, corn oil, anise flavoring concentrate, barley, oats, soybean oil meal, peanut meal, and dried chicken feces were incorporated into a low-fat purified broiler diet. An all-vegetable type protein diet and a purified diet were fed as positive and negative controls, respectively. It was concluded that the flavor of broilers was significantly influenced by different feed ingredients in a purified diet.

Goertz, Vail, Harrison, and Sanford (1955) reported that turkeys fed a high-density low fiber feed scored slightly higher in aroma and flavor than those fed a high fiber low-density feed. Leong, Sunde, Bird, and Weckel (1958) compared the organoleptic values of one group of broilers fed 25 per cent stabilized choice white grease with another group which had received no grease supplementation. They concluded that the only significant difference was between the skin samples. Brunson (1958) fed thiouracil and thyroprotein with and without diethylstilbestrol injections for varying lengths of time to produce broilers with varying degrees of fat content. After the carcasses were cooked those containing higher fat content were scored slightly higher for tenderness, juiciness, and flavor than those containing the lower fat content.

Darrow and Essary (1955) reported that the organoleptic values of fryers fed tallow at the 5 per cent level and hydrolyzed cottonseed and soybean fats at levels of 5 and 10 per cent were acceptable after six and nine months storage. Peroxide values did not indicate the presence of rancidity during this storage period. Arscott and Sather (1958) fed broilers on rations supplemented with 0, 3, 6, or 9 per cent prime tallow and found no consistent differences could be detected in flavor or juiciness between the broilers from the different feed groups when tested fresh or after 6 and 12 months frozen storage. While no difference in tenderness was noted between groups on fresh and 6 months storage tests, slight differences were indicated at 12 months that were not supported by shear force values.

VII. EXPERIMENTAL PROCEDURE

a. Source of chicks and general procedure

Twelve White Cornish Cross[1] chicks of each sex were fed from day old to ten weeks of age in six experiments containing five lots and 12 chicks in each lot. Experiments 4, 5, and 6 were replicates of Experiments 1, 2, and 3, respectively. Chicks used in Experiments 1, 2, and 3 were obtained from a commercial hatchery who received the eggs from the same supply flocks. White Cornish crossbred chicks used in Experiments 4, 5, and 6 were obtained from the same hatchery as before but the supply flock was different from the one used in the first three experiments.

The sexed chicks were wing-banded at one day of age and placed at random by sex into five lots. Only one experiment was conducted at a time in order to use the same batteries and location for each experiment. The chicks were raised in electrically heated batteries, housed in a temperature and humidity controlled broiler house.

During the first five weeks the chicks were reared in two starter-type batteries. They were transferred to two developer-type batteries located in the same

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1 White Cornish male X White Rock female.

broiler house and reared there from five to ten weeks of age. Each starter-type battery was equipped with three pens 35" x 23" x 10", arranged with one pen above the other. Lots 1, 2, and 3 were located in one battery, and Lots 4 and 5 in the top two pens of the other battery. This arrangement was used in each experiment since location within these batteries was found to be not significant in previous feeding tests. The developer-type batteries had pens that were 30" x 28" x 15" each, arranged so that four pens were on each of three levels. Six birds were placed in a pen so that each lot occupied four pens on the same level. Lots 1, 2, and 3 were placed in the three levels from top to bottom, respectively, in one battery. Lots 4 and 5 occupied the two top layers in the other battery.

Feed and water were supplied ad libitum in metal troughs attached to the outside of each pen. Birds and feed were weighed at the start of the test and at two-week intervals to 10 weeks of age in order to determine growth rate and feed efficiency. All weights except feed weights and those in analytical procedures were obtained to the nearest gram.

Mortality occurred in five of the six experiments. Two birds died, each occurred in Lot 3 of Experiment 4, Lot 4 of Experiment 5, and Lot 1 of Experiment 6. One mortality each occurred in Lot 5 of Experiment 1, Lots 1, 4, and 5 of Experiment 3, Lots 1, 2, 4, and 5 of Experiment 4, Lots 1, 2, and 5 of Experiment 5, and Lots 2 and 3 of Experiment 6.

Feed consumption was adjusted for mortality by deducting the average consumption per bird for each day times the number of days prior to mortality. The weight of the bird was also subtracted from the total pen weight. Feed consumption therefor was calculated from the pounds of feed consumed and weight of live birds at the end of each weighing period.

Management was as near the same for all experiments as possible.

b. Feed rations

The composition of the diets tested are shown in Tables 1, 2, and 3. All rations were considered adequate for all known nutrients and in their proper amounts and relationship. Tables 4, 5, and 6 show the calculated analyses of rations used in Experiments 1 and 4, 2 and 5, and 3 and 6, respectively. Fat was calculated to have 2900 calories per pound. Percentage of added fat and protein were varied in

Table 2. Composition of experimental rations for Experiments 2 and 5

Lots:	1 lb.	2 lb.	3 lb.	4 lb.	5 lb.
Ground yellow corn	55.847	51.847	47.847	43.847	39.847
Soybean oil meal, 45% crude protein	22.0	24.0	26.0	28.0	30.0
Stabilized animal fat	0.0	2.0	4.0	6.0	8.0
Wheat flour middlings	5.0	5.0	5.0	5.0	5.0
Corn gluten meal	2.0	2.0	2.0	2.0	2.0
Menhaden fish meal	5.0	5.0	5.0	5.0	5.0
Meat scraps, 52% crude protein	2.0	2.0	2.0	2.0	2.0
Alfalfa meal, 17% crude protein	3.0	3.0	3.0	3.0	3.0
Dried whey	1.5	1.5	1.5	1.5	1.5
Ground limestone	1.3	1.3	1.3	1.3	1.3
Defluorinated rock phosphate	0.8	0.8	0.8	0.8	0.8
Iodized salt	0.4	0.4	0.4	0.4	0.4
Manganese sulfate, 80%	0.05	0.05	0.05	0.05	0.05
Dry Choline chloride, 25%	0.2	0.2	0.2	0.2	0.2
Vitamin A - D_3 mix[1]	0.1	0.1	0.1	0.1	0.1
Multi-vitamin mix[2]	0.2	0.2	0.2	0.2	0.2
Vitamin B_{12} antibiotic mix[3]	0.5	0.5	0.5	0.5	0.5
D L - Methionine, 97%	0.05	0.05	0.05	0.05	0.05
Arsanilic acid	0.01	0.01	0.01	0.01	0.01
Antioxidant[4]	0.01	0.01	0.01	0.01	0.01
Menadione	0.033	0.033	0.033	0.033	0.033

1. Contained 4000 IU vitamin A and 750 ICU vitamin D_3 per gram.
2. Contained 2 grams riboflavin, 4 grams calcium pantothenate, 6 grams niacin, and 20 grams Choline chloride per pound.
3. Contained 1.5 milligrams vitamin B_{12} and 2 grams Chlortetracycline per pound.
4. Contained 25% butylated hydroxy toluene.

Table 4. Calculated analyses of ration for Experiments 1 and 4

Lots:	1	2	3	4	5	N. R. C. Requirement
Crude protein, %	20.23	20.22	20.21	20.19	20.18	
Productive energy, cal./lb.	880	912	946	978	1011	
C-P ratio	43.5	45.1	46.8	48.4	50.1	
Added fat, %	0	2	4	6	8	
Total fat, %	3.14	5.06	6.97	8.89	10.79	
Calcium, %	1.32	1.32	1.32	1.32	1.32	1.00
Total phosphorus, %	0.70	0.70	0.69	0.69	0.69	0.60
Available phosphorus, %	0.40	0.40	0.40	0.39	0.39	0.45
Manganese, mg./lb.	66	66	66	66	66	25
Vitamin A, IU/lb.	4309	4273	4237	4201	4165	2000
Vitamin D_3, ICU/lb.	340	340	340	340	340	90
Choline, mg./lb.	757	757	757	758	758	600
Riboflavin, mg./lb.	5.11	5.10	5.10	5.09	5.09	1.3
Pantothenic acid, mg./lb.	12.10	12.07	12.03	12.00	11.96	4.2
Niacin, mg./lb.	24.09	23.90	23.69	23.51	23.32	12
Folic acid, mg./lb.	0.58	0.59	0.59	0.60	0.60	0.25
Vitamin B_{12}, mg./lb.	10.07	10.07	10.08	10.08	10.08	4
Methionine, %	0.49	0.49	0.49	0.48	0.49	0.45
Methionine and cystine, %	0.80	0.81	0.79	0.78	0.80	0.80

Table 5. Calculated analyses of ration for Experiments 2 and 5

Lots:	1	2	3	4	5	N. R. C. Requirement
Crude protein, %	20.77	21.35	21.93	22.51	23.09	
Productive energy, cal./lb.	889	912	935	959	982	
C-P ratio	42.8	42.7	42.6	42.6	42.5	
Added fat, %	0	2	4	6	8	
Total fat, %	3.09	4.95	6.81	8.67	10.53	
Calcium, %	1.31	1.32	1.32	1.33	1.33	1.00
Total phosphorus, %	0.72	0.70	0.71	0.71	0.71	0.60
Available phosphorus, %	0.39	0.39	0.40	0.39	0.39	0.45
Manganese, mg./lb.	65	65	65	66	66	25
Vitamin A, IU/lb.	4354	4294	4234	4174	4114	2000
Vitamin D_3, ICU/lb.	340	340	340	340	340	90
Choline, mg./lb.	768	786	794	822	840	600
Riboflavin, mg./lb.	5.13	5.14	5.14	5.15	5.15	1.3
Pantothenic acid, mg./lb.	12.11	12.13	12.16	12.18	12.20	4.2
Niacin, mg./lb.	24.32	24.12	23.82	23.72	23.52	12
Folic acid, mg./lb.	0.61	0.65	0.68	0.71	0.75	0.25
Vitamin B12, mg./lb.	10.02	10.04	10.05	10.07	10.09	4
Methionine, %	0.50	0.51	0.53	0.53	0.54	0.45
Methionine and cystine, %	0.81	0.83	0.86	0.87	0.88	0.80

Table 6. Calculated analyses of ration for Experiments 3 and 6

Lots:	1	2	3	4	5	N. R. C. Requirement
Crude protein, %	20.77	21.80	22.83	23.86	24.89	
Productive energy, cal./lb.	889	889	889	889	889	
C-P ratio	42.8	40.8	38.9	37.3	35.7	
Added fat, %	0	1	2	3	4	
Total fat, %	3.09	3.96	4.82	5.69	6.55	
Calcium, %	1.31	1.32	1.33	1.33	1.34	1.00
Total phosphorus, %	0.70	0.71	0.72	0.73	0.73	0.60
Available phosphorus, %	0.39	0.40	0.40	0.40	0.40	0.45
Manganese, mg./lb.	65	65	66	66	67	25
Vitamin A, IU/lb.	4354	4294	4234	4174	4114	2000
Vitamin D_3, ICU/lb.	340	340	340	340	340	90
Choline, mg./lb.	768	799	820	861	892	600
Riboflavin, mg./lb.	5.13	5.15	5.17	5.18	5.20	1.3
Pantothenic acid, mg./lb.	12.11	12.19	12.28	12.36	12.49	4.2
Niacin, mg./lb.	23.22	24.12	24.11	23.91	22.90	12
Folic acid, mg./lb.	0.61	0.67	0.72	0.77	0.79	0.25
Vitamin B_{12}, mg./lb.	10.02	10.05	10.07	10.10	10.13	4
Methionine, %	0.50	0.52	0.54	0.55	0.58	0.45
Methionine and cystine, %	0.81	0.85	0.88	0.90	0.95	0.80

the five lots of each experiment to give different calorie-protein ratios needed to study the effect of these ratios on fat deposition and certain carcass characteristics. Lot 1 in every experiment was used as the control.

In Experiments 1 and 4, protein was calculated to be approximately 20.2 per cent for each lot but the percentage of added fat (bleached tallow[1]) to which Tenox R[2] had been added at the recommended level was increased by 2.0 per cent for each succeeding lot from 0 per cent for Lot 1 to 8 per cent for Lot 5. Fat was substituted for corn in the rations. The calorie-protein ratios were calculated to be 43.5, 45.1, 46.8, 48.4, and 50.1 to 1 for Lots 1 to 5, respectively.

The rations for Experiments 2 and 5 contained added fat at 0 per cent level for Lot 1 with an increase of 2 per cent for each succeeding lot up to 8 per cent for Lot 5 as was done in Experiments 1 and 4. However, the percentage of protein was

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1. Bleached tallow furnished courtesy of Swift and Co., Chicago, Ill.

2. Tenox R furnished courtesy of Eastman Chemical Co., Kingsport, Tenn.

increased for each lot as the level of fat was increased. The per cent protein was calculated to be 20.77 for Lot 1, 21.35 for Lot 2, 21.93 for Lot 3, 22.51 for Lot 4, and 23.09 for Lot 5. The calorie-protein ratio for each lot was calculated to be approximately 42.6 to 1.

In Experiments 3 and 6 the added fat was increased by 1.0 per cent for each succeeding lot from 0 per cent for Lot 1 to 4.0 per cent for Lot 5. Protein was increased for each lot with 20.77, 21.80, 22.83, 23.86, and 24.89 per cent for Lots 1 to 5, respectively. The calorie-protein ratios were calculated to be 42.8, 40.8, 38.9, 37.3, and 35.7 to 1 for Lots 1 to 5, respectively.

c. Processing of fryers

All fryers were processed at 10 weeks of age. Each bird was weighed in the processing laboratory immediately before dressing in order to minimize the error in eviscerated yield which could be altered by the shrink of the birds while off feed, Essary (1958). The average length of time each lot of birds was off feed before processing was approximately one hour. The birds were killed by an external throat cut, bled for two minutes, sub-scalded at 138 °F for 40 seconds, and picked on a drum-type picker. All birds were warm eviscerated by the same person immediately after picking.

In order to determine eviscerated yield and areas of fat deposition, the warm eviscerated weights of giblets (heart, liver, and gizzard with attached fat) and intestinal tract were obtained. All weights were obtained by the same two persons.

Specific gravity of the warm eviscerated carcasses including the cleaned gizzard with attached fat was obtained. The birds were split down the back to avoid air pockets within the body cavity during the weighing process in water. The giblets from each bird were placed in numbered giblet bags containing holes and chilled in ice slush with the carcasses for approximately four hours. After chilling, the birds and giblets were allowed to drain for 10 minutes before being reweighed to obtain the percentage moisture pick-up resulting from chilling. Chilled abdominal fat and fat attached to the gizzard were removed and weighed to determine the percentage of fat deposited in these two areas, based on live bird weight.

d. Chemical analyses

In Experiments 4, 5, and 6, two males and two females were selected at random from a weight range around the mean of each lot so that any differences obtained in chemical analysis would not be due to different size birds.

Chemical analyses were determined on the raw meat of the breast, wing (except third joint), thigh, and drumstick from one half of each fryer and the skin from the other half of each carcass. The whole eviscerated birds were held overnight in stainless steel trays of crushed ice in a walk-in type cooler at 38 °F ± 2 °F before the same persons cut-up the carcasses each time. The carcasses were drained thoroughly before they were cut-up. The meat and skin with attached fat from each of the pieces were removed, placed in labeled glass jars equipped with screw-type lids, and held frozen at -20 °F until analyzed approximately three months later.

Tissues were defrosted at room temperature and ground three times in a Kitchen-Aid meat grinder. The fluid which escaped from the tissue during defrosting was added back to the tissue while being ground. The ground tissue was mixed thoroughly before samples for analysis were taken. The entire tissue was used for moisture and fat determinations, and 0.3 gram sample used for protein analysis using A. O. A. C. methods (1955).

e. Cooking tests

Birds not used for chemical analyses were wrapped butcher-style in freezer-locker wax-tite paper, labeled, and frozen at -20 °F. After three months storage four birds of each sex of each lot and experiment were selected at random from a weight range about the mean of each lot, defrosted overnight at room temperature, weighed without giblets, and placed breast-up on racks in open pans in an electrically heated, commercial size oven preheated to 325 °F. The birds were brushed lightly once with melted butter. Meat-type thermometers were inserted in the muscle along the thigh bone and in the thickest part of the major breast muscle of a representative sample of birds for each group being cooked. The birds were cooked to an internal temperature of 190 °F. The juices were drained from the body cavity and weighed after cooling for 10 minutes. The juices were not weighed to determine the percentage of volatile and non-volatile material cooked from the carcasses.

f. Other determination of carcasses

After two months storage four birds of each sex were selected, defrosted at room temperature, and skinned to determine percentage skin weight of the eviscerated carcass.

g. Cost of production (feed ingredients only)

Feed costs for the first three experiments were calculated on ingredient costs at Roanoke, Virginia, April 8, 1958. The cost of producing a pound of live broiler to 10 weeks of age and on warm eviscerated weight of 10 week old fryers were determined by using the cost of the feed (not including mixing costs), feed efficiency, and eviscerated yield of each lot of each experiment.

The chilled abdominal fat and fat attached to gizzard were used to determine the potential loss to a processor if part or all of the fat from these areas was lost during the processing operation.

The data were treated by the analysis of variance, Snedecor (1946), and by the multiple range and multiple F tests, Duncan (1955).

VIII. RESULTS

a. Experiment 1

Each ration fed in Experiment 1 contained approximately 20.2 per cent protein while fat was increased by 2 per cent for each succeeding lot from 0 per cent for Lot 1 to 8 per cent for Lot 5. Productive energy in calories per pound of feed was 880, 912, 946, 978, and 1011 for Lots 1 to 5, respectively. The growth rates of fryers to 10 weeks of age in the 5 lots are shown in Figure 1 and the average weights are given in Table 7. It will be noted from Figure 1 that the growth rate for the females in each lot was similar up to 10 weeks of age. The growth rates for the males were similar during this period, except those in Lot 1 increased at a slower rate after 8 weeks. The males and females grew at different rates during most of the period. At 10 weeks of age the average weight was 3.26 pounds for Lot 1, 3.57 for Lot 2, 3.61 for Lot 3, and 3.62 for Lots 4 and 5. There was a significant difference at the 1 per cent level of probability between lots and sex, and at the 5 per cent level for lots X sex. There was no significant difference between the average weights of Lots 2, 3

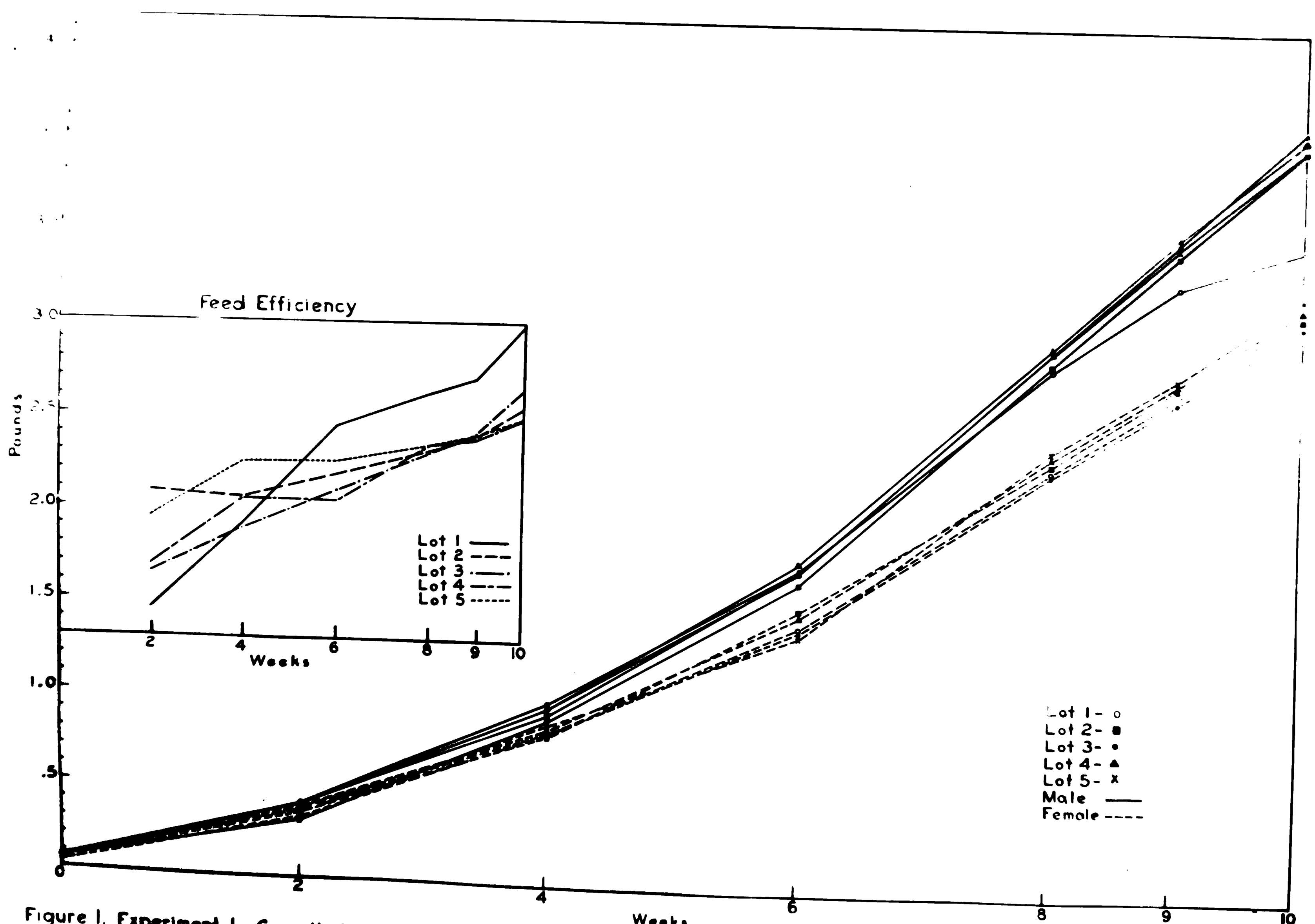

Figure 1. Experiment 1.-Growth Rate and Feed Efficiency to 10 Weeks of Age

Table 7. Experiment 1, Ten week live weights. Average 11 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Pounds			
Male	3.48	4.02	4.14	4.08	4.02	3.95
Female	3.03	3.11	3.08	3.16	3.21	3.12
Grand mean	3.26	3.57	3.61	3.62	3.62	

Table 7a. Experiment 1, analysis of variance[2], 10 week live weights.

