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Bulletin 324 April, 1961

Effects of Diets Containing Milo On Broilers

and consumer acceptance of broilers differing in degree of skin pigmentation

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Summary and Conclusions

● Four 9-week floor trials, involving 4,800 broilers, for evaluating the use of milo as a feed ingredient for broilers are reported. The trials were made at about 6-month intervals from November, 1956, to September, 1958. A diet containing about 60 percent yellow corn was used as the basal diet. Broiler diets were formulated which contained various levels of milo, with or without 3 percent alfalfa meal, 3 percent corn gluten meal, or additional vitamin A. These diets were fed to broilers to determine their effects upon body weight, feed efficiency, eviscerated yield, deposition of skin pigment, livability, and feathering. Three experiments were conducted at grocery stores to determine consumer acceptance of broilers with varying degrees of skin color. A survey was made of 221 grocery stores to determine the degree of skin pigmentation of broilers sold throughout the state.

● A significant decrease (5 percent level of probability) in average body weight of broilers was found when milo replaced more than 50 percent of the yellow corn in the diet. This effect was partly prevented by supplementing the diet with alfalfa meal and corn gluten meal, and entirely prevented by substituting milo for only 50 percent of the yellow corn. Supplementing broiler diets that contained milo with additional vitamin A failed to increase body weight gains appreciably.

● Average differences in feed efficiency, eviscerated yields, livability, and feathering of broilers in any of the tests were not significant at the 5 percent level of probability.

● The amount of yellow pigment deposited in the skin on shanks and breasts of broilers was decreased significantly (5 percent level of probability) with each 25 percent increase of milo in the cereal grain portion of the diet. This effect was prevented when alfalfa meal and corn gluten meal supplemented the diets containing milo. Broilers fed 100 percent milo as the only cereal grain in the diet, and no supplements of alfalfa or corn gluten meal, were practically devoid of any skin pigment. The pigmentation scores of broilers averaged lower for female than for male birds, and lower for processed broilers than for live birds, except in the experiment where 100 percent milo was used as the cereal portion of the diet.

● In the grocery store experiment where broilers of three different degrees of skin pigmentation were displayed for sale at

the same time, the more deeply pigmented birds were selected by 43 percent of the customers. In two experiments where a display of broilers of only one degree of skin pigmentation was offered for sale during randomized 20-minute intervals, no significant differences (5 percent level of probability) were found in the percentage of broilers sold. The results of this study showed that over 99 percent of the customers accepted broilers of any degree of pigmentation provided that the birds rated high in quality and there was a choice as to weights.

● A sample of 120,000 broilers sold during one week by 221 Tennessee grocery stores indicated that 16 percent showed little or no yellow color, 22 percent very light to light yellow, 22 percent light to fairly yellow, 22 percent fairly yellow to fairly deep yellow, and 18 percent fairly deep to deep yellow. Degree of pigmentation of broilers sold by the 221 grocery stores was related to the origin of the broilers. Broilers bought from different firms in Tennessee and other states varied in degree of pigmentation. This was largely attributed to differences in feed ingredients in broiler rations, breed or crosses used, and methods of processing.

Acknowledgments

The authors of this bulletin acknowledge the assistance of the managers of 221 grocery stores and 25 broiler processing plants who co-operated in the study of pigmentation of broilers. The Kroger Company and White Stores, Inc., Knoxville, co-operated in the controlled broiler consumer acceptance experiments.

Appreciation also is expressed to staff members of the Tennessee Agricultural Experiment Station and to members of the Technical Committee of the Southern Regional Project SM-15 (Revised) for suggestions in preparing this report.

The arsanilic acid and menadione sodium bisulfite used in broiler diets covered in this study were supplied through the courtesy of Abbott Laboratories, North Chicago, Ill. The vitamins A and D used in the experiments were supplied through the courtesy of Charles F. Pfizer & Company, Terre Haute, Ind.