Source of variation	d.f.	Mean square
Between treatments	9	500,677.70**
Lots	4	114,867.43**
Sex	1	3,849,956.74**
Lots x sex	4	49,168.20*
Error	100	16,917.71

** P < .01
* P < .05

Lot 1[1]	Lot 2	Lot 3	Lot 4	Lot 5
3.26	3.57	3.61	3.62	3.62

1. Lots not underlined by the same line are significantly different.

2. Analyses of variance of Experiments 1 to 6 for live weights were analyzed using weights in grams.

4, and 5. However, Lot 1 weighed significantly less than all other lots, Table 7a.

Feed efficiency[1] to 10 weeks of age, as shown in Figure 1 and Table 8, was the highest for Lot 1 (2.98 pounds) and lowest for Lots 4 and 5 (2.49 pounds). Lots 2 and 3 had feed efficiencies of 2.55 and 2.64 pounds, respectively.

Warm eviscerated yields for fryers 10 weeks of age are given in Table 9. In general, slightly greater eviscerated yields resulted in those lots receiving higher levels of fat in the diet. However, this difference was not significant, Table 9a.

The average specific gravity of the warm eviscerated carcasses with gizzard and attached fat, as shown in Table 10, was less for lots which received higher levels of fat in the diet. Lot 1 had an average specific gravity of 1.054 which showed that less fat was deposited in the carcasses of Lot 1 than in Lots 2, 3, 4, and 5 which had an average specific gravity of 1.048, 1.049, 1.047, and 1.050, respectively. There was a significant difference in specific gravity at the 5 per cent level of probability between lots, and at the 1 per

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1. Feed efficiency is interpreted to mean pounds of feed for each pound of gain.

Table 8. Experiment 1, Feed efficiency to 10 weeks of age.

Lot 1	Lot 2	Lot 3	Lot 4	Lot 5
Pounds of feed per pound of live weight				
2.98	2.55	2.64	2.49	2.49

Table 9. Experiment 1, Warm eviscerated yield of 10 week old fryers. Average 11 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	71.54	71.32	72.52	71.58	73.33	72.06
Female	71.00	72.18	71.62	71.88	71.30	71.60
Grand mean	71.27	71.75	72.07	71.73	72.32	

Table 9a. Experiment 1, Analysis of variance, warm eviscerated yield of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	5.2147
Lots	4	3.4259
Sex	1	5.8559
Lots x sex	4	6.8433
Error	100	2.7726

Table 10. Experiment 1, Specific gravity of warm eviscerated carcasses with gizzards and attached fat. Average 11 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Specific gravity			
Male	1.059	1.049	1.050	1.050	1.051	1.052
Female	1.049	1.046	1.047	1.044	1.048	1.047
Grand mean	1.054	1.048	1.049	1.047	1.050	

Table 10a. Experiment 1, Analysis of variance, specific gravity of warm eviscerated carcasses with gizzards and attached fat.

Source of variation	d.f.	Mean square
Between treatments	9	0.000627**
Lots	4	0.000156*
Sex	1	0.000653**
Lots x sex	4	0.001092**
Error	100	0.000052

** $P < .01$
 * $P < .05$

Lot 4	Lot 2	Lot 3	Lot 5	Lot 1
1.047	1.048	1.049	1.050	1.054

cent level between sex and lots X sex. Specific gravity of fryers in Lot 1 was significantly higher (1 per cent level) from the other 4 lots, Table 10a.

There was no significant difference in moisture pick-up from the chilling operation between lots, Tables 11 and 11a. However, there was a sex difference at the 5 per cent level of probability. Females picked up a higher percentage of moisture than did the males.

The chilled abdominal fat and gizzard fat, expressed as a percentage of live weight, increased as the level of added fat in the diet increased with the percentage protein constant in all diets, Table 12. Fryers in Lot 1 had 1.10 per cent abdominal and gizzard fat which was the lowest of the 5 lots. Lots 4 and 5 had the two highest amounts of fat, 2.23 and 1.86 per cent, respectively. There was a highly significant difference in fat percentages between lots and sex, Table 12a.

The average percentage heart weights, based on 10 week live weights, are shown in Table 13. There were no significant differences between lots or sex, but a significant difference occurred in lots X sex, Table 13a. The heart weights, as a percentage of live weights, increased as the level of fat in the diet increased.

Table 11. Experiment 1, Percentage moisture pick-up during chilling operation. Average 11 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	4.84	4.75	4.79	5.25	4.73	4.87
Female	6.15	5.13	5.55	5.53	5.89	5.65
Grand mean	5.50	4.94	5.17	5.39	5.31	

Table 11a. Experiment 1, Analysis of variance, percentage moisture pick-up during chilling operation.

Source of variation	d.f.	Mean square
Between treatments	9	2.8131
Lots	4	1.0154
Sex	1	16.6220*
Lots x sex	4	1.1585
Error	100	2.4131

* $P < .05$

Table 12. Experiment 1, Percentage chilled abdominal and gizzard fat of 10 week old fryers. Average 11 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	0.73[1]	1.23	1.48	1.80	1.69	1.38
Female	1.46	1.63	1.54	2.66	2.03	1.86
Grand mean	1.10	1.43	1.51	2.23	1.86	

Table 12a. Experiment 1, Analysis of variance, percentage chilled abdominal and gizzard fat of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	2.796553**
Lots	4	4.143930**
Sex	1	6.341282**
Lots x sex	4	0.502992
Error	100	0.804498

** $P < .01$

Lot 1	Lot 2	Lot 3	Lot 5	Lot 4
1.10	1.43	1.51	1.86	2.23

1. Percentage rounded off to second place. Analysis of variance calculated on percentage carried to third place.

Table 13. Experiment 1, Percentage heart of 10 week old fryers. Average 11 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	0.45	0.41	0.43	0.42	0.48	0.44
Female	0.38	0.44	0.43	0.43	0.44	0.42
Grand mean	0.42	0.42	0.43	0.42	0.46	

Table 13a. Experiment 1, Analysis of variance, percentage heart of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.007193
Lots	4	0.005509
Sex	1	0.005334
Lots x sex	4	0.009342*
Error	100	0.003656

* $P < .05$

Percentage gizzard with attached fat, based on live weight, increased as the level of added fat in the diet increased, as shown in Table 14. This difference was not statistically significant between lots. However, it was highly significant between sex, Table 14a. The females had a higher percentage gizzard with attached fat than did the males from the same lots. Some of this difference was due probably to the greater amount of fat attached to the gizzard of the females. Table 15 shows that the females had a higher percentage gizzard without fat than the males which was significant at the 5 per cent level of probability, Table 15a. The average percentage gizzard weights without fat decreased in lots receiving higher levels of fat in the diet.

The average percentage liver based on live weight was comparable between the different lots, Table 16. However, the females had a significantly greater percentage liver weight than the males, Table 16a.

The percentage intestinal weights, Table 17, were comparable for all lots. The intestines of the females, on a percentage basis, however, were significantly heavier than those of the males, as shown in Table 17a.

Table 14. Experiment 1, Percentage gizzard with attached fat of 10 week old fryers. Average 11 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	2.03	2.03	2.10	1.93	2.22	2.06
Female	2.31	2.34	2.46	2.58	2.30	2.40
Grand mean	2.17	2.18	2.28	2.26	2.26	

Table 14a. Experiment 1, Analysis of variance, percentage gizzard with attached fat of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.469205**
Lots	4	0.053428
Sex	1	3.124159**
Lots x sex	4	0.221244
Error	100	0.162331

** $P < .01$

Table 15. Experiment 1, Percentage chilled gizzard, without attached fat, of 10 week old fryers. Average 11 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	1.80	1.75	1.65	1.56	1.58	1.67
Female	1.82	1.83	1.81	1.73	1.76	1.79
Grand mean	1.81	1.79	1.73	1.65	1.67	

Table 15a. Experiment 1, Analysis of variance, percentage chilled gizzard, without attached fat, of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.1095
Lots	4	0.1186
Sex	1	0.3948*
Lots x sex	4	0.0290
Error	100	0.0783

* $P < .05$

Table 16. Experiment 1, Percentage liver of 10 week old fryers. Average 11 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	1.83	1.85	1.71	1.78	1.81	1.80
Female	1.80	1.94	1.84	1.96	1.91	1.89
Grand mean	1.82	1.89	1.77	1.87	1.86	

Table 16a. Experiment 1, Analysis of variance, percentage liver of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.061834
Lots	4	0.052100
Sex	1	0.230008*
Lots x sex	4	0.029525
Error	100	0.049202

* $P < .05$

Table 17. Experiment 1, Percentage intestine of 10 week old fryers. Average 11 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	6.58	6.72	6.58	6.74	6.31	6.59
Female	7.00	7.44	6.90	7.02	6.82	7.04
Grand mean	6.79	7.08	6.74	6.88	6.57	

Table 17a. Experiment 1, Analysis of variance, percentage intestine of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	1.0446
Lots	4	0.7974
Sex	1	5.5194**
Lots x sex	4	0.1731
Error	100	0.6632

** $P < .01$

The percentage skin of the chilled eviscerated carcass is shown in Table 18. With the exception of Lot 3, lots receiving the higher levels of fat in the diet showed a greater percentage skin. The per cent of skin weights were 13.11, 13.65, 12.90, 14.37, and 14.32, respectively, for Lots 1 to 5. There was a significant difference between lots at the 5 per cent level of probability. There were no statistical differences in percentage of skin weights between Lots 1, 2, and 3; however, Lots 4 and 5 were higher than Lots 1 and 3, Table 18a.

The percentage cooked yields are shown in Table 19. There was no statistical difference between lots or sex but a significant difference existed in sex X lots, Table 19a. With the abdominal fat and gizzard fat removed from the carcass there was no significant difference in cooking yields of the carcasses between the different lots.

Table 18. Experiment 1, Percentage skin of chilled eviscerated carcass weights. Average 4 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	13.14	13.48	13.07	14.62	13.35	13.53
Female	13.08	13.81	12.73	14.11	15.28	13.80
Grand mean	13.11	13.65	12.90	14.37	14.32	

Table 18a. Experiment 1, analysis of variance, percentage skin of chilled eviscerated carcass weights.

Source of variation	d.f.	Mean square
Between treatments	9	2.5526*
Lots	4	3.6351*
Sex	1	0.7426
Lots x sex	4	1.9226
Error	40	1.0378

* $P < .05$

Lot 3	Lot 1	Lot 2	Lot 5	Lot 4
12.90	13.11	13.65	14.32	14.37

Table 19. Experiment 1, Percentage cooking yield. Average 4 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	77.44	80.40	78.54	77.07	78.50	78.39
Female	83.06	77.59	77.67	77.31	77.25	78.58
Grand mean	80.25	79.00	78.11	77.19	77.88	

Table 19a. Experiment 1, Analysis of variance, percentage cooking yield.

Source of variation	d.f.	Mean square
Between treatments	9	14.2448
Lots	4	11.1445
Sex	1	0.3330
Lots x sex	4	20.8230*
Error	30	7.0311

* $P < .05$

b. Experiment 2

In this experiment the percentages of fat and protein were increased in the same proportion for each succeeding lot from Lot 1 to Lot 5. The C-P ratio was approximately 43 to 1 for all lots. The growth rate of the birds in different lots is shown in Figure 2 and Table 20. Birds in all lots gained weight at approximately the same rate. The growth rates for the males and females were different within the same lots indicating a difference in the nutritional requirements between males and females. There was no significant difference in the average 10 week live weights between lots, Table 20a.

Feed efficiency for the 5 lots ranged from 2.62 pounds of feed per pound of gain for Lot 1 to 2.33 pounds for Lot 5, Table 21 and Figure 2. The higher levels of fat and protein in the diet increased feed efficiency but did not increase rate of growth.

Warm eviscerated yields, as shown in Table 22, were comparable for the 5 lots. Even though there was no significant difference in yield between lots, Table 22a, yields were slightly lower in lots which received higher levels of fat and protein in the diet.

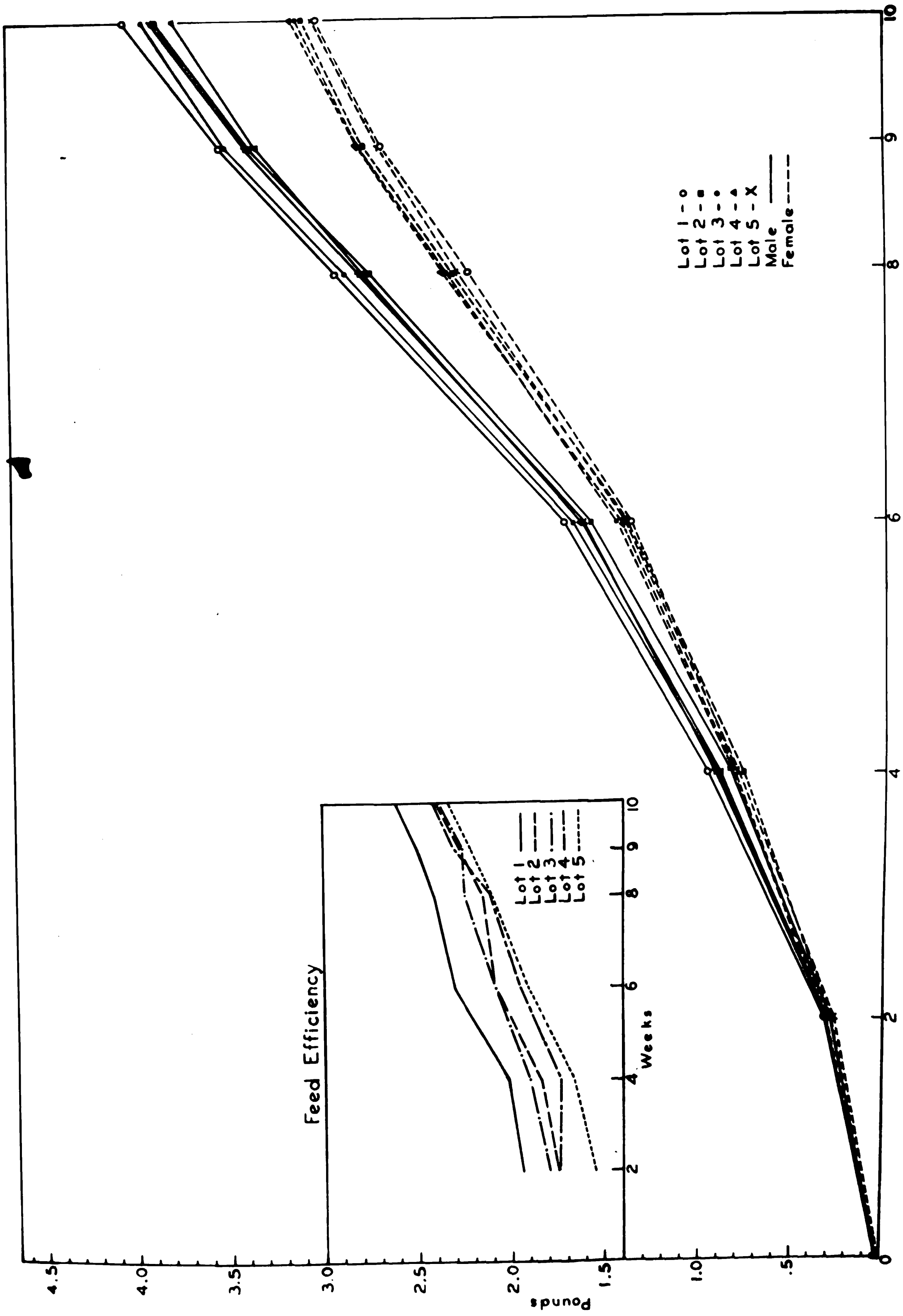

Figure 2. Experiment 2.-Growth Rate and Feed Efficiency to 10 Weeks of Age

Table 20. Experiment 2, Ten week live weights. Average 11 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Pounds			
Male	4.02	3.84	3.93	3.74	3.85	3.88
Female	2.99	3.07	3.09	3.13	3.03	3.06
Grand mean	3.51	3.46	3.51	3.44	3.44	

Table 20a. Experiment 2, Analysis of variance, 10 week live weights.

Source of variation	d.f.	Mean square
Between treatments	9	440,894.44**
Lots	4	2,056.00
Sex	1	3,870,563.00**
Lots x sex	4	22,315.75
Error	100	19,677.21

** $P < .01$

Table 21. Experiment 2, Feed efficiency to 10 weeks of age.

Lot 1	Lot 2	Lot 3	Lot 4	Lot 5
Pounds of feed per pound of live weight				
2.62	2.40	2.39	2.42	2.33

Table 22. Experiment 2, Warm eviscerated yield of 10 week old fryers. Average 11 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	72.20	71.64	71.73	71.13	71.33	71.61
Female	71.17	71.16	71.16	71.33	71.44	71.25
Grand mean	71.69	71.40	71.45	71.23	71.39	

Table 22a. Experiment 2, Analysis of variance, warm eviscerated yield of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	1.7714
Lots	4	0.3283
Sex	1	4.3045
Lots x sex	4	2.5813
Error	100	2.0122

Table 23 shows the average specific gravity for fryers in the different lots. Lot 1 had an average specific gravity of 1.063 which indicates that the carcasses contained less fat than Lots 2, 3, 4, and 5 which had specific gravities of 1.060, 1.061, 1.056, and 1.058, respectively. However, these differences were not significant, as shown in Table 23a.

There were differences between lots in the percentage of moisture pick-up during the chilling operation, Table 24. These small differences were not significant between lots but were highly significant between the males and females, Table 24a.

When the percentages of chilled abdominal and gizzard fats removed from the carcasses are compared, Table 25, lots which received higher levels of fat and protein in the diet deposited more fat in these areas of the birds. There was a highly significant difference between lots, Table 25a. Lot 4 showed the greatest and Lot 1 the lowest percentage fat in these areas.

The percentage hearts of the live weights ranged from 0.40 per cent in Lot 1 to 0.46 per cent in Lot 3, as shown in Table 26. There was a significant difference between lots, Table 26a. Percentage

Table 23. Experiment 2, Specific gravity of warm eviscerated carcass with gizzard and attached fat. Average 11 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Specific gravity			
Male	1.063	1.063	1.063	1.059	1.059	1.061
Female	1.063	1.056	1.059	1.053	1.057	1.058
Grand mean	1.063	1.060	1.061	1.056	1.058	

Table 23a. Experiment 2, Analysis of variance, specific gravity of warm eviscerated carcass with gizzard and attached fat.

Source of variation	d.f.	Mean square
Between treatments	9	0.000108
Lots	4	0.000128
Sex	1	0.000285
Lots x sex	4	0.000044
Error	100	0.102051

Table 24. Experiment 2, Percentage moisture pick-up during chilling operation. Average 11 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	4.11	4.26	4.22	4.38	4.13	4.22
Female	5.19	4.72	4.72	5.03	4.30	4.79
Grand mean	4.65	4.49	4.47	4.71	4.22	

Table 24a. Experiment 2, Analysis of variance, percentage moisture pick-up during chilling operation.

Source of variation	d.f.	Mean square
Between treatments	9	1.6313
Lots	4	0.9940
Sex	1	9.0262**
Lots x sex	4	0.6199
Error	100	1.4725

** $P < .01$

Table 28. Experiment 2, Percentage chilled gizzard, without attached fat, of 10 week old fryers. Average 11 birds of each sex in each lot

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	1.79	1.76	1.51	1.70	1.64	1.68
Female	1.92	1.90	1.77	1.69	1.64	1.78
Grand mean	1.85	1.83	1.64	1.69	1.64	

Table 28a. Experiment 2, Analysis of variance, percentage chilled gizzard, without attached fat, of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.308780**
Lots	4	0.238506**
Sex	1	0.296816*
Lots x sex	4	0.382044**
Error	100	0.063239

** $P < .01$
* $P < .05$

Lot 5	Lot 3	Lot 4	Lot 2	Lot 1
1.64	1.64	1.69	1.83	1.85

Table 29. Experiment 2, Percentage liver of 10 week old fryers. Average 11 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	1.63	1.59	1.70	1.73	1.85	1.70
Female	1.80	1.73	1.75	1.69	1.90	1.77
Grand mean	1.71	1.66	1.73	1.71	1.87	

Table 29a. Experiment 2, Analysis of variance, percentage liver of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.096893**
Lots	4	0.141426**
Sex	1	0.144438*
Lots x sex	4	0.040472
Error	100	0.028803

** $P < .01$
* $P < .05$

Lot 2	Lot 4	Lot 1	Lot 3	Lot 5
1.66	1.71	1.71	1.73	1.87

hearts from Lots 2, 3, and 5 were significantly higher than for Lot 1. There was a lots x sex interaction in percentage heart.

The percentage gizzard with attached fat was influenced by the diet, Table 27. In general, the percentage gizzard weights with attached fat decreased as the levels of fat and protein in the diet increased. Lots 1, 2, and 4 had the highest percentage gizzards with attached fat as shown in Table 27a.

Table 28 shows that fryers from lots with higher levels of fat and protein in the diet had lower percentage of gizzards without attached fat. This indicates that higher energy diets resulted in smaller gizzards. The gizzards from Lots 1 and 2, which were on lower levels of fat and protein, were significantly heavier than those from Lots 3 and 5, Table 28a. Lot x sex interaction was highly significant.