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Effects of Diets Containing Milo on Broilers and Consumer Acceptance of Broilers Differing in Degree of Skin Pigmentation

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INTRODUCTION

Grain sorghums are grown in large volume in the South and Southwest, and production in 1958 or 1959 was over double that of the 1948-57 average. Production of grain sorghums in 12 states of the southern region in 1959 amounted to 307,162,000 bushels, or 8,600,536 tons. In Tennessee, grain sorghum production in 1959 was 1,246,000 bushels, or 34,888 tons (Appendix I). During the years 1956 to 1959 the farm price per 100 pounds of grain sorghums in 11 states of the southern region averaged about 10 percent lower than corn (Appendix II).

With the increase in production of grain sorghums and lower price per hundredweight in comparison with corn, feed manufacturers and producers have become interested in the extent to which sorghum grains might be used in broiler diets. As shown in Appendix III, the estimated feed requirements for producing broilers in 13 states of the southern region amounted to about 4,760,000 tons in 1959. With feed valued at $95 per ton, the feed cost is estimated at $452 million. A reduction of only 1 percent in the annual feed cost of producing broilers would result in substantial savings to feed manufacturers, and or producers.

The objectives of this study were: 1) to determine the effect of feeding broilers diets in which different levels of milo were substituted for yellow corn when measured in terms of growth,

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feed efficiency, mortality, feathering, and deposition of yellow pigment in the skin; and 2) to determine the nature and extent of consumer acceptance of broilers differing in intensity of degree of skin pigmentation.

EFFECTS OF FEEDING MILO ON BROILERS

General Procedure for Feeding Experiments

The study included four separate floor experiments totaling 4,800 broilers. Each experiment covered a period of 9 weeks with about 6-month intervals between trials to provide for tabulation and analysis of the results. In the fourth experiment the broilers were maintained to 4 weeks of age in battery brooders and for an additional 5 weeks on the floor.

Cross-bred, broiler-type chicks, obtained from a local commercial hatchery, were used in all of the experiments. At 1 day of age the chicks were debeaked, sexed, and vaccinated for bronchitis and New Castle disease using the intraocular method. The chicks were wing-banded as a means of identification. Infrared light was used in floor brooding. Floor pens were 10 x 12 feet in size and each pen was provided with three 4-foot feed troughs and one 4-foot automatic watering trough. Feed and water were available to the chicks **ad libitum.** Wood shavings were used as litter.

At the end of each of the four experiments, the birds were individually weighed and feed efficiency calculated. In Experiment IV the birds also were weighed at the end of the battery brooder test, or at 4 weeks. In Experiment III records were kept on eviscerated yield. In each of the experiments, records were kept on the degree of pigmentation of shanks and breasts of the birds. In Experiment III, records were kept on the degree of pigmentation of both live and dressed birds, and on both males and females. Records were kept on the percent of livability and degree of feathering of the birds in each of the experiments.

The results obtained from Experiments I and II of the four experiments on effects of feeding milo on broilers were published in an earlier report.[1] Data presented in Tables 1 and 2 and data relating to Experiments I and II in Table 7 are identical with those

1. Harms, R. H., Raskopf, B. D., Hochreich, H. J., Kidd, I.H., and Douglas, C. R., "Milo as a Feed Ingredient for Broilers," **Poultry Science**, Vol. 37, pages 359-363, 1958.

shown in the earlier report. Each of the four experiments are discussed separately to show the differences which existed with respect to such factors as procedure, diets, body weights, feed efficiency, skin pigmentation, eviscerated yield, and livability and feathering.

Experiment I

Procedure. Fifty male and 50 female chicks were randomly assorted into each of 12 pens. At the termination of the feeding period, all birds were individually weighed and the feed efficency calculated. Random samples of 15 birds from each pen were slaughtered and each bird visually scored for deposition and intensity of pigment in the skin over the breast and shanks and for feathering. Pigmentation scoring was from 1 to 6, with 6 indicating the most deeply pigmented birds. Seventy-five birds were slaughtered from the group receiving the diet containing 100 percent cereal grain as milo; 75 from the group receiving the diet containing the 50 percent milo and 50 percent yellow corn; and 75 from the group receiving the control diet. Tests were conducted with the broilers of these three groups to determine the nature and extent of consumer acceptance of broilers exhibiting various degrees of skin pigmentation. The results of these tests are discussed later in the report.