As shown in Tables 29 and 29a, there was a significant difference between lots and sex in percentage liver. Lot 5, which received the highest level of fat and protein in the diet, had the highest per cent liver (1.87). Lot 2 had the lowest per cent liver (1.66).

Table 30. Experiment 2, Percentage intestine of 10 week old fryers. Average 11 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	5.89	6.05	6.57	6.61	6.61	6.35
Female	6.80	6.68	6.76	6.37	7.06	6.73
Grand mean	6.35	6.37	6.67	6.49	6.84	

Table 30a. Experiment 2, Analysis of variance, percentage intestine of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	1.3602**
Lots	4	0.9501
Sex	1	4.1750**
Lots x sex	4	1.0665*
Error	100	0.4162

** $P < .01$
* $P < .05$

Table 31. Experiment 2, Percentage skin of chilled eviscerated carcass weights. Average 5 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	12.30	12.78	12.96	13.55	12.77	12.87
Female	13.79	14.16	13.95	14.29	14.16	14.07
Grand mean	13.05	13.47	13.46	13.92	13.47	

Table 31a. Experiment 2, Analysis of variance, percentage skin of chilled eviscerated carcass weights.

Source of variation	d.f.	Mean square
Between treatments	9	2.5212
Lots	4	0.9431
Sex	1	17.9161**
Lots x sex	4	0.2507
Error	40	1.4669

** $P < .01$

Table 32. Experiment 2, Percentage cooking yield. Average 4 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	81.48	82.21	83.06	80.11	83.15	82.00
Female	81.45	77.54	75.35	79.60	79.96	78.78
Grand mean	81.47	79.88	79.21	79.86	81.56	

Table 32a. Experiment 2, Analysis of variance, percentage cooking yield.

	d.f.	Mean square
Between treatments	9	24.3529
Lots	4	8.9271
Sex	1	103.9095*
Lots x sex	4	19.8895
Error	30	15.6668

* $P < .05$

c. Experiment 3

In this experiment the per cent protein in the diet was increased from 20.77 in the ration for Lot 1 to 24.89 for Lot 5, while added fat was increased by 1 per cent for each succeeding lot from 0 per cent for Lot 1 to 4 per cent for Lot 5. This relationship between added fat and protein gave a C-P ratio of 42.8, 40.8, 38.9, 37.3, and 35.7 to 1 for Lots 1 to 5, respectively. Productive energy in calories per pound of feed was 889 for each lot. The growth rate and 10 week live weights from these rations are shown in Figure 3 and Table 33. It will be noted in Figure 3 that the growth rates, particularly of the males, varied at the two week intervals. Birds in Lot 3 with 2 per cent added fat gained at a lower rate than did birds in other lots which contained either lower or higher levels of added fat. Lots x sex interaction was significant. There was a highly significant difference between Lot 3 and the other lots, and between sex, Table 33a. Apparently there was some factor other than C-P ratio involved in the growth rate of Lot 3. However, a reason for this difference is not known.

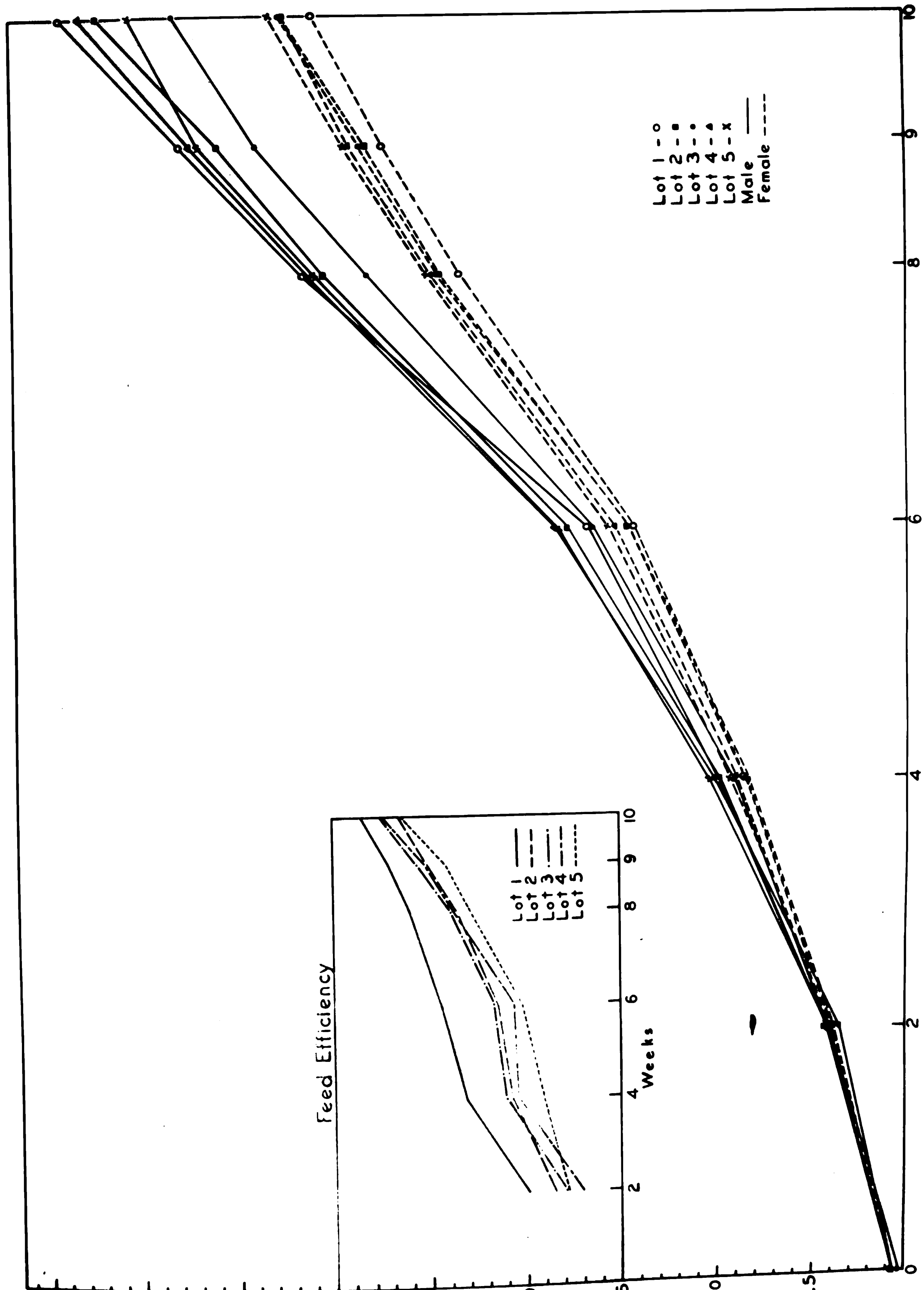

Figure 3. Experiment 3. – Growth Rate and Feed Efficiency to 10 Weeks of Age.

Table 33. Experiment 3, Ten week live weights. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Pounds			
Male	4.39	4.18	3.77	4.28	4.02	4.13
Female	3.07	3.23	3.23	3.21	3.27	3.20
Grand mean	3.73	3.71	3.50	3.75	3.65	

Table 33a. Experiment 3, Analysis of variance, 10 week live weights.

Source of variation	d.f.	Mean square
Between treatments	9	570,355.56**
Lots	4	81,561.32**
Sex	1	4,541,587.21**
Lots x sex	4	66,341.88*
Error	90	21,719.28

** $P < .01$
* $P < .05$

Lot 3	Lot 2	Lot 4	Lot 1	Lot 5
3.50	3.71	3.75	3.73	3.65

The feed efficiencies, Table 34 and Figure 3, were 2.84, 2.66, 2.75, 2.74, and 2.64 for Lots 1 to 5, respectively. The higher percentage of protein with a small increase in the amount of fat in the diet increased feed efficiency by 0.2 per cent between Lots 1 and 5.

The average percentage warm eviscerated yields were comparable between lots, Table 35. There was a significant difference in lots x sex interaction for eviscerated yield, Table 35a.

The average specific gravity ranged from a high of 1.048 for birds in Lot 1 to a low of 1.045 for those in Lot 4, Table 36. Birds on higher levels of protein with a small amount of added fat had a lower specific gravity than those on lower levels of protein and fat. There was a highly significant difference between sex but not between lots, Table 36a.

The percentage moisture pick-up during the chilling operation is presented in Table 37. Even though some differences were noted between lots, these differences were not significant, Table 37a. There was a highly significant difference between sex. The female fryers picked up a greater percentage of

Table 34. Experiment 3, Feed efficiency to 10 weeks of age.

Lot 1	Lot 2	Lot 3	Lot 4	Lot 5
Pounds of feed per pound of live weight				
2.84	2.66	2.75	2.74	2.64

Table 35. Experiment 3, Warm eviscerated yield of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	72.34	71.66	69.80	71.40	71.74	71.39
Female	70.30	72.08	71.56	71.98	72.08	71.60
Grand mean	71.32	71.87	70.68	71.69	71.91	

Table 35a. Experiment 3, Analysis of variance, warm eviscerated yield of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	6.7073*
Lots	4	5.2156
Sex	1	1.1088
Lots x sex	4	9.5985*
Error	90	2.5432

* $P < .05$

Table 36. Experiment 3, Specific gravity of warm eviscerated carcass with gizzard and attached fat. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Specific gravity			
Male	1.052	1.053	1.053	1.048	1.053	1.052
Female	1.043	1.040	1.041	1.042	1.038	1.041
Grand mean	1.048	1.047	1.047	1.045	1.046	

Table 36a. Experiment 3, Analysis of variance, specific gravity of warm eviscerated carcass with gizzard and attached fat.

Source of variation	d.f.	Mean square
Between treatments	9	0.000352**
Lots	4	0.000026
Sex	1	0.002830**
Lots x sex	4	0.000060
Error	90	0.000053

* $P < .01$

Table 37. Experiment 3, Percentage moisture pick-up during chilling operation. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	4.54	3.82	5.27	5.57	4.61	4.76
Female	5.72	5.78	5.02	5.79	5.59	5.58
Grand mean	5.13	4.80	5.15	5.68	5.10	

Table 37a. Experiment 3, Analysis of variance, percentage moisture pick-up during chilling operation.

Source of variation	d.f.	Mean square
Between treatments	9	4.3949*
Lots	4	2.0235
Sex	1	16.5649**
Lots x sex	4	3.7238
Error	90	1.7441

** $P < .01$
* $P < .05$

moisture during the chilling operation than did the male fryers.

The percentages of abdominal and gizzard fat as shown in Table 38 are not consistent between the different lots. Lots 1 and 4 which received lower and higher levels of protein, respectively, had the two highest percentages of fat. There was a significant difference at the 1 per cent level of probability in the amount of abdominal and gizzard fat between sex, Table 38a.

The percentage heart was comparable between lots, Table 39. However, there was a highly significant difference in heart percentages between sex, and a significant interaction of lots x sex, Table 39a.

In the percentage gizzard with attached fat, Table 40, there was no significant difference between lots but there was a highly significant difference between sex. Gizzards were heavier (percentage basis) in the female birds, Table 40a.

After the fat had been removed from the cleaned gizzards there was no significant difference in weights (percentage basis) between lots or sex, Tables 41 and 41a.

Table 38. Experiment 3, Percentage chilled abdominal and gizzard fat of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	1.17	1.13	0.48	1.45	0.88	1.02
Female	1.78	1.25	1.75	1.84	1.69	1.66
Grand mean	1.48	1.19	1.11	1.65	1.29	

Table 38a. Experiment 3, Analysis of variance, percentage chilled abdominal and gizzard fat of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	1.984508**
Lots	4	0.954134
Sex	1	10.278436**
Lots x sex	4	0.941400
Error	90	0.496910

** $P < .01$

Table 39. Experiment 3. Percentage heart of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	0.46	0.47	0.44	0.44	0.43	0.45
Female	0.38	0.39	0.45	0.41	0.45	0.41
Grand mean	0.42	0.43	0.44	0.42	0.44	

Table 39a. Experiment 3, Analysis of variance, percentage heart of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.00888387*
Lots	4	0.00221198
Sex	1	0.02894724**
Lots x sex	4	0.01053992*
Error	90	0.00366130

** $P < .01$
* $P < .05$

Table 40. Experiment 3, Percentage gizzard, with attached fat, of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	1.94	1.79	1.84	1.86	1.82	1.85
Female	2.26	2.14	2.19	2.12	1.91	2.12
Grand mean	2.10	1.97	2.02	1.99	1.87	

Table 40a. Experiment 3, Analysis of variance, percentage gizzard, with attached fat, of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.295178
Lots	4	0.141480
Sex	1	1.858315**
Lots x sex	4	0.053091
Error	90	0.151909

** P < .01

Table 41. Experiment 3, Percentage chilled gizzard, without attached fat, of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	1.68	1.63	1.78	1.49	1.59	1.63
Female	1.89	1.79	1.73	1.68	1.60	1.74
Grand mean	1.78	1.71	1.75	1.58	1.60	

Table 41a. Experiment 3, Analysis of variance, percentage chilled gizzard, without attached fat, of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.134604
Lots	4	0.167142
Sex	1	0.268635
Lots x sex	4	0.068560
Error	90	0.084605

The liver weights, expressed as a percentage of live weights, were comparable between lots and sex, Tables 42 and 42a. When the productive energy was 889 calories in each pound of feed for each lot, no differences in liver weights were found between lots.

In Tables 43 and 43a the percentage intestines of the 10 week old live weights were comparable between lots.

The percentage skins of the chilled eviscerated carcasses are presented in Table 44. There was about 1.5 per cent difference in skin weights between the males and females. Statistical analyses were not determined because of uneven numbers in the different lots.

There was no difference in the cooking yield between lots, Table 45. However, the females gave about 3 per cent higher cooking yield which was significant at the 1 per cent level of probability, Table 45a.

Since the rations within each of the three different experiments contained a certain relationship between the level of added fat and percentage protein, the average cooking yield for the lots within each experiment were combined for analysis. As shown in

Table 42. Experiment 3, Percentage liver of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	1.83	1.83	1.71	1.75	1.76	1.78
Female	1.72	1.82	1.85	1.83	1.95	1.83
Grand mean	1.78	1.82	1.78	1.79	1.85	

Table 42a. Experiment 3, Analysis of variance, percentage liver of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.049256
Lots	4	0.022740
Sex	1	0.081054
Lots x sex	4	0.067822
Error	90	0.057869

Table 43. Experiment 3, Percentage intestine of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	6.59	6.82	7.43	6.65	6.82	6.86
Female	6.88	6.84	7.06	7.25	7.16	7.04
Grand mean	6.74	6.83	7.25	6.95	6.99	

Table 43a. Experiment 3, Analysis of variance, percentage intestine of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.7206
Lots	4	0.7448
Sex	1	0.8118
Lots x sex	4	0.6736
Error	90	0.5225

Table 44. Experiment 3, Percentage skin of chilled eviscerated carcass weights. Average 4 birds of each sex in Lots 2, 3, and 4. Average 2 birds of each sex in Lots 1 and 5.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	13.41	13.51	13.95	14.75	13.85	13.89
Female	15.27	15.16	15.56	15.78	13.85	15.12
Grand mean	14.34	14.34	14.76	15.27	13.85	

Table 45. Experiment 3, Percentage cooking yield. Average 4 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	80.48	79.77	81.42	79.06	81.48	80.44
Female	85.50	80.37	80.63	86.28	85.57	83.67
Grand mean	82.99	80.07	81.03	82.67	83.53	

Table 45a. Experiment 3, Analysis of variance, Percentage cooking yield.

Source of variation	d.f.	Mean square
Between treatments	9	28.6194
Lots	4	16.7934
Sex	1	104.4259**
Lots x sex	4	21.4938
Error	30	13.0876

** $P < .01$

Table 46, there was a highly significant difference in cooking yields between birds in Experiments 1, 2, and 3. Birds in Experiment 1 which received the highest level of added fat in relation to the percentage of protein in the diet had the lowest cooking yield. Birds in Experiment 3, which had the highest level of protein with a low amount of fat in the different rations, had the highest cooking yield.

Table 46. Combined statistical analysis for cooking yields of Experiments 1, 2, and 3.

Source of variation	d.f.	Mean square
Between experiments	2	127.8902**
Lots	4	20.3386
Sex	1	0.1209
Experiments x lots	8	8.2632
Experiments x sex	2	104.2738**
Lots x sex	4	49.3340**
Experiments x lots x sex	8	6.4361
Error	90	11.9285

** P < .01

Experiments		
1	2	3
78.48	80.39	82.06

d. Cost of production, Experiments 1, 2, and 3

It is well known that the cost of feed is influenced by the kind and amount of each ingredient used. There were differences in the cost of the rations fed and in the feed efficiencies of the different rations used in these experiments. It seemed advisable, therefore, to determine the cost of producing, say, for example, 10,000 pounds of live broilers and the cost per pound of warm eviscerated carcasses based on ingredient cost, feed efficiency, and dressing percentage obtained in the different lots. The ingredient costs were based on prices quoted by the Cooperative Mills, Roanoke, Virginia, April 8, 1958.

The results obtained are presented in Table 47. It will be noted that neither feed efficiency nor cost of feed ingredients can be used as a correct measure for the most economical production of broilers or of dressed birds. For example, the best feed efficiency from these 15 lots in the 3 experiments was obtained from Lot 5, Experiment 2. Yet, it was the most expensive feed based on ingredient cost only. Lot 1, Experiment 1, had the least expensive feed of all lots but feed efficiency was much higher than for several

Table 47. Production cost of live broilers and dressed carcasses, based on the cost of feed ingredients, feed efficiency, and dressing percentage

	Feed Efficiency	Feed Cost/ 100 lbs	Production[a] Cost of 10,000 lbs	Dressing[b] Percentage	Cost/lb of[c] Eviscerated Carcass
	Pounds	Dollars	Dollars	Per Cent	Dollars
Experiment 1					
Lots					
1	2.98	4.35	1296.30	71.27	0.182
2	2.55	4.47	1139.85	71.75	0.159
3	2.64	4.58	1209.12	72.07	0.168
4	2.49	4.69	1167.81	71.73	0.163
5	2.49	4.80	1195.20	72.32	0.165
Experiment 2					
Lots					
1	2.62	4.53	1186.86	71.69	0.166
2	2.40	4.66	1118.40	71.40	0.157
3	2.39	4.78	1142.42	71.45	0.160
4	2.42	4.91	1188.22	71.23	0.167
5	2.33	5.03	1171.91	71.39	0.164
Experiment 3					
Lots					
1	2.84	4.53	1494.90	71.32	0.210
2	2.66	4.61	1710.31	71.87	0.238
3	2.75	4.69	1758.75	70.68	0.249
4	2.74	4.71	1779.21	71.69	0.248
5	2.64	4.85	1770.25	71.91	0.246

a. Feed efficiency x 10,000 lbs x cost/lb of feed = cost 10,000 lbs of live broilers.

b. Dressing percentage is determined by dividing the live fryer weight by the warm eviscerated carcass weight including the giblets.

c. $\frac{\text{Eviscerated yield x 10,000 lbs}}{\text{Cost 10,000 lbs live broilers}}$ = Cost/lb of dressed carcass.

other lots. When the costs of producing 10,000 pounds of live broilers are compared for these two lots, using feed ingredient costs and feed conversion as a means of establishing the cost, Lot 1 of Experiment 1 was $124.00 higher than for Lot 5, Experiment 2. Lot 2, Experiment 2, had neither the best feed conversion nor the least expensive ration but produced the least expensive live broilers. Lot 2 also produced the least expensive dressed carcass. Lot 5, Experiment 2, and Lot 1, Experiment 1, which had the best feed conversion and lowest feed ingredient cost, respectively, cost more per pound of eviscerated carcass than Lot 2, Experiment 2. If 10,000 pounds of dressed broilers were produced from feed used in Lot 1, Experiment 1, Lot 2, Experiment 2, and Lot 5, Experiment 2, the costs would be $9,100.00, $7,850.00, and $8,200.00, respectively. These differences in production cost would be significant.

It is recognized that in some cases there were no statistically significant differences in eviscerated yields of the birds between many of these lots, yet, it is well known that when a large number of birds are processed, the small differences which exist would be economically important.

e. Experiment 4

In Experiment 4, which is a replicate of Experiment 1, the percentage protein was held at approximately 20.2 per cent in each lot while the percentage added fat was increased by 2 per cent in each succeeding lot from 0 per cent in Lot 1 to 8 per cent in Lot 5. Productive energy in calories per pound of feed was 880, 912, 946, 978, and 1011 for Lots 1 to 5, respectively.

The growth rates for the males and females of the different lots are shown in Figure 4. Average 10 week weights are presented in Table 48. Figure 4 shows that the growth rates for the males were comparable between lots to 10 weeks of age except for Lot 2 which increased at a slower rate starting at 9 weeks of age. The growth rates for the males and females were different starting about the second week of growth. Apparently the nutritional requirements or ability to use the different rations are different for the males and females. There was a significant difference in 10 week weights between sex at the 1 per cent level of probability, Table 48a.