Diets. The basal diet in Experiment I consisted of the following:

Diet Component	Percent	Diet Component	Percent
Yellow corn	62.6	Defluorinated rock phosphate (34% calcium & 17% phosphorus)	1.0
Soybean oil meal, (50% protein)	29.0		
Fish meal (Menhaden, 60% protein)	2.5	Salt	0.5
Dried whey	2.5	Vitamin mix	0.7
Ground limestone	1.2	Total	100.0

Per pound of feed the completed diets contained the following:

Diet Component	Amount	Diet Component	Amount
Choline chloride	250 mg.	Procaine penicillin	2.0 mg.
Manganese sulphate	80 mg.	Riboflavin	0.9 mg.
Arsanilic acid	45 mg.	Menadione sodium bisulfite	0.5 mg.
Niacin	5 mg.	Vitamin A	2,737 I.U.
Calcium pantothenate	3 mg.	Vitamin B	3 mcg.
Nitrofurazone	2.5 mg.	Vitamin D	1,050 I.C.U.

Four additional experimental diets were formulated by replacing 25, 50, 75, and 100 percent of the yellow corn, respectively, with red milo. The sixth diet, designated as the control, was formulated by using yellow corn as the only source of cereal grain along with 4 percent corn gluten meal and 3 percent alfalfa meal. Each of the six diets was fed to two separate groups of broilers, making a total of 12 pens in Experiment I. All diets were adjusted to be iso-nitrogenous by varying the amounts of yellow corn and/or milo and soybean oil meal. No attempt was made to adjust the productive energy content of the diets. When calculated it was found that the diets varied about 8 calories of productive energy per pound of feed.

Body Weight. The average body weight of broilers was decreased when milo replaced 50 percent or more of the yellow corn in their diet. No significant difference was found between the average body weight of the birds receiving the diet in which yellow corn was the only source of cereal grain and those receiving the diet containing 25 percent milo and 75 percent yellow corn (Table 1). The average body weight of the birds receiving the diet containing yellow corn as the only cereal grain was significantly heavier than those receiving diets containing 50, 75, or 100 percent of the cereal grain as milo. The body weights of the birds in the control group, fed yellow corn as the only source of cereal grain, along with 4 percent corn gluten meal and 3 percent alfalfa meal averaged only 7 grams under those receiving 25 percent milo and 75 percent yellow corn. The difference was not significant.

Feed Efficiency. No significant differences were found in the average feed efficiency of birds among any of the six groups in Experiment I (Table 1).

Skin Pigmentation. Birds receiving the diet containing milo as the only source of cereal grain were almost completely devoid of yellow pigment. The average amount of yellow pigment deposited in the skin of broilers was increased significantly with each 25 percent increase of yellow corn in the diet (Table 1). The most deeply-pigmented birds were those fed the control diet which, in addition to yellow corn, contained corn gluten and alfalfa meal. This appeared to indicate that if small amounts of corn gluten and alfalfa meal were added to the diet, a considerable increase in degree of skin pigmentation could be obtained in broilers fed diets containing various proportions of milo. This thesis was tested in later experiments.

Table 1—Effects of Feeding Diets Containing Various Levels of Milo on Body Weight, Feed Efficiency, and Pigmentation of 1,200 Broilers, Nine-Weeks Test, Experiment I, November 1956 to January 1957, Knoxville, Tennessee.

Cereal grain as milo	Body weight (av.)*	Feed used per pound of broiler (av.)*	Pigmentation score (av.)*
%	Grams	Lb.	No.
100	1,256a	2.50a	1.15a
75	1,357b	2.47a	2.04b
50	1,356b	2.49a	2.67c
25	1,384b,c	2.48a	3.44d
0	1,400 c	2.45a	4.44e
Control	1,377b,c	2.51a	5.08f

*Averages with the same letter symbol are not significantly different from each other at the 5 percent level of probability. Pigmentation score ranged from 1 to 6, with 6 being the most deeply pigmented.

Livability and Feathering. No significant differences existed in the average percent livability or degree of feathering of birds among any of the six groups in Experiment I.