Feed efficiencies for the different lots are shown in Figure 4 and Table 49. It will be noted from

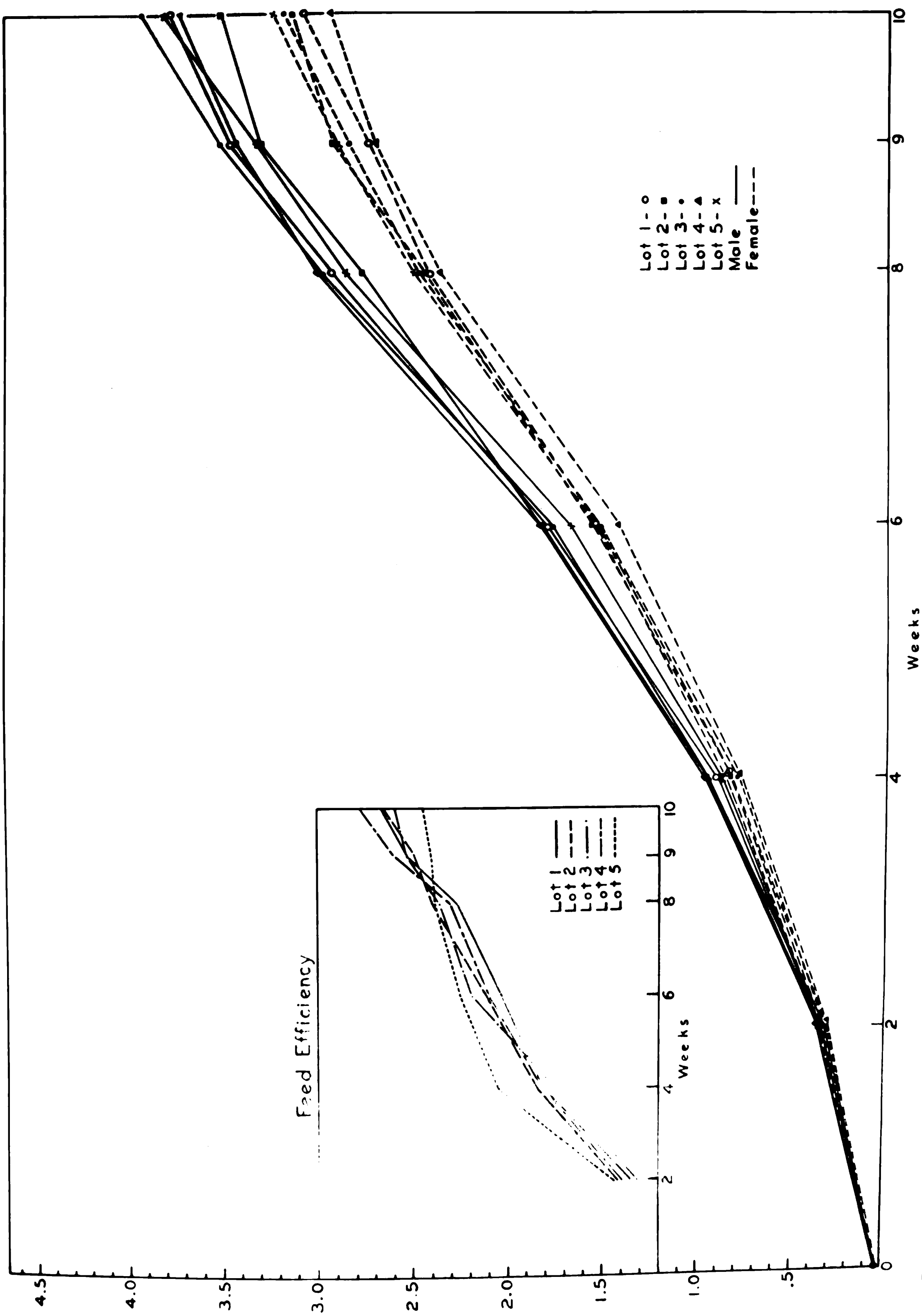

Figure 4. Experiment 4.– Growth Rate and Feed Efficiency to 10 Weeks of Age.

Table 48. Experiment 4, Ten week live weights. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Pounds			
Male	3.76	3.49	3.92	3.72	3.79	3.74
Female	3.05	3.11	3.16	2.92	3.24	3.10
Grand mean	3.41	3.30	3.54	3.32	3.52	

Table 48a. Experiment 4, Analysis of variance, 10 week live weights.

Source of variation	d.f.	Mean square
Between treatments	9	325,228.90**
Lots	4	33,155.30
Sex	1	2,687,960.30**
Lots x sex	4	26,619.85
Error	90	13,574.64

** $P < .01$

Table 49. Experiment 4, Feed efficiency to 10 weeks of age.

Lot 1	Lot 2	Lot 3	Lot 4	Lot 5
Pounds of feed per pound of live weight				
2.67	2.66	2.59	2.77	2.44

Figure 4 that the rations had a different relationship to each other in feed efficiency at different intervals during the 10 week growth period. That is, one of the lots gave the best feed efficiency at one age and some other lot at another age. Feed in Lot 1 which had no added fat gave a feed efficiency of 2.67 pounds to 10 weeks of age. Feed in Lots 2, 3, 4, and 5 gave feed efficiencies of 2.66, 2.59, 2.77, and 2.44 pounds of feed per pound of gain, respectively. Except for Lot 4, the lots which had higher levels of fat in the diet showed a better feed efficiency than the control lot, Lot 1. However, growth rate, Table 48a, was not increased significantly with higher levels of added fat.

Warm eviscerated yields were comparable between lots as shown in Table 50. There was no significant difference between lots but there was between sex, Table 50a.

The warm eviscerated carcasses with gizzard and attached fat were used to measure specific gravity. The results are shown in Table 51. Specific gravity values indicate that a greater amount of fat was deposited in the birds which received higher levels of added fat in the diet. This difference, however, was not significant between lots or sex, Table 51a.

Table 50. Experiment 4, Warm eviscerated yield of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	71.95	72.33	71.30	71.84	71.62	71.81
Female	70.40	70.37	71.13	70.89	71.72	70.90
Grand mean	71.18	71.35	71.22	71.37	71.67	

Table 50a. Experiment 4, Analysis of variance, warm eviscerated yield of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	4.3410
Lots	4	0.7539
Sex	1	20.5662*
Lots x sex	4	3.8719
Error	90	3.6981

* $P < .05$

Table 51. Experiment 4, Specific gravity of warm eviscerated carcasses with gizzards and attached fat. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Specific gravity			
Male	1.054	1.053	1.052	1.052	1.048	1.052
Female	1.051	1.047	1.044	1.046	1.042	1.046
Grand mean	1.053	1.050	1.048	1.049	1.045	

Table 51a. Experiment 4, Analysis of variance, specific gravity of warm eviscerated carcasses with gizzards and attached fat.

Source of variation	d.f.	Mean square
Between treatments	9	0.000177
Lots	4	0.000171
Sex	1	0.000835
Lots x sex	4	0.000018
Error	90	0.000380

After the eviscerated carcasses had been chilled in ice slush,the percentage moisture pick-up was determined and is presented in Table 52. The females showed about 1 per cent greater moisture pick-up than the males which was highly significant, Table 52a. Differences between lots were not significant.

The percentage chilled abdominal and gizzard fat, Table 53, increased as the level of fat in the diet increased. These differences in fat deposition were highly significant between lots and sex. Lot 5 was significantly different from Lots 1, 2, 3, and 4, Table 53a.

The percentage heart, Table 54, was not significantly different between lots, Table 54a.

The percentage gizzard with attached fat varied between sex and lots, Table 55. Lots on higher levels of fat in the diet showed a greater percentage gizzard with attached fat. The different per cents were 2.25, 2.14, 2.37, 2.42, and 2.48 for Lots 1 to 5, respectively. There was a significant difference between lots and a highly significant difference between sex, Table 55a.

When the average percentages of gizzards without attached fat are compared, the differences were not

Table 52. Experiment 4, Percentage moisture pick-up during chilling operation. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	5.51	5.86	5.35	5.07	5.47	5.45
Female	6.79	6.87	6.70	6.77	5.94	6.61
Grand mean	6.15	6.37	6.03	5.92	5.71	

Table 52a. Experiment 4, Analysis of variance, percentage moisture pick-up during chilling operation.

Source of variation	d.f.	Mean square
Between treatments	9	4.7499
Lots	4	1.2208
Sex	1	33.6748**
Lots x sex	4	1.0478
Error	90	2.2720

** $P < .01$

Table 53. Experiment 4, Percentage chilled abdominal and gizzard fat of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	0.99	0.70	0.94	1.35	1.47	1.09
Female	1.22	1.01	1.54	1.67	2.59	1.61
Grand mean	1.11	0.86	1.24	1.51	2.03	

Table 53a. Experiment 4, Analysis of variance, percentage chilled abdominal and gizzard fat of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	2.8036**
Lots	4	3.9930**
Sex	1	6.6100**
Lots x sex	4	0.6626
Error	90	0.4722

** $P < .01$

Lot 2	Lot 1	Lot 3	Lot 4	Lot 5
0.86	1.11	1.24	1.51	2.03

Table 54. Experiment 4, Percentage heart of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	0.49	0.49	0.50	0.54	0.53	0.51
Female	0.46	0.52	0.51	0.54	0.52	0.51
Grand mean	0.47	0.50	0.50	0.54	0.52	

Table 54a. Experiment 4, Analysis of variance, percentage heart of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.006257
Lots	4	0.011953
Sex	1	0.000006
Lots x sex	4	0.002124
Error	90	0.006293

Table 55. Experiment 4, Percentage gizzard with attached fat of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	2.10	1.99	2.10	2.20	2.27	2.13
Female	2.41	2.28	2.65	2.63	2.68	2.53
Grand mean	2.25	2.14	2.37	2.42	2.48	

Table 55a. Experiment 4, Analysis of variance, percentage gizzard with attached fat of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.6356**
Lots	4	0.3716*
Sex	1	4.0160**
Lots x sex	4	0.0545
Error	90	0.1303

** P < .01
* P < .05

Lot 2	Lot 1	Lot 3	Lot 4	Lot 5
2.14	2.25	2.37	2.42	2.48

significant between lots and sex, Tables 56 and 56a. The differences observed in Table 55a were due to the difference in the amount of fat attached to the gizzards.

Percentage livers were determined and are shown in Table 57. There was a significant difference between sex but not between lots, Table 57a.

When the percentages of intestines are compared, Table 58, there were highly significant differences between lots and sex, Table 58a. Lots with higher levels of fat in the feed gave a higher percentage of intestines. The percentage of intestines were significantly different between lots; yet, the warm eviscerated yields shown in Table 50a were not significantly different between lots, which is unexplainable.

The percentage of skin, based on chilled eviscerated carcass weights, increased as the level of fat in the diet increased, Table 59. However, these differences in skin percentages between lots were not significant, Table 59a. There was a lots x sex interaction which was significant at the 1 per cent level of probability.

Table 56. Experiment 4, Percentage chilled gizzard, without attached fat, of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	1.99	1.91	1.87	1.93	1.96	1.93
Female	2.18	2.16	2.28	2.26	2.01	2.18
Grand mean	2.08	2.03	2.08	2.10	1.99	

Table 56a. Experiment 4, Analysis of variance, Percentage chilled gizzard, without attached fat, of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.2253**
Lots	4	0.0401
Sex	1	1.5104
Lots x sex	4	0.0892
Error	90	0.0851

** $P < .01$

Table 57. Experiment 4, Percentage liver of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	1.76	1.73	1.70	1.62	1.78	1.72
Female	1.81	1.86	1.93	1.74	1.80	1.83
Grand mean	1.78	1.80	1.81	1.68	1.79	

Table 57a. Experiment 4, Analysis of variance, percentage liver of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.0735
Lots	4	0.0566
Sex	1	0.3014**
Lots x sex	4	0.0335
Error	90	0.0414

** $P < .01$

Table 58. Experiment 4, Percentage intestine of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	5.65	5.35	6.59	5.67	6.53	5.96
Female	7.18	6.45	7.16	6.35	6.99	6.83
Grand mean	6.42	5.90	6.88	6.01	6.76	

Table 58a. Experiment 4, Analysis of variance, percentage intestine of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	4.2018**
Lots	4	3.7945**
Sex	1	18.7489**
Lots x sex	4	0.9723
Error	90	0.5808

** $P < .01$

Lot 2	Lot 4	Lot 1	Lot 5	Lot 3
5.90	6.01	6.42	6.76	6.88

Table 59. Experiment 4, Percentage skin of chilled eviscerated carcass of 10 week old fryers. Average 4 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	11.16	12.45	12.10	13.27	12.08	12.21
Female	12.77	11.99	12.27	12.16	14.08	12.65
Grand mean	11.97	12.22	12.19	12.72	13.08	

Table 59a. Experiment 4, Analysis of variance, percentage skin of chilled eviscerated carcass of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	2.5165
Lots	4	1.6432
Sex	1	1.9494
Lots x sex	4	3.5316*
Error	30	1.2739

* $P < .05$

With the abdominal fat removed for determining other measurements, the carcasses were cooked to determine the cooking yield. It was found that no significant difference existed between lots, Table 60a. It may be noted, however, in Table 60 that Lot 1 which contained no added fat in the diet gave slightly higher yields than any of the other lots indicating less fat deposition in the carcasses of birds in Lot 1. Perhaps significant differences would have been obtained with larger numbers of birds.

Table 60. Experiment 4, Percentage cooking yield. Average 4 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	84.78	84.79	81.14	83.36	84.39	83.69
Female	84.17	81.09	83.13	81.04	83.33	82.55
Grand mean	84.48	82.94	82.14	82.20	83.86	

Table 60a. Experiment 4, Analysis of variance, Percentage cooking yield.

Source of variation	d.f.	Mean square
Between treatments	9	8.9227
Lots	4	8.2254
Sex	1	12.8482
Lots x sex	4	8.6386
Error	30	5.4099

f. Experiment 5

This experiment is a replicate of Experiment 2. The level of fat and percentage of protein in the 5 lots were increased at the same rate in each succeeding lot from Lot 1 to Lot 5. The same rate of increase in the diet of these two ingredients resulted in a C-P ratio of approximately 43 to 1 in all lots.

The growth rates are shown in Figure 5, and 10 week weights in Table 61. It will be noted in Figure 5 that the growth rates were comparable for each sex. However, males in Lot 5 grew at a faster rate than the males in the other lots, particularly after 8 weeks of age. The males and females showed different growth rates starting at about the second week. The males grew at a faster rate than the females. There was a highly significant difference in 10 week live weights between sex but not between lots, Table 61a.

Feed efficiencies, as presented in Figure 5 and Table 62, show that lots which received higher levels of fat gave better feed conversions. Lot 1 had a feed conversion of 2.78 pounds of feed per pound of gain. Lots 2, 3, 4, and 5 had feed conversions of 2.80, 2.62, 2.75, and 2.47 pounds, respectively, a difference of 0.33 pound between Lots 2 and 5.

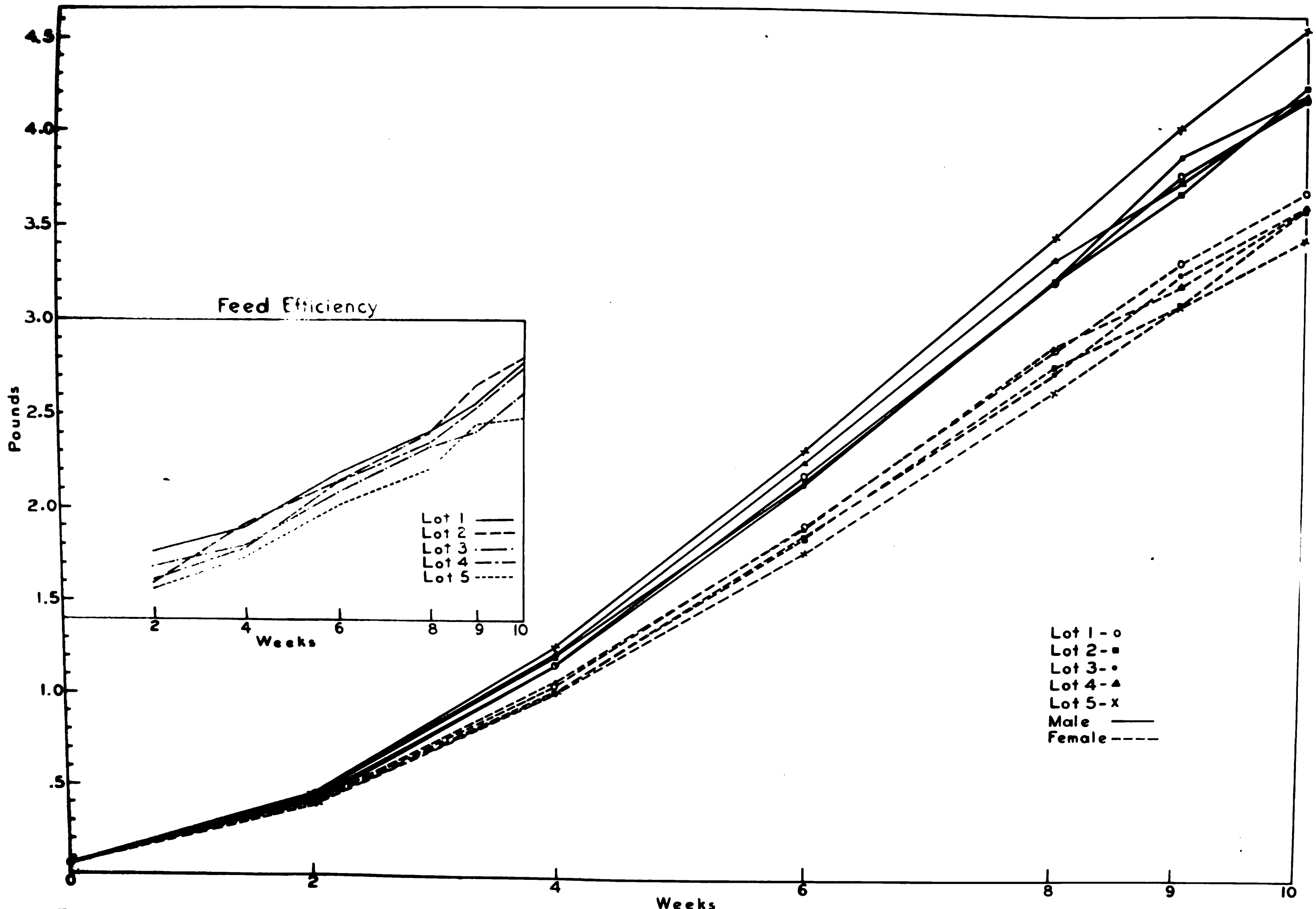

Figure 5. Experiment 5.–Growth Rate and Feed Efficiency to 10 Weeks of Age.

Table 61. Experiment 5, Ten week live weights. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Pounds			
Male	4.20	4.27	4.22	4.21	4.59	4.30
Female	3.70	3.61	3.62	3.62	3.45	3.60
Grand mean	3.95	3.94	3.92	3.92	4.02	

Table 61a. Experiment 5, Analysis of variance, 10 week live weights.

Source of variation	d.f.	Mean square
Between treatments	9	361,495.00**
Lots	4	16,292.75
Sex	1	2,990,479.00
Lots x sex	4	49,452.25
Error	90	69,332.79

** $P < .01$

Table 62. Experiment 5, Feed efficiency to 10 weeks of age.

Lot 1	Lot 2	Lot 3	Lot 4	Lot 5
Pounds of feed per pound of live weight				
2.78	2.80	2.62	2.75	2.47

The warm eviscerated yields were comparable between lots, Table 63. There was no significant difference in yields between lots or sex, Table 63a. This would be expected since all lots received feed which had the same C-P ratio and all lots were comparable in weight at 10 weeks of age.

Specific gravities which are a measure of fat deposition in the carcass are shown in Table 64. Even though there was a lower specific gravity in most lots which received higher levels of fat and protein in the diet, these differences were not significant between lots, Table 64a. There was a highly significant difference between sex and this would be expected since females ordinarily deposit more fat in the carcass than do males.

In percentage of moisture pick-up, Table 65, there was some variation between lots and sex. There was a highly significant difference between sex, Table 65a, but not between lots.

The percentages of abdominal and gizzard fat obtained from the fryers are shown in Table 66. Females showed greater fat deposits in the abdominal region than did the males. Differences existed in the percentage of fat between birds of the different lots.

Table 63. Experiment 5. Eviscerated warm yield of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	71.96	72.09	72.96	71.41	73.28	72.34
Female	72.37	72.01	73.10	72.59	72.23	72.46
Grand mean	72.17	72.05	73.03	72.00	72.76	

Table 63a. Experiment 5, Analysis of variance, Eviscerated warm yield of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	3.3997
Lots	4	4.3183
Sex	1	0.3553
Lots x sex	4	3.2422
Error	90	2.2961

Table 64. Experiment 5, Specific gravity of warm eviscerated carcasses with gizzards and attached fat. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Specific gravity			
Male	1.055	1.049	1.054	1.049	1.046	1.051
Female	1.044	1.046	1.040	1.041	1.044	1.043
Grand mean	1.050	1.048	1.047	1.045	1.045	

Table 64a. Experiment 5, Analysis of variance, specific gravity of warm eviscerated carcasses with gizzards and attached fat.

Source of variation	d.f.	Mean square
Between treatments	9	0.000258**
Lots	4	0.000070
Sex	1	0.001521**
Lots x sex	4	0.000131
Error	90	0.000062

** $P < .01$

Table 65. Experiment 5, Percentage moisture pick-up during chilling operation. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	4.31	5.02	4.45	5.14	4.82	4.75
Female	5.46	6.14	4.88	5.55	5.56	5.52
Grand mean	4.89	5.58	4.67	5.35	5.19	

Table 65a. Experiment 5, Analysis of variance, percentage moisture pick-up during chilling operation.

Source of variation	d.f.	Mean square
Between treatments	9	3.1195
Lots	4	2.6626
Sex	1	14.8379**
Lots x sex	4	0.6469
Error	90	1.5137

** $P < .01$

Table 66. Experiment 5, Percentage chilled abdominal and gizzard fat of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	0.92	1.24	0.88	1.30	1.55	1.18
Female	2.50	1.60	2.45	2.91	1.92	2.28
Grand mean	1.71	1.42	1.67	2.11	1.73	

Table 66a. Experiment 5, Analysis of variance, percentage chilled abdominal and gizzard fat of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	4.8814**
Lots	4	1.2162
Sex	1	30.0169**
Lots x sex	4	2.2627
Error	90	0.9981

** $P < .01$

However, these differences were not significant. There was a highly significant difference between sex, Table 66a.