Experiment II

Procedure. The second floor study, like the first, consisted of 1,200 broilers and extended over a 9-week period. Experiment II was a repetition of Experiment I, and the handling and treatment of the birds was the same. At the end of the experiment, a test was conducted on the nature and extent of consumer acceptance of broilers of various degrees of skin pigmentation. The results of these tests are discussed later in the report.

Diets. See Experiment I, Diets.

Body Weight. The results of the second experiment corroborated those of the first; that is, the average body weight of broilers was decreased when milo replaced most of the yellow corn in the diet. However, the differences were not so pronounced. No significant difference was found between the average body weight of the birds receiving the diet in which yellow corn was the only source of cereal grain and the weight of those receiving the diet containing 25 or 50 percent milo (Table 2). The average body weight of the birds receiving the diet containing yellow corn as the only cereal grain was significantly heavier than the weight of those receiving diets containing either 75 or 100 percent of the cereal grain as milo.

Table 2—Effects of Feeding Diets Containing Various Levels of Milo on Body Weights, Feed Efficiency, and Pigmentation of 1,200 Broilers, Nine-Weeks Test, Experiment II, May to July 1957, Knoxville, Tennessee.

Cereal grain as milo	Body weight (av.)*	Feed used per pound of broiler (av.)*	Pigmentation score (av.)*
%	Grams	Lb.	No.
100	1,213a	2.44a	1.19a
75	1,210a	2.54a	2.16b
50	1,247b,c	2.53a	2.94c
25	1,231a,c,d	2.52a	3.29d
0	1,252b, d	2.50a	3.61e
Control	1,216a	2.56a	4.43f

*Averages with the same letter symbol are not significantly different from each other at the 5 percent level of probability. Pigmentation score ranged from 1 to 6, with 6 being the most deeply pigmented.

Feed Efficiency. In the second experiment no significant differences were found in the average feed efficiency of birds among any of the six groups when measured in pounds of feed required to produce a pound of broiler.

Skin Pigmentation. Birds receiving the diet containing milo as the only source of cereal grain were nearly devoid of yellow pigment. The average amount of yellow pigment in the skin of broilers was increased significantly with each 25 percent increase of yellow corn in the diet (Table 2). Again, as in Experiment I, the most deeply pigmented birds were those fed the control diet which contained corn gluten and alfalfa meal. Supplementation of the diet with corn gluten and alfalfa meal provided a greater carotenoid pigment content in the feed.

Livability and Feathering. No significant differences were found in the average percent livability or degree of feathering of birds among any of the six groups in Experiment II.

Experiment III

Procedure. The third floor experiment consisted of 1,800 broilers and extended for 9 weeks. Fifty male and 50 female chicks were randomly assorted into each of 18 pens. In Experiment III, some changes were made in the diets as indicated below.

At the termination of Experiment III, all birds were individually weighed and the feed efficiency calculated. Random samples

of 10 birds from each pen were selected for processing and were visually scored for deposition of skin pigment and feathering. After slaughter, the birds were again scored for pigmentation and eviscerated weights obtained. The live weight of the birds was obtained when they were moved from the brooder house to be slaughtered. Eviscerated weight was obtained after removing the shanks at the hock joints, the head near the atlas joint, and all edible and inedible viscera except the kidneys.

One hundred and fifty birds were slaughtered from the group receiving the diet containing 100 percent cereal grain as milo; 150 from the group receiving the diet containing 50 percent milo and 50 percent yellow corn; and 150 from the group receiving all yellow corn. Tests were conducted with the broilers of these three groups to determine the nature and extent of consumer acceptance of broilers possessing various degrees of skin pigmentation. The results of these tests are discussed later in the report.

Diets. Composition of the six diets used in Experiment III are given in Table 3. All diets were adjusted to be iso-nitrogenous and iso-caloric by varying the amounts of yellow corn and/or milo, soybean oil meal, or by adding animal fat. Each of the six diets was

Table 3—Composition of Broiler Diets Used in Nine-Weeks Feeding Test, Experiment III, November 1957 to January 1958, Knoxville, Tennessee.