Tables 67 and 67a show that no significant difference existed in percentage of heart weights between the different lots.

The average percentage gizzard with attached fat was higher for females than males, Table 68. With the exception of Lot 4, lots on higher levels of added fat and protein in the diet showed a lower percentage of gizzard with attached fat. There was a highly significant difference between sex and a significant difference between lots for this measurement. Lot 5 showed significantly less gizzard with attached fat than did Lots 1 to 4, Table 68a.

When Tables 69 and 69a are observed it will be noted that the average percentage gizzards with the fat removed are less in lots which had higher levels of fat and protein in the diet. There were highly significant differences between sex and lots, and a significant lots x sex interaction. Lots 1 and 2 had a significantly higher percentage gizzard than Lots 3, 4, and 5 which were not different from each other. It appears that higher levels of fat and protein in the diet result in smaller gizzards.

Table 67. Experiment 5, Percentage heart of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	0.40	0.40	0.43	0.43	0.43	0.42
Female	0.41	0.40	0.43	0.42	0.45	0.42
Grand mean	0.40	0.40	0.43	0.43	0.44	

Table 67a. Experiment 5, Analysis of variance, percentage heart of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.002707
Lots	4	0.005283
Sex	1	0.000255
Lots x sex	4	0.000744
Error	90	0.004484

Table 68. Experiment 5, Percentage gizzard with attached fat of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	1.85	1.76	1.72	1.75	1.45	1.71
Female	2.54	2.17	2.14	2.55	2.08	2.30
Grand mean	2.20	1.96	1.93	2.15	1.76	

Table 68a. Experiment 5, Analysis of variance, percentage gizzard with attached fat of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	1.3033**
Lots	4	0.6204*
Sex	1	8.6493**
Lots x sex	4	0.1496
Error	90	0.1775

** $P < .01$
* $P < .05$

Lot 5	Lot 3	Lot 2	Lot 4	Lot 1
1.76	1.93	1.96	2.15	2.20

Table 69. Experiment 5, Percentage chilled gizzard, without attached fat, of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	1.72	1.59	1.54	1.46	1.23	1.51
Female	1.83	1.86	1.50	1.58	1.75	1.70
Grand mean	1.78	1.73	1.52	1.52	1.49	

Table 69a. Experiment 5, Analysis of variance, percentage chilled gizzard, without attached fat, of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.3646**
Lots	4	0.3530**
Sex	1	0.9604**
Lots x sex	4	0.2272*
Error	90	0.0732

** $P < .01$
* $P < .05$

Lot 5	Lot 3	Lot 4	Lot 2	Lot 1
1.49	1.52	1.52	1.73	1.78

The percentage liver of 10 week old fryers and statistical analysis of these data are shown in Tables 70 and 70a. There was no significant difference between lots or sex.

The percentages of intestines, as presented in Table 71, are comparable between the different lots. No significant difference occurred between lots but a difference at the 1 per cent level of probability existed between sex, Table 71a.

Skin percentages of the chilled carcass weights were similar between the different lots, Table 72. There were no significant differences between lots or sex, Table 72a.

Four birds of each sex in each lot were cooked by baking. There were no significant differences in the cooking yield between sex or lots, Tables 73 and 73a.

Table 70. Experiment 5, Percentage liver of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	1.72	1.82	1.65	1.72	1.69	1.72
Female	1.75	1.74	1.74	1.77	1.91	1.78
Grand mean	1.74	1.78	1.70	1.74	1.80	

Table 70a. Experiment 5, Analysis of variance, percentage liver of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.0496
Lots	4	0.0324
Sex	1	0.0876
Lots x sex	4	0.0574
Error	90	0.0350

Table 71. Experiment 5, Percentage intestine of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	6.46	6.48	5.96	6.39	6.40	6.34
Female	6.68	6.72	6.80	6.78	6.81	6.76
Grand mean	6.57	6.60	6.38	6.59	6.61	

Table 71a. Experiment 5, Analysis of variance, percentage intestine of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.7081
Lots	4	0.1887
Sex	1	4.3639**
Lots x sex	4	0.3134
Error	90	0.4538

** $P < .01$

Table 72. Experiment 5, Percentage skin of chilled eviscerated carcass of 10 week old fryers. Average 4 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	12.92	12.24	12.77	12.46	12.44	12.57
Female	13.20	13.69	14.03	13.92	12.05	13.38
Grand mean	13.06	12.97	13.40	13.19	12.25	

Table 72a. Experiment 5, Analysis of variance, percentage skin of chilled eviscerated carcass of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	2.0241
Lots	4	1.5224
Sex	1	6.6097
Lots x sex	4	1.3795
Error	30	2.4182

Table 73. Experiment 5, Percentage cooking yield. Average 4 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	81.47	82.15	82.62	85.34	84.89	83.29
Female	83.91	80.28	80.21	81.84	80.64	81.38
Grand mean	82.69	81.22	81.42	83.59	82.77	

Table 73a. Experiment 5, Analysis of variance, percentage cooking yield.

Source of variation	d.f.	Mean square
Between treatments	9	11.4465
Lots	4	7.5194
Sex	1	27.7888
Lots x sex	4	11.2880
Error	30	9.0029

g. Experiment 6

Rations in this experiment were the same as Experiment 3 in which the percentage protein was increased in each succeeding lot from 20.77 in Lot 1 to 24.89 in Lot 5. The percentage of added fat in the diet was increased by 1 per cent in each succeeding lot from 0 per cent in Lot 1 to 4 per cent in Lot 5. The C-P ratio was decreased in each succeeding lot. The ratios were 42.8, 40.8, 38.9, 37.3, and 35.7 to 1 in Lots 1 to 5, respectively. Productive energy in calories per pound of feed was 889 for each lot.

The growth rate and 10 week live weights are presented in Figure 6 and Table 74, respectively. The growth rates for the males and females were different after the second week. The growth rates for the different lots were similar for each sex. There was no significant difference in 10 week live weights between lots, Table 74a, even though the average live weight increased in each lot from Lots 1 to 5. This indicates that higher levels of protein increased live weights in spite of the fact that the productive energy was constant in all lots. There was a highly significant difference between sex.

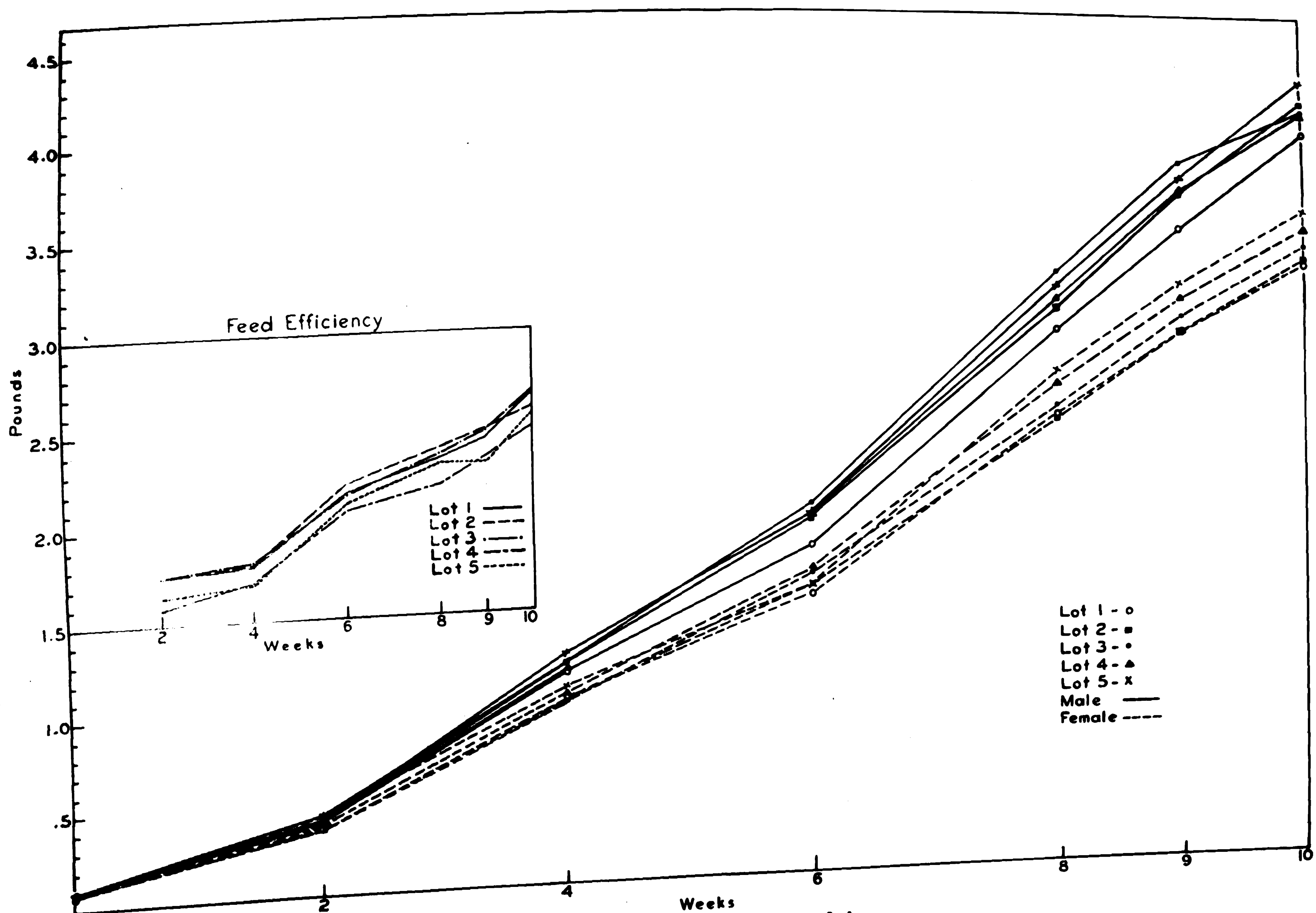

Figure 6. Experiment 6.- Growth Rate and Feed Efficiency to 10 Weeks of Age.

Table 74. Experiment 6, Ten week live weights.
Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Pounds			
Male	3.99	4.18	4.13	4.12	4.30	4.14
Female	3.26	3.29	3.37	3.46	3.56	3.39
Grand mean	3.63	3.74	3.75	3.79	3.93	

Table 74a. Experiment 6, Analysis of variance, 10 week live weights.

Source of variation	d.f.	Mean square
Between treatments	9	380,081.22**
Lots	4	43,706.25
Sex	1	3,222,025.00**
Lots x sex	4	5,970.25
Error	90	22,486.96

** $P < .01$

Feed efficiency for the different lots is shown in Figure 6 and Table 75. With the exception of Lot 3, less feed was required per pound of gain in lots which received higher levels of protein.

Warm eviscerated yields were comparable for the different lots, Table 76. Females which were smaller than the males, as would be expected, gave slightly higher yields which is unexplainable. There was no significant difference between lots or sex, Table 76a.

Specific gravities of the carcasses with gizzards and attached fat are shown in Table 77. Females had a lower specific gravity which means that more fat was deposited in the females than in the males. This difference in specific gravity between sex was significant at the 1 per cent level of probability, Table 77a. Specific gravities between lots were comparable.

Percentage moisture pick-up during the chilling operation will be noted in Table 78. The females showed an average gain in weight of 5.76 per cent for all lots, while the average gain for the males was 5.03 per cent. There was a significant difference between sex at the 5 per cent level of probability, Table 78a.

Table 75. Experiment 6, Feed efficiency to 10 weeks of age.

Lot 1	Lot 2	Lot 3	Lot 4	Lot 5
Pounds of feed per pound of live weight				
2.67	2.59	2.68	2.49	2.55

Table 76. Experiment 6, Warm eviscerated yield of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	71.31	72.38	71.79	71.49	71.95	71.78
Female	71.77	71.49	72.99	72.09	72.22	72.11
Grand mean	71.54	71.94	72.39	71.79	72.09	

Table 76a. Experiment 6, Analysis of variance, warm eviscerated yield of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	2.5019
Lots	4	2.0394
Sex	1	2.7390
Lots x sex	4	2.9052
Error	90	2.1946

Table 77. Experiment 6, Specific gravity of warm eviscerated carcasses with gizzards and attached fat. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Specific gravity			
Male	1.056	1.053	1.056	1.055	1.057	1.055
Female	1.050	1.053	1.048	1.050	1.048	1.050
Grand mean	1.053	1.053	1.052	1.053	1.053	

Table 77a. Experiment 6, Analysis of variance, specific gravity of warm eviscerated carcasses with gizzards and attached fat.

Source of variation	d.f.	Mean square
Between treatments	9	0.000120**
Lots	4	0.000006
Sex	1	0.000784**
Lots x sex	4	0.000067
Error	90	0.000044

** $P < .01$

Table 78. Experiment 6, Percentage moisture pick-up during chilling operation. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	4.75	4.91	4.95	5.28	5.25	5.03
Female	6.15	5.71	6.15	5.41	5.36	5.76
Grand mean	5.45	5.31	5.55	5.35	5.31	

Table 78a. Experiment 6, Analysis of variance, percentage moisture pick-up during chilling operation.

Source of variation	d.f.	Mean square
Between treatments	9	2.3474
Lots	4	0.2250
Sex	1	13.2423*
Lots x sex	4	1.7461
Error	90	1.9819

* $P < .05$

Abdominal and gizzard fat, expressed as a percentage of live weight, are shown in Table 79. The females showed a greater fat deposition in these areas than did the males which was highly significant, Table 79a. Fat deposition between lots was comparable.

Percentage heart was similar between lots and sex, Tables 80 and 80a.

The average percentage gizzard with attached fat, Table 81, decreased in lots as the percentage of protein in the diet was increased. There was a highly significant difference between lots and sex. Lot 1 was significantly different from Lots 2, 3, 4, and 5, but these lots were comparable to each other, Table 81a.

With the attached fat removed from the gizzards, the average percentage gizzard for each lot was determined and is shown in Table 82. The same trend of reduction in weight of the gizzards existed as was found with the gizzards with attached fat, Table 81. A highly significant difference still existed between lots and sex after the fat was removed, Table 82a. Lot 1 was significantly different from Lots 3, 4, and 5 but not from Lot 2. Apparently higher levels of protein in the diet resulted in smaller gizzards.

Table 79. Experiment 6, Percentage chilled abdominal and gizzard fat of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	0.93	1.10	0.82	0.98	0.86	0.94
Female	1.78	1.16	1.66	1.92	1.62	1.63
Grand mean	1.36	1.13	1.24	1.45	1.24	

Table 79a. Experiment 6, Analysis of variance, percentage chilled abdominal and gizzard fat of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	1.725857**
Lots	4	0.294652
Sex	1	11.890773**
Lots x sex	4	0.615833
Error	90	0.437089

** $P < .01$

Table 80. Experiment 6, Percentage heart of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	0.40	0.38	0.44	0.39	0.38	0.40
Female	0.42	0.40	0.41	0.40	0.40	0.41
Grand mean	0.41	0.39	0.42	0.40	0.39	

Table 80a. Experiment 6, Analysis of variance, percentage heart of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.002878
Lots	4	0.003807
Sex	1	0.002153
Lots x sex	4	0.002130
Error	90	0.002288

Table 81. Experiment 6, Percentage gizzard with attached fat of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	1.91	1.70	1.55	1.60	1.52	1.66
Female	2.39	1.95	2.12	2.23	1.99	2.14
Grand mean	2.15	1.82	1.84	1.92	1.76	

Table 81a. Experiment 6, Analysis of variance, percentage gizzard with attached fat of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.8903**
Lots	4	0.4722**
Sex	1	5.6930**
Lots x sex	4	0.1077
Error	90	0.0771

** $P < .01$

Lot 5	Lot 2	Lot 3	Lot 4	Lot 1
1.76	1.82	1.84	1.92	2.15

Table 82. Experiment 6, Percentage chilled gizzard, without attached fat, of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	1.71	1.59	1.42	1.48	1.44	1.53
Female	1.89	1.75	1.81	1.57	1.56	1.71
Grand mean	1.80	1.67	1.62	1.52	1.50	

Table 82a. Experiment 6, Analysis of variance, percentage chilled gizzard, without attached fat, of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.2539**
Lots	4	0.2903**
Sex	1	0.8649**
Lots x sex	4	0.0647
Error	90	0.0641

** $P < .01$

Lot 5	Lot 4	Lot 3	Lot 2	Lot 1
1.50	1.52	1.62	1.67	1.80

Percentage livers of 10 week live weights varied between lots and sex, Table 83. The differences observed, however, were not significant, Table 83a.

The intestinal weights expressed as a percentage of 10 week live weights are presented in Table 84. Birds which received higher levels of protein showed either heavier or lighter intestinal weights than did the control lot, Lot 1, which received the lowest level of protein of any of the lots. These differences were highly significant between lots and significant at the 5 per cent level of probability between sex, Table 84a.

Females showed a higher percentage of skin than did the males, Table 85, which was highly significant, Table 85a. Average percentage skin was similar for the different lots.

Four birds of each sex in each lot were cooked by baking. The cooking yields were comparable between lots and sex, Tables 86 and 86a. Perhaps differences in yield would have been obtained if the abdominal fat had been left attached to the carcasses.

Table 83. Experiment 6, Percentage liver of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	1.75	1.82	1.73	1.64	1.77	1.74
Female	1.89	1.84	1.77	1.72	1.84	1.81
Grand mean	1.82	1.83	1.75	1.68	1.80	

Table 83a. Experiment 6, Analysis of variance, percentage liver of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	0.0531
Lots	4	0.0779
Sex	1	0.1211
Lots x sex	4	0.0112
Error	90	0.0328

Table 84. Experiment 6, Percentage intestine of 10 week old fryers. Average 10 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	6.57	6.33	6.01	6.58	6.88	6.47
Female	6.79	6.64	6.36	6.92	7.34	6.81
Grand mean	6.68	6.49	6.19	6.75	7.11	

Table 84a. Experiment 6, Analysis of variance, percentage intestine of 10 week old fryers.

Source of variation	d.f.	Mean square
Between treatments	9	1.3700*
Lots	4	2.3360**
Sex	1	2.8292*
Lots x sex	4	0.0392
Error	90	0.5772

** $P < .01$
* $P < .05$

Lot 3	Lot 2	Lot 1	Lot 4	Lot 5
6.19	6.49	6.68	6.75	7.11

Table 85. Experiment 6, Percentage skin of chilled eviscerated carcass weights. Average 4 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	11.97	11.66	10.65	11.70	10.56	11.31
Female	13.66	12.40	12.98	13.42	12.35	12.96
Grand mean	12.82	12.03	11.82	12.56	11.46	

Table 85a. Experiment 6, Analysis of variance, percentage skin of chilled eviscerated carcass weights.

Source of variation	d.f.	Mean square
Between treatments	9	4.4287
Lots	4	2.4290
Sex	1	29.5062**
Lots x sex	4	0.6590
Error	30	2.0881

** P < .01

Table 86. Experiment 6, Percentage cooking yield. Average 4 birds of each sex in each lot.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Avg.
			Per cent			
Male	81.44	81.55	82.25	81.18	81.29	81.54
Female	81.18	80.55	83.04	82.20	81.45	81.68
Grand mean	81.31	81.05	82.65	81.69	81.37	

Table 86a. Experiment 6, Analysis of variance, percentage cooking yield.

Source of variation	d.f.	Mean square
Between treatments	9	1.9748
Lots	4	3.0782
Sex	1	0.2044
Lots x sex	4	1.3140
Error	30	8.9908

h. Chemical Analyses, Experiment 4

The percentage of moisture, fat, and protein of the breast, calculated on a moist basis, are shown in Table 87. Percentages of moisture and fat varied between the different lots and sex. Protein varied also, but statistically, the differences in levels of protein were not significant. Lots which contained higher levels of fat in the breast meat showed correspondingly lower levels of moisture so that an inverse relationship existed between these values.

Tables 87a, 87b, and 87c show the analysis of variance for the percentage of moisture, fat, and protein, respectively, of the breast. There was a significant difference between lots and a highly significant difference between sex for percentage moisture and fat. There was no statistical difference in percentage moisture between Lots 1, 2, and 4, but these lots were different than Lot 5. In percentage fat, Lots 3 and 5 were significantly higher than Lot 1. There was no difference between Lots 2, 3, and 4.

The results of the chemical analyses for the thigh meat are presented in Tables 88, 88a, 88b, and 88c. There were variations between lots and sex for the levels of fat and protein as shown in Table 88. Lots

Table 87. Experiment 4, Percentage moisture, fat, and protein of breast. Average 2 birds of each sex in each lot.

	Moisture			Fat			Protein		
Lots	Male	Female	Avg.	Male	Female	Avg.	Male	Female	Avg.
					Per cent				
1	72.37	73.55	72.96	5.00	5.67	5.34	21.52	19.64	20.58
2	74.87	72.38	73.63	4.96	7.47	6.22	19.06	18.99	19.03
3	71.75	71.94	71.85	7.70	8.50	8.10	19.16	18.82	18.99
4	74.23	72.09	73.16	5.39	7.89	6.64	19.75	18.92	19.34
5	73.57	68.72	71.15	5.94	11.74	8.84	19.40	18.64	19.02
Grand mean	73.36	71.74		5.80	8.25		19.78	19.00	

Table 87a. Experiment 4, Analysis of variance, percentage moisture of breast.

Source of variation	d.f.	Mean square
Between treatments	9	5.8210**
Lots	4	4.1588*
Sex	1	13.1869**
Lots x sex	4	5.6417*
Error	10	1.1021

** $P < .01$
 * $P < .05$

Lot 5	Lot 3	Lot 1	Lot 4	Lot 2
71.14	71.84	72.96	73.16	74.62

Table 87b. Experiment 4, Analysis of variance, percentage fat of breast.

Source of variation	d.f.	Mean square
Between treatments	9	8.8446**
Lots	4	8.0908*
Sex	1	30.0861**
Lots x sex	4	4.2880
Error	10	1.7229

** $P < .01$
 * $P < .05$

Lot 1	Lot 2	Lot 4	Lot 3	Lot 5
5.34	6.22	6.64	8.09	8.84

Table 87c. Experiment 4, Analysis of variance, percentage protein of breast.

Source of variation	d.f.	Mean square
Between treatments	9	1.3669
Lots	4	1.8497
Sex	1	3.0109
Lots x sex	4	0.4731
Error	10	0.6216

Table 88. Experiment 4, Percentage moisture, fat, and protein of thigh. Average 2 birds of each sex in each lot.

	Moisture			Fat			Protein		
Lots	Male	Female	Avg.	Male	Female	Avg.	Male	Female	Avg.
					Per cent				
1	72.93	71.47	72.20	9.38	11.79	10.59	16.55	15.92	16.24
2	73.05	72.71	72.88	8.49	10.44	9.47	17.04	15.92	16.48
3	70.83	68.82	69.83	12.11	14.78	13.45	15.98	15.23	15.61
4	72.22	68.61	70.42	10.09	14.44	12.27	16.83	15.90	16.37
5	67.83	67.71	67.77	15.15	17.20	16.18	15.87	15.63	15.75
Grand mean	71.37	69.86		11.04	13.73		16.45	15.72	

Table 88a. Experiment 4, Analysis of variance, percentage moisture of thigh.

Source of variation	d.f.	Mean square
Between treatments	9	11.7073*
Lots	4	20.6038**
Sex	1	17.5032*
Lots x sex	4	1.3620
Error	10	3.4289

	Lot 5	Lot 3	Lot 4	Lot 1	Lot 2
** $P < .01$ * $P < .05$	67.02	69.82	70.42	72.05	72.88

Table 88b. Experiment 4, Analysis of variance, percentage fat of thigh.

Source of variation	d.f.	Mean square
Between treatments	9	16.9962*
Lots	4	28.0593*
Sex	1	37.1554*
Lots x sex	4	0.8934
Error	10	4.7523

	Lot 2	Lot 1	Lot 4	Lot 3	Lot 5
* $P < .05$	9.46	10.58	12.26	12.45	16.28

Table 88c. Experiment 4, Analysis of variance, percentage protein of thigh.

Source of variation	d.f.	Mean square
Between treatments	9	0.6138
Lots	4	0.5913
Sex	1	2.7012
Lots x sex	4	0.1146
Error	10	0.7273

which contained higher levels of fat showed lower levels of moisture. Lot 5 was significantly lower in moisture content than Lots 1, 2, and 4. There was a significant difference between sex and lots for percentage fat. No statistical difference at either the 1 or 5 per cent level of probability existed in percentage protein between lots or sex. Fat was about 4 to 6 per cent higher in the thigh than the breast tissue.

The percentage of moisture, fat, and protein of the drumsticks were comparable for all lots, Tables 89, 89a, 89b, and 89c. There was a highly significant difference between sex for percentage moisture and fat. Apparently fat deposition in the drumstick was not influenced by the level of fat in the diet as were the breasts and thighs.

The percentage of fat and moisture of the wings varied by approximately 4 per cent between lots, Table 90. Females had the higher fat levels with the lower percentage of moisture. Protein was higher in the male than in the female birds. The percentage moisture decreased from Lot 1 to 5 while the percentage of fat increased in these lots. Higher fat levels in the five rations, with the same level

Table 89. Experiment 4, Percentage moisture, fat, and protein of drumstick. Average 2 birds of each sex in each lot.

	Moisture			Fat			Protein		
Lots	Male	Female	Avg.	Male	Female	Avg.	Male	Female	Avg.
					Per cent				
1	76.15	75.96	76.06	4.23	4.60	4.42	18.44	18.21	18.33
2	76.16	75.23	75.70	4.04	5.29	4.67	18.55	17.96	18.26
3	75.32	75.31	75.32	5.41	5.74	5.58	18.43	18.16	18.30
4	76.21	74.62	75.42	4.08	5.72	4.40	19.11	18.57	18.84
5	76.59	74.16	75.38	5.39	6.91	5.65	17.84	17.34	17.59
Grand mean	76.09	75.06		4.43	5.65		18.47	18.05	

Table 89a. Experiment 4, Analysis of variance, percentage moisture of drumstick.

Source of variation	d.f.	Mean square
Between treatments	9	1.2174
Lots	4	0.4068
Sex	1	5.1816**
Lots x sex	4	1.0370
Error	10	0.4468

** $P < .01$

Table 89b. Experiment 4, Analysis of variance, percentage fat of drumstick.

Source of variation	d.f.	Mean square
Between treatments	9	1.7416*
Lots	4	1.2043
Sex	1	7.4542**
Lots x sex	4	0.8509
Error	10	0.5406

** $P < .01$
* $P < .05$

Table 89c. Experiment 4, Analysis of variance, percentage protein of drumstick.

Source of variation	d.f.	Mean square
Between treatments	9	0.4632
Lots	4	0.7898
Sex	1	0.9032
Lots x sex	4	0.0266
Error	10	0.2854

Table 90. Experiment 4, Percentage moisture, fat, and protein of wing. Average 2 birds of each sex in each lot.

	Moisture			Fat			Protein		
Lots	Male	Female	Avg.	Male	Female	Avg.	Male	Female	Avg.
					Per cent				
1	71.63	72.53	72.08	9.21	9.21	9.21	17.53	16.92	17.23
2	73.36	70.57	71.97	7.79	11.36	9.58	17.45	16.66	17.06
3	71.36	70.71	71.04	10.77	11.93	11.35	17.03	16.18	16.61
4	71.05	69.72	70.39	10.70	11.58	11.14	17.38	17.54	17.46
5	69.85	67.97	68.91	12.66	14.84	13.75	16.35	16.14	16.25
Grand mean	71.45	70.30		10.23	11.78		17.15	16.69	

Table 90a. Experiment 4, Analysis of variance, percentage moisture of wing.

Source of variation	d.f.	Mean square
Between treatments	9	4.5938
Lots	4	6.7548*
Sex	1	6.6010
Lots x sex	4	1.9312
Error	10	1.5848

	Lot 5	Lot 4	Lot 3	Lot 2	Lot 1
* $P < .05$	68.91	70.38	71.03	71.96	72.08

Table 90b. Experiment 4, Analysis of variance, percentage fat of wing.

Source of variation	d.f.	Mean square
Between treatments	9	7.9285*
Lots	4	12.9320**
Sex	1	12.1368*
Lots x sex	4	1.8730
Error	10	1.8144

	Lot 1	Lot 2	Lot 4	Lot 3	Lot 5
** $P < .01$ * $P < .05$	9.21	9.57	11.14	11.35	13.74

Table 90c. Experiment 4, Analysis of variance, percentage protein of wing.

Source of variation	d.f.	Mean square
Between treatments	9	0.6207
Lots	4	0.9500
Sex	1	1.0580
Lots x sex	4	0.1822
Error	10	0.8694

of protein in all lots, increased the amount of fat deposited in the wing. The percentage protein was comparable between lots, Table 90c. There was a significant difference in the moisture content between lots, Table 90a. Lots 1 and 2 had a significantly lower percentage moisture than Lot 5, but Lot 5 was significantly higher in fat deposited in the wing than Lots 1, 2, 3, and 4, Table 90b.

The skin from one-half fryer from four carcasses in each lot was analyzed and the results are presented in Table 91. Variations existed in the percentages of moisture, fat, and protein between lots. However, there were no significant differences between lots for percentage moisture or fat, Tables 91a and 91b. A significant difference in the percentage protein occurred between sex, Table 91c.

Table 91. Experiment 4, Percentage moisture, fat, and protein of skin. Average 2 birds of each sex in each lot.

	Moisture			Fat			Protein		
Lots	Male	Female	Avg.	Male	Female	Avg.	Male	Female	Avg.
					Per cent				
1	61.08	61.11	61.10	24.91	26.09	25.50	13.55	10.90	12.23
2	62.81	59.29	61.05	21.92	26.39	24.16	13.49	12.52	13.01
3	59.46	59.23	59.35	27.69	27.12	27.42	12.07	11.35	11.71
4	63.48	56.52	60.00	22.55	32.07	27.31	12.86	11.57	12.22
5	60.75	63.89	62.32	26.26	21.21	23.74	12.07	10.36	11.22
Grand mean	61.52	60.01		24.67	26.58		12.81	11.34	

Table 91a. Experiment 4, Analysis of variance, percentage moisture of skin.

Source of variation	d.f.	Mean square
Between treatments	9	10.2283
Lots	4	5.3094
Sex	1	10.4976
Lots x sex	4	15.0799
Error	10	8.3177

Table 91b. Experiment 4, Analysis of variance, percentage fat of skin.

Source of variation	d.f.	Mean square
Between treatments	9	14.2660
Lots	4	9.5832
Sex	1	36.4770
Lots x sex	4	13.3961
Error	10	13.5362

Table 91c. Experiment 4, Analysis of variance, percentage protein of skin.

Source of variation	d.f.	Mean square
Between treatments	9	2.2862
Lots	4	1.7856
Sex	1	10.7458*
Lots x sex	4	0.5702
Error	10	2.1448

* $P < .05$

i. Chemical analyses, Experiment 5

Chemical and statistical analyses of the breast are given in Tables 92, 92a, 92b, and 92c. The percentage moisture and fat were inversely related. With the exception of Lot 4, birds in lots which received higher levels of added fat and protein in the diet resulted in a higher average fat and lower moisture content of the breast meat. The percentage protein was not significantly different between lots but was between sex. There was a significant difference in percentage moisture between lots and a highly significant difference between sex. Lot 4 was significantly higher in moisture content than Lots 3 and 5. However, Lots 1, 2, and 4 were not significantly different from each other.

Percentages of moisture, fat, and protein for the thigh tissues are given in Table 93. The percentage of moisture and fat in the thigh did not show any trend between lots which was expected from the levels of fat and protein in the rations. For example, the ration used in Lot 4 contained a higher level of fat and protein than Lot 1; yet, the moisture and fat contents of the thigh tissue were lower. The average percentage

Table 92. Experiment 5, Percentage moisture, fat, and protein of breast. Average 2 birds of each sex in each lot.

	Moisture			Fat			Protein		
Lots	Male	Female	Avg.	Male	Female	Avg.	Male	Female	Avg.
					Per cent				
1	74.20	69.19	71.70	3.73	10.16	6.95	20.40	18.83	19.62
2	71.85	71.60	71.73	6.48	7.95	7.22	20.71	19.03	19.87
3	72.36	67.27	69.82	6.24	12.75	9.50	19.77	19.11	19.44
4	73.74	72.73	73.24	4.29	6.24	5.27	21.08	19.89	20.49
5	71.79	67.82	69.81	6.88	10.63	8.76	20.70	20.64	20.67
Grand mean	72.79	69.72		5.52	9.55		20.53	19.50	

Table 92a. Experiment 5, Analysis of variance, percentage moisture of breast.

Source of variation	d.f.	Mean square
Between treatments	9	11.3237**
Lots	4	8.5259*
Sex	1	46.9405**
Lots x sex	4	5.2173
Error	10	2.0236

	Lot 5	Lot 3	Lot 1	Lot 2	Lot 4
** P < .01 * P < .05	69.80	69.81	71.69	71.72	73.24

Table 92b. Experiment 5, Analysis of variance, percentage fat of breast.

Source of variation	d.f.	Mean square
Between treatments	9	16.3829*
Lots	4	10.9220
Sex	1	80.8422**
Lots x sex	4	5.7290
Error	10	4.1143

** P < .01
* P < .05

Table 92c. Experiment 5, Analysis of variance, percentage protein of breast.

Source of variation	d.f.	Mean square
Between treatments	9	1.3117
Lots	4	1.1592
Sex	1	5.3251*
Lots x sex	4	0.4607
Error	10	0.9786

* P < .05

Table 93. Experiment 5, Percentage moisture, fat, and protein of thigh. Average 2 birds of each sex in each lot.

	Moisture			Fat			Protein		
Lots	Male	Female	Avg.	Male	Female	Avg.	Male	Female	Avg.
					Per cent				
1	73.13	64.66	68.90	7.36	19.26	13.31	18.10	14.64	16.37
2	72.11	68.61	70.36	9.55	13.76	11.66	17.55	16.03	16.79
3	69.40	66.33	67.87	12.30	17.47	14.89	17.17	15.06	16.12
4	72.82	71.09	71.96	8.55	11.10	9.83	17.82	16.58	17.20
5	68.45	65.65	67.05	13.92	17.34	15.63	16.62	15.84	16.23
Grand mean	71.18	67.27		10.34	15.79		17.45	15.63	

Table 93a. Experiment 5, Analysis of variance, percentage moisture of thigh.

Source of variation	d.f.	Mean square
Between treatments	9	18.4488*
Lots	4	15.4292
Sex	1	76.6362**
Lots x sex	4	6.9216
Error	10	4.4546

** $P < .01$
* $P < .05$

Table 93b. Experiment 5, Analysis of variance, percentage fat of thigh.

Source of variation	d.f.	Mean square
Between treatments	9	32.6064**
Lots	4	22.4406
Sex	1	148.4580**
Lots x sex	4	13.8094
Error	10	6.5862

** $P < .01$

Table 93c. Experiment 5, Analysis of variance, percentage protein of thigh.

Source of variation	d.f.	Mean square
Between treatments	9	3.0048**
Lots	4	0.7995
Sex	1	16.5984**
Lots x sex	4	1.0693
Error	10	0.4713

** $P < .01$

of fat was higher for females than for males. There was a highly significant difference for moisture, fat, and protein in favor of the females, Tables 93a, 93b, and 93c.

Results of the chemical analyses of the drumstick, Table 94, show that female fryers had higher levels of fat than did the males. The percentage fat between lots did not show a consistent pattern, however. Percentage protein was about equal between lots. However, the males had a significantly higher protein content than the females. There was no significant difference in moisture between lots or sex, Tables 94a, 94b, and 94c; however, there was a significant difference in fat content between lots and lots X sex interaction, and a highly significant difference between sex. The fat content of Lots 3 and 5 were significantly higher than for Lots 2 and 4.

Except for Lot 4, wings showed a general increase in fat content as the levels of fat and protein in the diet increased, Table 95. The average per cent fat for Lots 1 to 5, respectively, were 10.32, 10.59, 12.91, 8.93, and 13.62. The moisture content was inversely related to the fat content. There was a significant difference in percentage moisture and protein between

Table 94. Experiment 5, Percentage moisture, fat, and protein of drumstick. Average 2 birds of each sex in each lot.

	Moisture			Fat			Protein		
Lots	Male	Female	Avg.	Male	Female	Avg.	Male	Female	Avg.
					Per cent				
1	75.84	72.83	74.34	3.88	7.55	5.72	19.46	18.42	18.94
2	74.76	74.95	74.86	5.38	5.01	5.20	18.52	17.99	18.26
3	74.40	71.69	73.05	5.04	9.33	7.19	19.23	17.39	18.31
4	75.01	75.34	75.18	4.63	5.20	4.92	19.55	18.46	19.02
5	72.59	73.86	73.23	7.71	7.32	7.52	18.43	18.03	18.23
Grand mean	74.52	73.73		5.33	6.88		19.04	18.06	

Table 94a. Experiment 5, Analysis of variance, percentage moisture of drumstick.

Source of variation	d.f.	Mean square
Between treatments	9	4.7513*
Lots	4	3.6452
Sex	1	3.0968
Lots x sex	4	3.7712
Error	10	1.2366

* $P < .05$

Table 94b. Experiment 5, Analysis of variance, percentage fat of drumstick.

Source of variation	d.f.	Mean square
Between treatments	9	6.0756**
Lots	4	5.5684*
Sex	1	12.0435**
Lots x sex	4	5.0910*
Error	10	1.0603

** $P < .01$

* $P < .05$

Lot 4	Lot 2	Lot 1	Lot 3	Lot 5
4.91	5.19	5.71	7.18	7.52

Table 94c. Experiment 5, Analysis of variance, percentage protein of drumstick.

Source of variation	d.f.	Mean square
Between treatments	9	0.9447
Lots	4	0.6077
Sex	1	4.7824*
Lots x sex	4	0.3224
Error	10	0.5653

* $P < .05$

Table 95. Experiment 5, Percentage moisture, fat, and protein of wing. Average 2 birds of each sex in each lot.

	Moisture			Fat			Protein		
Lots	Male	Female	Avg.	Male	Female	Avg.	Male	Female	Avg.
					Per cent				
1	72.54	68.05	70.30	7.63	14.00	10.82	18.69	16.46	17.58
2	70.93	69.23	70.08	10.00	11.17	10.59	17.94	17.07	17.51
3	70.80	66.88	68.84	9.81	16.00	12.91	18.07	15.89	16.98
4	73.01	70.83	71.92	7.23	10.73	8.98	18.80	17.42	18.11
5	68.32	69.53	68.93	13.21	14.03	13.62	17.26	15.70	16.48
Grand mean	71.12	68.90		9.58	13.19		18.15	16.51	

Table 95a. Experiment 5, Analysis of variance, percentage moisture of wing.

Source of variation	d.f.	Mean square
Between treatments	9	7.7569*
Lots	4	6.2882
Sex	1	24.5976*
Lots x sex	4	5.0156
Error	10	2.4803

* $P < .05$

Table 95b. Experiment 5, Analysis of variance, percentage fat of wing.

Source of variation	d.f.	Mean square
Between treatments	9	16.5996**
Lots	4	14.0637**
Sex	1	65.1966**
Lots x sex	4	6.9864
Error	10	2.1276

** $P < .01$

Lot 4	Lot 2	Lot 1	Lot 3	Lot 5
8.98	10.58	10.82	12.90	13.62

Table 95c. Experiment 5, Analysis of variance, percentage protein of wing.

Source of variation	d.f.	Mean square
Between treatments	9	2.3299
Lots	4	1.5282
Sex	1	13.5631*
Lots x sex	4	0.3235
Error	10	1.3329

* $P < .05$

sex and a highly significant difference in the percentage fat between lots and sex, Tables 95a, 95b, and 95c. There was no significant difference in fat between Lots 1, 2, and 3, but Lot 5 was different than Lots 1, 2, and 4.

Chemical analyses of skin tissue, Table 96, show that the skin was influenced by the levels of fat and protein in the diet. With the exception of Lot 4, birds which received higher levels of fat and protein in the diet deposited higher levels of fat in the skin. There was a striking difference in the levels of moisture, fat, and protein between sex. There was a highly significant difference in the percentage moisture and fat between lots and sex, Tables 96a and 96b. In moisture content, Lot 4 was significantly higher than Lots 1, 2, 3, and 5. Lots 3 and 5 were significantly higher in fat than Lot 4. There was a significant difference in percentage protein between lots and a significant difference at the 1 per cent level of probability between sex, Table 96c.

Table 96. Experiment 5, Percentage moisture, fat, and protein of skin. Average 2 birds of each sex in each lot.

Lots	Moisture			Fat			Protein		
	Male	Female	Avg.	Male	Female	Avg.	Male	Female	Avg.
					Per cent				
1	63.80	48.77	56.29	20.56	41.14	30.85	14.36	8.91	11.64
2	62.14	50.98	56.56	23.71	36.82	30.27	13.00	10.45	11.73
3	57.12	47.16	52.14	28.55	42.71	35.63	12.46	9.02	10.74
4	64.96	59.89	62.43	19.84	27.91	23.88	13.84	11.10	12.47
5	53.04	48.04	50.54	34.30	41.91	38.11	10.92	8.83	9.88
Grand mean	60.21	50.77		25.39	38.10		12.92	9.66	

Table 96a. Experiment 5, Analysis of variance, percentage moisture of skin.

Source of variation	d.f.	Mean square
Between treatments	9	93.6247**
Lots	4	85.5548**
Sex	1	427.3501**
Lots x sex	4	18.2632
Error	10	12.9196

** P < .01	Lot 5	Lot 3	Lot 1	Lot 2	Lot 4
	50.54	52.14	56.28	56.56	62.42

Table 96b. Experiment 5, Analysis of variance, percentage fat of skin.

Source of variation	d.f.	Mean square
Between treatments	9	155.6574**
Lots	4	120.4911**
Sex	1	807.3393**
Lots x sex	4	27.9033
Error	10	16.5934

** P < .01	Lot 4	Lot 2	Lot 1	Lot 3	Lot 5
	23.87	30.26	30.85	35.62	38.10

Table 96c. Experiment 5, Analysis of variance, percentage protein of skin.

Source of variation	d.f.	Mean square
Between treatments	9	9.9156**
Lots	4	4.0015*
Sex	1	52.9751**
Lots x sex	4	1.7418
Error	10	0.7476

** P < .01	Lot 5	Lot 3	Lot 1	Lot 2	Lot 4
* P < .05	9.87	10.74	11.63	11.72	12.41

j. Chemical analyses, Experiment 6

Table 97 shows the chemical analyses of the breast meat. Even though there was an inverse relationship between the percentages of fat and moisture, these averages did not set any definite pattern as would be expected from the levels of fat and protein in the diet. The per cent fat was 6.47 for Lot 1, 7.49 for Lot 2, 6.43 for Lot 3, 5.52 for Lot 4, and 6.06 for Lot 5. Protein contents were comparable between lots. There were significant differences between sex for percentage moisture, fat, and protein, Tables 97a, 97b, and 97c.

Percentage of moisture and fat were comparable between lots for the thigh meat, Table 98. However, there was a significant difference in moisture and fat levels between sex. There was no significant difference in percentage protein between lots or sex, Tables 98a, 98b, and 98c.

The percentage moisture, fat, and protein for the drumsticks were comparable for all lots, Tables 99, 99a, 99b, and 99c. There was a difference in the percentage fat between sex which was significantly higher for the females.

Chemical analyses for percentage of moisture, fat, and protein of the wings were comparable between lots

Table 97. Experiment 6, Percentage moisture, fat, and protein of breast. Average 2 birds of each sex in each lot.

	Moisture			Fat			Protein		
Lots	Male	Female	Avg.	Male	Female	Avg.	Male	Female	Avg.
					Per cent				
1	72.75	71.65	72.20	5.12	7.82	6.47	20.78	19.86	20.32
2	73.65	68.63	71.13	4.25	10.73	7.49	20.55	19.23	19.89
3	73.58	71.52	72.55	4.75	8.10	6.43	20.87	19.52	20.20
4	74.74	71.19	72.97	4.09	6.94	5.52	20.34	20.24	20.29
5	74.07	71.79	72.93	5.27	6.84	6.06	19.47	20.17	19.82
Grand mean	73.76	70.96		4.70	8.09		20.40	19.80	

Table 97a. Experiment 6, Analysis of variance, percentage moisture of breast.

Source of variation	d.f.	Mean square
Between treatments	9	6.1582**
Lots	4	2.5839
Sex	1	36.5581**
Lots x sex	4	2.1577
Error	10	0.7754

** $P < .01$

Table 97b. Experiment 6, Analysis of variance, percentage fat of breast.

Source of variation	d.f.	Mean square
Between treatments	9	8.8282**
Lots	4	2.0828
Sex	1	57.5283**
Lots x sex	4	3.3988
Error	10	1.0965

** $P < .01$

Table 97c. Experiment 6, Analysis of variance, percentage protein of breast.

Source of variation	d.f.	Mean square
Between treatments	9	1.1241
Lots	4	0.2158
Sex	1	1.7820
Lots x sex	4	0.7790
Error	10	0.5694

Table 98. Experiment 6, Percentage moisture, fat, and protein of thigh. Average 2 birds of each sex in each lot.

	Moisture			Fat			Protein		
Lots	Male	Female	Avg.	Male	Female	Avg.	Male	Female	Avg.
					Per cent				
1	73.88	69.06	71.47	7.45	13.74	10.60	16.85	16.07	16.46
2	73.87	66.24	70.05	7.25	16.55	11.90	17.55	15.86	16.71
3	72.25	71.02	71.64	9.82	11.65	10.74	16.82	16.07	16.45
4	73.77	69.98	71.88	7.70	13.03	10.37	17.63	15.62	16.63
5	71.71	70.77	71.24	10.49	12.07	11.28	16.69	15.85	16.27
Grand mean	73.10	69.41		8.54	13.41		17.11	15.89	

Table 98a. Experiment 6, Analysis of variance, percentage moisture of thigh.

Source of variation	d.f.	Mean square
Between treatments	9	2.0909
Lots	4	2.0064
Sex	1	67.7485**
Lots x sex	4	7.6193
Error	10	3.8084

** $P < .01$

Table 98b. Experiment 6, Analysis of variance, percentage fat of thigh.

Source of variation	d.f.	Mean square
Between treatments	9	2.1111
Lots	4	1.5292
Sex	1	118.4871**
Lots x sex	4	10.4832
Error	10	5.6720

** $P < .01$

Table 98c. Experiment 6, Analysis of variance, percentage protein of thigh.

Source of variation	d.f.	Mean square
Between treatments	9	6.1128*
Lots	4	0.1150
Sex	1	7.3812
Lots x sex	4	0.3528
Error	10	1.6030

* $P < .05$

Table 99. Experiment 6, Percentage moisture, fat, and protein of drumstick. Average 2 birds of each sex in each lot.

	Moisture			Fat			Protein		
Lots	Male	Female	Avg.	Male	Female	Avg.	Male	Female	Avg.
					Per cent				
1	76.53	73.06	74.80	3.47	6.02	4.75	18.91	19.84	19.38
2	75.94	73.86	74.90	3.78	6.58	5.18	19.45	18.83	19.14
3	75.36	75.43	75.40	4.86	5.18	5.02	18.95	18.50	18.73
4	75.54	74.67	75.11	5.68	6.32	6.00	18.04	18.03	18.04
5	75.38	75.71	75.55	4.81	4.79	4.80	18.85	18.29	18.57
Grand mean	75.75	74.55		4.52	5.78		18.84	18.70	

Table 99a. Experiment 6, Analysis of variance, percentage moisture of drumstick.

Source of variation	d.f.	Mean square
Between treatments	9	2.0909
Lots	4	0.4054
Sex	1	7.2240
Lots x sex	4	2.4933
Error	10	1.6227

Table 99b. Experiment 6, Analysis of variance, percentage fat of drumstick.

Source of variation	d.f.	Mean square
Between treatments	9	2.1113
Lots	4	1.0290
Sex	1	7.9506*
Lots x sex	4	1.7338
Error	10	0.8913

* $P < .05$

Table 99c. Experiment 6, Analysis of variance, percentage protein of drumstick.

Source of variation	d.f.	Mean square
Between treatments	9	0.6792
Lots	4	1.0858
Sex	1	0.1022
Lots x sex	4	0.4168
Error	10	0.6408

as shown in Table 100. The females had higher levels of fat; whereas, the males had the higher levels of protein. There were highly significant differences between sex for moisture, fat, and protein, Tables 100a, 100b, and 100c.

In the percentage moisture, fat, and protein of the skin, Table 101, very little difference occurred between lots. However, analyses of variance for these percentages, Tables 101a, 101b, and 101c, show that there were significant differences for moisture, fat, and protein between sex. The males had the higher levels of moisture and protein with the lower percentage of fat.

Table 100. Experiment 6, Percentage moisture, fat, and protein of wing. Average 2 birds of each sex in each lot.

	Moisture			Fat			Protein		
Lots	Male	Female	Avg.	Male	Female	Avg.	Male	Female	Avg.
					Per cent				
1	72.41	69.40	70.91	7.57	12.42	10.00	18.78	16.95	17.87
2	65.77	67.05	66.41	7.44	14.89	11.17	18.69	16.61	17.65
3	71.11	70.41	70.76	9.81	11.22	10.52	18.07	17.22	17.65
4	68.47	69.70	69.09	8.78	12.55	10.67	17.30	16.64	16.97
5	68.15	70.05	69.10	9.36	11.79	10.58	17.74	16.88	17.31
Grand mean	69.18	69.32		8.59	12.57		18.12	16.86	

Table 100a. Experiment 6, Analysis of variance, percentage moisture of wing.

Source of variation	d.f.	Mean square
Between treatments	9	6.1089
Lots	4	0.9389
Sex	1	35.8317**
Lots x sex	4	3.8484
Error	10	2.1999

** P < .01

Table 100b. Experiment 6, Analysis of variance, percentage fat of wing.

Source of variation	d.f.	Mean square
Between treatments	9	11.5488
Lots	4	0.6960
Sex	1	79.3215**
Lots x sex	4	5.4584
Error	10	2.7695

** P < .01

Table 100c. Experiment 6, Analysis of variance, percentage protein of wing.

Source of variation	d.f.	Mean square
Between treatments	9	1.2708
Lots	4	0.4950
Sex	1	7.8626**
Lots x sex	4	0.4238
Error	10	0.2460

** P < .01

Table 101. Experiment 6, Percentage moisture, fat, and protein of skin. Average 2 birds of each sex in each lot.

	Moisture			Fat			Protein		
Lots	Male	Female	Avg.	Male	Female	Avg.	Male	Female	Avg.
					Per cent				
1	62.28	54.91	58.60	22.57	32.61	27.59	13.50	10.97	12.24
2	64.33	52.44	58.39	20.62	35.70	28.16	13.65	10.63	12.14
3	62.68	58.88	60.78	22.61	29.32	25.97	13.06	10.75	11.91
4	63.20	56.28	59.74	21.90	31.99	26.95	12.79	10.61	11.70
5	60.21	59.01	59.61	26.25	27.82	27.04	12.33	11.83	12.08
Grand mean	62.54	56.30		22.79	31.49		13.07	10.96	

Table 101a. Experiment 6, Analysis of variance, percentage moisture of skin.

Source of variation	d.f.	Mean square
Between treatments	9	30.5062*
Lots	4	3.2281
Sex	1	194.5632**
Lots x sex	4	16.2201
Error	10	8.6515

** $P < .01$
* $P < .05$

Table 101b. Experiment 6, Analysis of variance, percentage fat of skin.

Source of variation	d.f.	Mean square
Between treatments	9	54.2069*
Lots	4	2.6703
Sex	1	377.9282**
Lots x sex	4	24.8106
Error	10	13.9525

** $P < .01$
* $P < .05$

Table 101c. Experiment 6, Analysis of variance, percentage protein of skin.

Source of variation	d.f.	Mean square
Between treatments	9	3.1727*
Lots	4	0.1810
Sex	1	22.1972**
Lots x sex	4	0.9084
Error	10	0.9954

** $P < .01$
* $P < .05$

IX. DISCUSSION

Most of the research concerning the addition of fat and protein in broiler diets has been conducted to study their influence on growth rate, feed efficiency, and relationship to other nutrients in the diet. Research has been conducted to study the influence of added fat in the diet on total fat content of the carcass. Very little emphasis has been directed towards determining the areas of fat deposition in broilers as influenced by the different levels of added fat with varying amounts of protein in the diet.

The work reported here was undertaken to determine and measure the fat deposited in different areas of the fryer as influenced by the levels of added fat and protein in the rations. The areas of fat deposition could have a great influence upon processing yields, cooking yields, and consumer acceptance of the dressed fryer. The cost of producing live birds, as well as the cost based on the eviscerated carcass and cooked product would be important to the success of all segments of the poultry industry.

a. Growth rate and 10 week live weights

The amount of added fat and protein in the diet influenced the 10 week live weights in the different experiments. In Experiment 1 the 10 week live weights of Lot 2 which received 2 per cent fat were comparable to the 10 week live weights in Lot 5 which received 8 per cent added fat, indicating that the extra 6 per cent fat did not further improve growth. There was no significant difference between the average weights of 10 week old fryers of Lots 2, 3, 4, and 5, but weights of these lots were highly significant from Lot 1. There was a highly significant difference between sex.

The rate of growth for the males and females, except for Lot 1, was comparable between lots until 10 weeks of age. However, the males in Lot 1 increased at a slower rate from 8 to 10 weeks of age than did those in other lots. A similar but less dramatic effect occurred in the females of Lot 1 from 8 to 10 weeks of age indicating a difference in the nutritional requirements for males and females. Live weights which were comparable between Lots 2, 3, 4, and 5 were probably due to the same level of protein used in each lot. Similar conclusions were shown by Biely and

March (1957). The additional fat in the diet from Lots 2 to 5, which resulted in an increase in the C-P ratio and productive energy in calories per pound of feed, did not further increase growth rate. Many authors have shown that the addition of fat to broiler rations did not improve growth, Rosenberg et al. (1955), Curtin and Raper (1956), and Runnels (1955).

Experiment 4 which was fed the same rations as Experiment 1 showed no difference in 10 week weights between lots. There were differences between sex, however. The difference in weights in Experiment 1 which showed a highly significant difference between Lot 1 and Lots 2, 3, 4, and 5 and Experiment 4 which showed no difference between lots could be due to strain differences. This agrees with work by Fox and Bohren (1954) and Slinger et al. (1955) who showed inter- and intra-strain differences in poultry in their ability to utilize feed efficiently. Experiments 1 and 4 were conducted at different times of the year which could also have contributed to the slight variation between weights for the two experiments, Bigbee (1956).

Ten week bird weights between lots were comparable in Experiment 2. There was a highly significant difference between sex. The growth rate was similar for the males and for the females of the different lots; however, the growth rates of the males and females began to separate at about the second week of age indicating a different nutritional requirement for the males and females. The comparable growth rates between lots could be expected since all lots received approximately the same C-P ratio even though the levels of fat and protein in the diets increased at the same rate from Lot 1 to Lot 5. Neither the level of fat nor level of protein used seemed to influence the rate of growth. There could have been a limiting factor not presently recognized which influenced growth in the relationship of these two ingredients and other nutrients in the rations since higher levels of fat and protein did not further stimulate growth.

Ten week live weights in Experiment 5 which had the same rations as Experiment 2 were comparable between lots but significant differences occurred between sex. The average 10 week weights were higher for both sex in Experiment 5 than in Experiment 2. For example, the average weight of Lot 1 was 3.51 pounds for Experiment 2 and 3.95 pounds for Experiment 5. Lot 5 in Experiment 2 was 3.44 pounds and 4.02 pounds in Experiment 5. The difference in weights between the lots in Experiments 2 and 5 could be due to the differences in strains used and the time of year each experiment was conducted.

In the diet used for Experiments 3 and 6 the per cent protein in each lot increased from 20.77 in Lot 1 to 24.89 in Lot 5. Added fat was increased by 1 per cent in each lot from 0 per cent in Lot 1 to 4 per cent in Lot 5. The productive energy in calories per pound of feed was 889 for each lot; whereas, C-P ratios were reduced from 42.8 to 1 in Lot 1 to 35.7 to 1 in Lot 5. It would appear, therefore, that C-P ratios of 42.8 to 1 in Lot 1 and 35.7 to 1 in Lot 5 gave better 10 week weights than a C-P ratio of 38.9 to 1 as found in Lot 3 even though the productive energy was the same for all lots. Apparently some other factor or factors not recognized exerted some influence on growth. Perhaps other nutrients could have been involved as suggested by Thayer and Davis (1953) and Rice _et al_. (1954).

Live weights for Experiment 3 were highly significant between lots and sexes. Lots 2, 4, 1, and 5 were comparable to each other but all were different than Lot 3. There was a highly significant difference between sex. The significant interaction between lots X sex indicates that the increasing higher levels of protein with the increase in levels of fat did not show a continuous increase in growth rate. This interaction was noted in Lot 3 which was different than the other lots.

The rate of growth was similar for the males and females of the different lots in Experiment 3 except for the males in Lot 3 and females of Lot 1. Males showed a different growth pattern than the females in Lot 3.

Ten week weights were similar for all lots in Experiment 6. There was a highly significant difference between sex, however. Strain differences and/or time of year Experiments 3 and 6 were conducted could have been responsible for the differences between the two experiments.

b. Feed efficiency

In Experiment 1 feed efficiency was improved as the level of fat was increased from 0 per cent in Lot 1 to 8 per cent in Lot 5. Similar results were reported by Bird (1954) and Runnels (1955). This increase in feed conversion is interesting in view of the fact that the C-P ratio was increased from 43.1 to 1 in Lot 1 to 50.1 to 1 in Lot 5. Richardson _et al._ (1956) suggested that the C-P ratio in broiler rations should be between 41 and 43 to 1 for optimum growth.

The ration used in Lot 1 gave the best feed conversion of any lot during the first 6 weeks but was the least desirable from 6 to 10 weeks, indicating that higher energy levels are needed in the broiler diets starting at about 6 weeks of age. Feed efficiency was almost identical for all lots at 9 weeks of age but was different for each lot from 9 to 10 weeks. In Experiment 4 this same grouping of feed efficiency in all lots occurred at about 8-1/2 weeks of age. However, feed efficiency for Lot 1 was comparable to Lots 2, 3, and 4 throughout the feeding period; whereas, in Experiment 1, Lot 1 had the poorest feed conversion after about 6 weeks. Perhaps the season of the year could have had an effect on this irregularity.

In Experiment 2, feed efficiencies were 2.62, 2.40, 2.39, 2.42, and 2.33 pounds of feed per pound of gain for Lots 1 to 5, respectively, giving a difference of 0.29 pound of feed per pound of gain between Lots 1 and 5. This difference would be significant in the production cost of broilers.

Feed conversions for the lots in Experiment 5 were quite comparable for all lots. However, Lot 5 gave the best feed conversion followed by Lots 3, 4, 1, and 2. There was less spread in feed efficiency between lots throughout the test in Experiment 5 than in Experiment 2.

In Experiment 3, feed conversion was better in Lots 2, 3, 4, and 5 than in Lot 1. However, it is doubtful whether any real difference existed between Lots 1, 3, and 4. There was a vast difference in feed efficiency between Lots 1 and 5 throughout the experiment. Apparently the higher level of protein fed in Lot 5 improved feed efficiency over the other lots even though the C-P ratio was reduced from 42.8 to 1 in Lot 1 to 35.7 to 1 in Lot 5. Perhaps part of the excess protein was converted to energy-type compounds in the bird which were then used for energy to increase feed efficiency.

When Experiment 3 is compared with the replicate test, Experiment 6, it was found that all lots in Experiment 6 gave the better feed conversions. However, the relationship between lots within each experiment was practically the same. Feed efficiency was improved as the level of protein increased in the diet.

It would hardly be practical to recommend using the rations used in Experiments 3 and 6 and perhaps Experiments 2 and 5 because of the increase in cost of higher levels of protein and fat. However, with higher levels of protein as in Experiments 3 and 6, and the higher levels of fat and protein together as in Experiments 2 and 5, C-P ratio was either lowered or raised from 42 and 43 to 1. These ratios, however, improved feed efficiency in practically all cases.

c. Warm eviscerated yields

Warm eviscerated yields were comparable between lots for Experiments 1 and 4. The males, as would be expected, gave higher eviscerated yields in each experiment which was significant at the 5 per cent level of probability in Experiment 4 but not in Experiment 1.

Warm eviscerated yields for Experiment 2 and Experiment 5 were comparable between lots and sex. Females in 3 of the 5 lots in Experiment 5 gave slightly higher eviscerated yields than the males which is unexplainable.

Eviscerated yields in Experiments 3 and 6 were comparable between lots and sex. Females gave higher yields than males in many lots which is difficult to explain. There was a lots x sex interaction in Experiment 3.

On the basis of the results obtained in these experiments, the levels of added fat and protein did not influence dressing percentages. During the dressing operation, fats which were attached to the abdominal cavity and gizzard were saved which might have partially caused yields to be comparable between experiments. With larger numbers of fryers and under commercial conditions, economical differences would probably have been obtained between the different lots and experiments.

d. Specific gravity of dressed carcasses

Specific gravity, a method often used to measure fat deposition in poultry carcasses, was obtained in all 6 experiments. Since a large amount of fat was often attached to the gizzards, the gizzards with attached fat were weighed with the warm eviscerated carcasses in obtaining specific gravities.

In Experiment 1, Lots 2, 3, 4, and 5, which received higher levels of fat in the diet, were found to have lower specific gravities than Lot 1 indicating more fat deposition in the carcasses of these lots. There was a lots x sex interaction.

Experiment 4, which was comparable to Experiment 1, failed to show any difference between lots or sex. The average specific gravity for the females of all lots in both experiments was lower than for the males.

In Experiment 2, specific gravities were comparable between lots and sex. In Experiment 5, there was no significant difference between lots even though lots on higher levels of fat and protein in the diet gave a lower specific gravity. However, there was a highly significant difference between sex. When the specific gravities of the birds in Experiments 2 and 5 are compared with those of Experiments 1 and 4, it is noted that lots of the latter experiments had lower specific gravities indicating fat deposition was greater in Experiments 1 and 4 which had higher C-P ratios.

Specific gravities were comparable between lots in Experiment 3. However, there was a difference between sex. The same results were obtained in Experiment 6. However, the average specific gravity was lower for the corresponding lots in Experiment 3 indicating some difference in fat deposition between the two experiments. In these experiments one can conclude that the level of fat in the diet influences specific gravity and that females in all cases showed a lower specific gravity than the males. Perhaps differences could have been obtained between lots with larger numbers of birds.

e. Moisture pick-up from chilling operation

The percentage moisture pick-up from chilling the carcasses and giblets in ice slush for approximately 4 hours was measured by weighing the carcasses immediately before chilling and again after draining for 10 minutes following the chilling operation. It was felt that the percentage of moisture pick-up would be altered by the amount of fat deposited on the carcass.

It was found in Experiment 1 that no significant difference existed between lots but there was a difference between sex. The males picked up 4.87 per cent weight from chilling while the females gained 5.65 per cent. In Experiment 4 males picked up 5.45 per cent and the females 6.61 per cent.

The percentage moisture pick-up in Experiments 2 and 5 were comparable between lots in both experiments; yet, there was a highly significant difference between sex. The females gained more from chilling than did the males.

Significant differences for percentage moisture pick-up between sex but not between lots were observed in Experiments 3 and 6. The percentage moisture pick-up was found to be comparable between lots in the 6 experiments. There was approximately 0.5 to 1.75 per cent difference in moisture pick-up in favor of the females between lots. Since females picked up more weight from chilling, one might conclude that birds with greater fat deposition gained more weight from chilling. Yet, the difference in the percentage gain in weight might be due to the fact that the females are smaller than the males and the same weight of moisture pick-up in each sex would appear as a greater percentage in the females.

f. Percentage chilled abdominal and gizzard fat

After the carcasses and giblets were chilled the abdominal and gizzard fat were removed, weighed, and expressed as a percentage of the live weight. This step was considered important since loss of deposited fat from these areas during the processing of fryers could be an economical loss to processors.

In Experiment 1 the percentage of abdominal and gizzard fat increased as the level of fat in the diet increased. There was a highly significant difference between lots and sex. Lots 4 and 5 which received higher levels of fat in the diet were significantly higher in fat deposition than Lot 1.

Practically the same results were obtained in Experiment 4 as in Experiment 1. Lots 4 and 5 were statistically different from Lot 1. There were significant differences between sex. One may conclude that the feeding of fat within the limits used in these rations result in greater fat deposits in these areas of the carcass.

There was a highly significant difference in fat deposition between lots and sex in Experiment 2. However, in Experiment 5 there was no difference between lots but a highly significant difference between sex. Again, the average abdominal and gizzard fat was higher for the females than the males. Deposited fat in these two areas ranged from 1.42 per cent in Lot 2 to 2.11 per cent in Lot 4. Expressed in terms of weights, these two percentages would amount to 14.21 and 21.08 pounds, respectively, per 1000 pounds of live fryers.

The percentage abdominal and gizzard fat in Experiment 3 was found to be comparable between lots but highly significant between sex. Fat deposition in the different lots was not consistent with the amount of protein in the diet. The same inconsistency was noticed between lots in Experiment 6, also. Apparently the different levels of protein did not influence fat deposition in these areas as did the different levels of fat used in Experiments 1 and 4.

Abdominal and gizzard fat could be lost if care is not exercised in the dressing procedure. In removing the viscera from the body cavity, fat is often removed with the gizzard. Fat attached to the abdominal wall may also be removed at the same time. If the fat attached to the abdominal wall and gizzard is lost during the cleaning operation, it would amount to a great economical loss for the processor. For example, in Lot 5, Experiment 1, 2.23 per cent of the live weight was abdominal and gizzard fat. Expressed as pounds, this could amount to as much as 223 pounds in 10,000 pounds of live fryers. This amount of fat, if sold for 30 cents a pound, would amount to $66.90. If a plant processed 30,000 fryers a week, and if the fryers averaged 3.5 pounds each, the loss from deposited fat alone could be up to 2,341 pounds a week. Most plants attempt to minimize the loss of fat in these areas, but if care is not exercised during processing, the loss of deposited fat can be tremendous.

g. Percentage heart of 10 week old fryers

The hearts were weighed to determine if diet had any influence on their weights. It was found that no significant difference existed between lots in any of the experiments except in Experiment 2. In this experiment there was a difference between the Control lot, Lot 1, and Lots 2, 3, and 5. However, in Experiment 5 which received the same five rations as Experiment 2, these differences between lots were not observed. There was a difference between sex in Experiments 2 and 3, and a lots x sex interaction in Experiment 1.

With an organ as small as the heart there are many variables which can enter into the weights which are difficult to control. Weights were determined to the nearest gram and processing was as similar as possible; yet, there could have been variations such as the presence of blood clots within the heart, differences in the degree of cleaning, or the presence of moisture within the walls or on the outside of the heart which could have influenced the weights. It is doubtful with the procedure used in processing plants that any differences in heart weights can be measured between birds of comparable size.

h. Percentage chilled gizzard with attached fat of 10 week old fryers

It has been shown by Harshaw (1936, 1939), Fraps (1943), and Newell et al. (1950) that high energy rations increased fat composition of carcasses. Yet, these authors did not study the location of fat deposition in the carcass. It seemed expedient, therefore, to determine if the weight of gizzards with attached fat would be influenced by the diet.

It was found in Experiment 1 that the percentage of gizzard with attached fat increased in the birds which received higher levels of fat in the diet. Statistically, these differences were not significant. Perhaps with a larger number of birds significant differences might have been obtained. There was a difference between sex. With the same rations fed in Experiment 4 there were significant differences between lots and sex. Birds in Experiment 4 which received higher levels of fat in the diet deposited more fat on the gizzard.

In Experiments 2 and 5 which received increasing higher levels of fat and protein in the rations from Lot 1 to Lot 5, there were significant differences in the percentage gizzard with attached fat between the males and females. There were also significant differences between lots in both experiments. Birds in lots which received the higher levels of fat and protein in the diet showed the smaller percentage gizzard and attached fat. This was the exact opposite of what was observed in Experiments 1 and 4 which showed a higher percentage of gizzard and fat in lots which received higher levels of fat in the diets. Apparently the extra energy from the fat in Experiments 1 and 4 was deposited elsewhere on the carcass. In Experiments 3 and 6, fat in the diet was required by the higher levels of protein so that fat deposition did not occur to an appreciable extent.

The percentage gizzard with attached fat was different in Experiments 3 and 6. Only sex differences occurred in Experiment 3; whereas, there were differences between lots and sex in Experiment 6. Birds in Lot 1 which received the lowest level of protein in the diet had the highest percentage gizzard with attached fat of any lot.

Fat and protein levels in the diet of Lot 1 resulted in a C-P ratio of 42.8 to 1. Perhaps this ratio was more conducive to fat deposition than lower C-P ratios present in the other lots.

i. Percentage chilled gizzard without attached fat of 10 week old fryers

After the gizzards with attached fat were weighed the fat was removed from the gizzards to determine whether the differences observed between lots and sex were due to greater fat deposition on the gizzards or due partially to different size gizzards. It was found that there was a difference in percentage gizzards between sex in Experiment 1. Females had a higher percentage gizzard than did the males. The difference observed in percentage gizzards with attached fat, between lots in Experiment 4, when the gizzard and attached fat were weighed together, no longer existed when the fat was removed from the gizzards.

In Experiments 2 and 5 there were highly significant differences in percentage gizzard with the fat removed. Birds in lots which were highest in the percentage of gizzard with attached fat in the previous measurements were also highest for percentage gizzards without the fat. Lots which received higher levels of fat and protein in the diet had significantly smaller gizzards in both Experiments 2 and 5.

In Experiment 3 there was no difference between lots or sex in the percentage gizzard without fat. However, in Experiment 6 there were highly significant differences between lots and sex. Females had higher percentage gizzards than did males. Birds in lots which received higher levels of protein in the diet had significantly smaller gizzards without the attached fat than those receiving lower amounts of protein. This phenomenon is unexplainable. Perhaps strain differences were at least partially responsible for the inconsistency between the two experiments receiving the same diets.

j. Percentage liver of 10 week old fryers

It was felt that higher levels of fat or protein in the diets might influence the percentage livers. In order to study this assumption, livers were weighed and expressed as a percentage of the live weights.

In Experiments 1 and 4, birds which received the higher levels of added fat showed a difference in percentage livers between sex. Females had the higher percentage livers of live weight.

In Experiment 2 there was a highly significant difference between lots and a significant difference between sex. Birds in Lot 5 had the highest percentage liver and those in Lot 2 the lowest. This indicated that higher levels of added fat and protein in the diet resulted in heavier livers. These results were not found in Experiment 5, however, which received the same rations as Experiment 2. Apparently other factors besides fat and protein were involved in liver size.

There was no difference in percentage of liver between lots or sex in Experiments 3 and 6. It might be concluded that higher levels of fat and protein together or higher levels of fat with a constant level of protein increased the percentage of liver weights. Higher levels of protein with lower levels of fat did not increase liver weights.

k. Percentage intestine of 10 week old fryers

It has been shown by Duckworth et al. (1950) that higher levels of fat in broiler rations result in greater fat deposition in birds. It was considered advisable to determine whether greater fat deposition occurred on the intestinal tract when higher levels of fat or protein are included in the diet. If so, the deposited fat, if in large enough quantities, would be expected to alter the dressing percentage.

The total intestinal tracts, including the esophagus to vent, were weighed and expressed as a percentage of live weights.

The intestinal tract in Experiment 1 represented 6.59 per cent of the male's weight at 10 weeks of age and 7.04 per cent of the female's weight. This difference was highly significant. There was no significant difference, however, between lots. The same rations were fed again in Experiment 4 using a different strain of chicks than those used in Experiment 1. In this experiment there was a highly significant difference between lots. Birds in lots which received higher levels of fat in the diet had a higher percentage of intestinal tract. There was also a significant difference between sex. Even though there were significant differences between lots, these differences did not influence the warm eviscerated yields which is unexplainable.

Birds in Experiments 2 and 5 which received high levels of fat and protein together showed a difference between sex but not between lots in either experiment. There was a lots X sex interaction in Experiment 2. The results obtained in these two experiments indicated that higher levels of fat with a correspondingly higher level of protein do not result in greater fat deposits on the intestinal tract.

Differences between lots or sex in the percentage of intestinal tract were not noted in Experiment 3. However, there was a highly significant difference between lots as well as between sex in Experiment 6. Birds in lots which received higher levels of protein in the diet had heavier intestinal tracts. It seems proper to assume that any difference in the percentage of intestines between birds of the different lots would be due to greater fat deposition or perhaps to an intestinal tract which has thicker walls caused by the different diets. The differences observed in the percentage intestines between two experiments receiving the same diets could have been due to strain differences.

1. Percentage skin of chilled eviscerated carcass weights

In a further effort to determine the areas of fat deposition in fryers, the fryers were skinned and the skin weight expressed as a percentage of the chilled eviscerated carcass weight. It was felt that any difference observed would be due to the amounts of fat deposited in or attached to the skin.

Birds in Experiment 1 showed a significant difference between lots with respect to percentage skin. Birds which received higher levels of fat in the diet had a higher percentage skin. However, in Experiment 4 there was no significant difference between lots even though each succeeding lot which received a higher level of fat in the diet showed a correspondingly greater percentage of skin. There must have been strain differences which caused one experiment to show one result and another experiment on the same feed to show a different result.

In Experiments 2 and 5, which received high levels of fat and protein, sex differences were noted in Experiment 2 but not between lots or sex in Experiment 5.

There were sex differences in Experiment 6 which seemed to be true for Experiment 3 even though the results of the latter were not treated statistically because of uneven numbers between lots.

m. Percentage cooking yield

It was reported by Harms et al. (1957), and Brunson (1958) that greater cooking losses resulted with broilers which had been fed diets containing higher levels of energy. It was felt advisable to determine whether the percentage cooking yield of birds would be altered after the abdominal fat had been removed from the carcasses. No difference in percentage cooking yield was found between lots in any of the experiments. However, there was a sex difference in Experiments 2 and 3. Since only eight birds were used in each lot, perhaps a larger number of birds would have given a significant difference in cooking yield.

When the cooking yields of Experiments 1, 2, and 3 were compared, Experiment 1, which received the highest level of fat in the diet without a corresponding increase in protein level gave the lowest cooked yield. Experiment 3 gave the highest cooked yield.

n. Cost of production

In these studies it was observed that the strain of Cornish Cross used in Experiments 4, 5, and 6 were heavier at 10 weeks of age than the strain of Cornish Cross used in Experiments 1, 2, and 3 even though the diets were the same for Experiments 1 and 3, 2 and 5, and 3 and 6. This strongly suggests a difference in the two strains. During the processing operation no differences were observed in quality between the different lots of birds. Yet, because of the feed cost and feed efficiency the production cost based on these two factors were different between lots. Rations which gave better feed efficiencies were not necessarily the most economical to use. In measuring the performance of a feed, feed conversion is often the primary criterion for determining its value. It would seem that other factors should also be used to measure the performance of a feed. In these studies it was found that the feed which produced the most economical broiler did not give as good a feed conversion as some other ration. It would appear that a ration which produced the most economical broiler at 9 to 10 weeks of age, without sacrifice to quality, would have an advantage over another ration which gave better feed conversion but produced a bird at a greater cost to the grower. In addition to feed cost and feed conversion, the influence of feed on the cost and quality of the ready-to-eat product as well as other factors should also be used to evaluate a ration.

o. Chemical analyses of carcasses

1. Experiment 4

To further establish the areas of fat deposition and influence of different levels of fat and protein on carcass composition, one-half breast, one thigh, one drumstick, one wing (minus third joint), and skin from one-half of a carcass from two birds of each sex for each lot in Experiments 4, 5, and 6 were analyzed to determine the percentage moisture, fat, and protein of these tissues. For the serving parts mentioned above the skin and muscles of each piece with adhering fat were used for analysis.

It was found that the level of fat in the diet influenced the moisture and fat content of the different tissues. In Experiment 4, birds which received the higher levels of fat in the diet showed the higher percentage of fat in the breast, thigh, and wing. The highest percentage of fat was in the wings of Lots 3 and 5. The different levels of fat in the diet of Experiment 4 did not seem to influence the amount of fat deposited in the drumstick. Percentage fat and moisture were inversely related to each other. Parts which had the highest percentage fat in the tissue showed the lowest level of moisture which agrees with results reported by McNally (1955). Thighs contained approximately 4 to 7 per cent more fat than did the breasts. Drumsticks contained less fat than either the breast or thigh. Wings were comparable to thighs in fat content but skin tissue was highest with approximately 23 to 27 per cent fat. Lots 1 and 2 which received the two lowest levels of fat in the diet and Lot 5 which received the highest level showed the three lowest levels of fat in the skin. This would indicate that birds on lower levels of fat (0 and 2 per cent) and fat at a level of 8 per cent in the diet did not deposit as much fat in the skin as did birds on diets with 4 and 6 per cent fat.

The females deposited more fat in the different tissues than the males. In almost every case the percentage of protein was fairly constant between lots for the same tissue. Males had from 1 to 3 per cent more protein than did the females.

2. Experiment 5

In Experiment 5 the higher levels of fat with correspondingly higher levels of protein did not always deposit more fat in the different tissues. There was a difference between sex but not between lots for percentage fat and protein in the breast tissue. There were differences, however, between lots with respect to percentage of moisture. Lot 4 which contained 6 per cent fat in the diet had the highest per cent moisture (73.24) of all lots. Lot 5 which contained 8 per cent fat in the diet had the lowest per cent moisture (69.80).

There was a sex difference in the percentages of moisture, fat, and protein of the thigh tissue. Females had higher fat levels and lower moisture levels than did the males. Males were about 2 per cent higher than females in protein content.

There was no difference between sex or lots in moisture or protein content of the drumsticks but there were differences in lots in percentage fat. Lots with higher levels of fat in the diet gave higher fat deposits in the drumstick. The wing and skin tissues, however, had sex differences for moisture, fat, and protein, and lot differences for fat in both tissues.

When Experiments 4 and 5 are compared one can conclude that the difference in fat deposition could be due to the ratio of fat and protein in the rations. In Experiment 4 there was surplus energy from the amount of fat added in the diet. This extra energy was deposited as fat in the different tissues; however, with fat and protein added at the levels used in Experiment 5, less surplus energy was available for fat deposits in the different tissues.

The average percentage of fat in the skin tissue of birds in Experiment 5, was four to six per cent higher than in Experiment 4. This difference in fat level might be associated with some physiological make-up of the bird since smaller amounts of surplus energy obtained from the feed were deposited as fat in the skin instead of in the breast, thigh, drumstick, wing, or abdominal cavity as was done with larger amounts of surplus energy as found in Experiment 4.

3. Experiment 6

Similar results were found in Experiment 6 and Experiment 5. There were differences in sex but not between lots in the moisture and fat content of the breast, thigh, drumstick, wing, and skin of the lots in Experiment 6.

There was one difference between the results of these two experiments which seems significant. The average percentage of fat for the different tissues was lower in Experiment 6 than Experiment 5. In Experiment 6 the fat levels in the diets were increased by 1 per cent from 0 per cent in Lot 1 to 4 per cent in Lot 5; whereas, protein was increased from 20.77 per cent to 24.89 per cent for the same lots. With low levels of fat in proportion to the levels of protein as used in Experiment 6, the C-P ratios were reduced from 42.8 to 1 in Lot 1 to 35.7 to 1 in Lot 5. One would conclude from the lower fat content and C-P ratios that fat deposition in this experiment was limited by the lack of surplus energy.

When fat depositions of Experiments 4 and 5 are compared, it will be noted that Experiment 5 deposited more fat in the skin than in the abdominal cavity or other tissues analyzed. Birds in

Experiment 4, however, which received large amounts of energy from the higher levels of fat in the diet deposited larger amounts of fat in the abdominal cavity and tissues, with smaller amounts in the skin tissue. This would strongly indicate that smaller amounts of surplus energy from the diet were deposited in larger quantities in the skin instead of the abdominal cavity as found in Experiment 5. However, with larger amounts of surplus energy from dietary fat as found in Experiment 4, fat was deposited in large amounts in the abdominal cavity and muscle tissues and smaller amounts in the skin tissue. From the results obtained in this study, there could be strain differences as well as other factors which determine the areas of fat deposition in the bird just as there are strain differences and other factors which are associated with growth rate, feed efficiency, and many other factors studied. Further research is needed to study fat deposition in fryers.

X. SUMMARY

Six experiments were conducted in which 12 White Cornish Cross chicks of each sex per lot for five lots for each experiment were used to determine the influence of different levels of added fat with varying levels of protein in the diet on many factors associated with the production and utilization of fryers. Growth rate, feed efficiency, warm eviscerated yield, specific gravity, moisture pick-up from chilling, percentage abdominal and gizzard fat, gizzard, liver, heart, skin, cooking yield, cost of production, and chemical composition of the breast, thigh, drumstick, wing, and skin were determined. Experiments 1, 2, and 3 were conducted using one strain of White Cornish Cross chicks for all experiments. Replicate Experiments 4, 5, and 6 of Experiments 1, 2, and 3, respectively, were conducted in which another strain of the same White Cornish Cross was used.

In Experiments 1 and 4 the level of fat in the diet was increased by two per cent in each succeeding lot from 0 per cent in Lot 1 to eight per cent in Lot 5. Protein was fed at approximately 20.2 per cent in all rations. The C-P ratios were 43.5, 45.1, 46.8, 48.4,

and 50.1 to 1 for Lots 1 to 5, respectively. Productive energy in calories per pound of feed were 880, 912, 946, 978, and 1011 for Lots 1 to 5, respectively.

In Experiments 2 and 5, the level of fat in the diets was the same for the five lots as in the five lots of Experiments 1 and 4. However, the level of protein was also increased in proportion to the level of fat in each succeeding lot. The different levels of protein were 20.77, 21.35, 21.93, 22.51, and 23.09 per cent, respectively, for Lots 1 to 5. Calorie-protein ratio was approximately 42.5 to 1 in all lots. Productive energy in calories per pound of feed were 889, 912, 935, 959, and 982 for Lots 1 to 5, respectively.

In Experiments 3 and 6 fat in the diet was increased by one per cent in each succeeding lot from 0 per cent in Lot 1 to four per cent in Lot 5. Protein was added at levels of 20.77, 21.80, 22.83, 23.86, and 24.89 per cent, respectively, for Lots 1 to 5. Calorie-protein ratios were 42.8, 40.8, 38.9, 37.3, and 35.7 to 1 for these five lots. Productive energy was calculated to be 889 calories per pound of feed in each lot.

The C-P ratios ranged from 50.1 to 35.7 to 1 in the different experiments. Productive energy ranged from 880 to 1011 calories per pound of feed.

The birds were fed to 10 weeks of age before being sacrificed to obtain other data.

On the basis of results obtained from these experiments, conducted under the conditions described and using the procedures mentioned, the following statements can be made.

1) The levels of fat and protein used in Experiments 1 and 3 resulted in greater live weight in 10 week old fryers. However, there was no difference between lots in 10 week weights in Experiments 2, 4, 5, and 6.

2) Rate of growth was higher for males than for females in all experiments, indicating a difference in the nutritional requirement of male and female chicks.

3) Feed efficiency was improved by adding fat up to eight per cent level. Fat at eight per cent of the diet with correspondingly higher levels of protein also improved feed efficiency. Higher levels of protein with a lower per cent of added fat improved feed efficiency only to a small extent. Rations which gave better feed conversions did not necessarily produce fryers as economically as similar rations which gave poorer feed conversions.

4) There was no significant difference in warm eviscerated yield between lots in any experiment.

5) Feed cost and feed conversion are a better measure for evaluating the production cost of fryers than feed conversion alone.

6) There was no difference in percentage moisture pick-up during the chilling operation between lots. However, the females picked up a higher percentage of moisture than did the males.

7) Specific gravity of the eviscerated carcasses was lower as the level of fat in the diet was increased indicating greater fat deposition in the carcass. The feeding of higher levels of fat and protein together and higher protein levels with lower levels of fat did not show a significant difference in specific gravity between lots.

8) Higher levels of fat in the diet resulted in greater fat deposition in the abdominal cavity and around the gizzard. Females deposited more fat in these areas than males. Greater fat deposits were noted in these areas when the diet contained higher levels of fat and protein together but not when protein levels were high without fat being high also. Fat

deposited in the abdominal cavity and attached to the gizzard can be a potential loss to the processor.

9) Birds which received higher levels of fat and protein together in the diet or higher levels of protein with lower levels of fat showed significantly smaller gizzards based on the percentage of live weight than did birds which received higher levels of fat with the same level of protein in all lots.

10) There appeared to be little if any difference between lots in the percentage heart. Only in one of the six experiments did any significant difference in heart size occur.

11) Birds which received higher levels of fat and protein in the diet showed a significantly higher percentage liver weights.

12) Percentage skin weight of eviscerated carcass was influenced by the level of fat in the diet. Generally speaking, lots with higher levels of fat in the diet had a higher percentage skin.

13) With the abdominal fat removed from the carcass there was no significant difference in cooking yields between lots within the same experiment. When the cooking yields of Experiments 1, 2, and 3 were

compared, Experiment 1 which received the highest levels of fat in the diet gave the lowest cooking yield.

14) Fat composition was higher and moisture content lower in the breast, thigh, wing, and skin of birds on higher levels of fat in the diet. All chemical analyses were based on the average of 2 birds of each sex in each lot. The fat composition of drumsticks was influenced by the amount of fat and protein in Experiment 5 but not in Experiments 4 and 6.

15) There was an inverse relationship between the percentage of fat and moisture in the tissue. Protein composition was fairly constant for the same tissue in all birds but males were about two per cent higher than females.

16) Fat composition was higher in the skin of birds which received higher levels of fat and protein together in the diet than in diets which received higher levels of fat with a constant level of protein.

17) Birds fed high levels of fat deposited more fat in the abdominal cavity, gizzard area, and tissues than in the skin.

18) The amount of fat deposited on the bird and areas of fat deposition were associated with the levels of fat and protein in the diet.

19) There were strain differences noted with regard to the amount of fat deposited, areas of fat deposition, and other measurements obtained. Nutritional factors in addition to the levels of fat and protein used in these experiments are probably associated with fat deposition.

20) There are several factors in addition to feed conversion which should be used to evaluate a ration. They are feed cost, dressing percentage, fat deposition, cooking yield, organoleptic values, influence of feed on storage quality, and consumer acceptance of the poultry product.

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