Feed ingredient	Number of diet					
	1	2	3	4	5	6
	Pounds of feed per hundredweight					
Yellow corn	58.1	30.0	—	61.0	31.5	—
Milo	—	30.0	62.0	—	31.5	65.0
Soybean oil meal (50% protein)	24.0	22.1	20.1	28.1	26.1	24.1
Fish meal (Menhaden, 60% protein)	2.5	2.5	2.5	2.5	2.5	2.5
Dried whey	2.5	2.5	2.5	2.5	2.5	2.5
Corn gluten meal	4.0	4.0	4.0	—	—	—
Alfalfa leaf meal	3.0	3.0	3.0	—	—	—
Ground limestone	1.2	1.2	1.2	1.2	1.2	1.2
Defluorinated rock phosphate(a)	1.0	1.0	1.0	1.0	1.0	1.0
Salt	0.5	0.5	0.5	0.5	0.5	0.5
Vitamin mix(b)	0.7	0.7	0.7	0.7	0.7	0.7
Nitrofurazone premix(c)	2.5	2.5	2.5	2.5	2.5	2.5

(a) 34% calcium and 17% phosphorus.
(b) Described under Diets in Experiment I.
(c) Supplies 2.5 mg. nitrofurazone per pound of feed.

Table 4—Effects of Feeding Diets Containing Various Levels of Milo on Body Weight, Feed Efficiency, Pigmentation and Livability, 1,800 Broilers, Nine-Weeks Test, Experiment III, November 1957 to January 1958, Knoxville, Tennessee.

Composition of diet			Body weight (av.)*	Feed used per lb. of broiler (av.)*	Eviscerated yield (av.)*	Pigmentation score		Livability (av.)*
Cereal grain as milo	Alfalfa meal	Corn gluten meal				Live (av.)*	Dressed (av.)*	
%	%	%	Grams	Lb.	%	No.	No.	%
100	3	4	1,411a	2.57a	59.61a	2.83a	2.73a	99a
100	0	0	1,276b	2.67a	61.40a	1.00b	1.00b	98a
50	3	4	1,427a,c	2.68a	60.87a	3.70c	3.48c	99a
50	0	0	1,447c	2.68a	60.32a	3.00a	2.73a	99a
0	3	4	1,441c	2.64a	61.78a	3.83c	3.77c	100a
0	0	0	1,448c	2.52a	60.61a	3.57c	3.27c	99a

*Averages with the same letter symbol are not significantly different from each other at the 5 percent level of probability. Pigmentation score ranged from 1 to 4, with 4 being the most deeply pigmented.

fed to three different pens of broilers, making a total of 18 pens in Experiment III.

Body Weight. The birds receiving 100 percent milo as the only cereal grain, without supplements of corn gluten and alfalfa meal, were found to be significantly lighter in average body weight than any other group of birds in Experiment III (Table 4). The broilers receiving 100 percent yellow corn as the only cereal grain were the heaviest with an average body weight of 1,448 grams. However no significant difference in average body weight was found between the birds in this group and those receiving 100 percent yellow corn as the only cereal, plus alfalfa and corn gluten meal, or those receiving 50 percent of the cereal grain as milo with or without these supplements.

There was no significant difference between the average body weight of birds receiving 50 percent of the cereal grain as milo plus alfalfa and corn gluten meal (1,427 grams), and of the birds rereceiving 100 percent of the cereal grain as milo, with supplements (1,411 grams).

Adding 3 percent alfalfa meal and 4 percent corn gluten meal significantly improved growth rate of broilers fed diets in which milo replaced all of the yellow corn as the cereal portion of the diet. The increase in body weight averaged nearly 11 percent. When 50 percent of the yellow corn was replaced with milo, adding alfalfa and corn gluten meal did not increase body weight.

Feed Efficiency. As in the previous two experiments, no significant differences were found in the average feed efficiency of birds among any of the six groups.

Eviscerated Yield. No significant difference in percent eviscerated yield was evident among the averages of broilers in any of the groups.

Skin Pigmentation. Deposition of yellow pigment in the skin of broilers was significantly increased by adding alfalfa and corn gluten meal to the diet containing either 50 or 100 percent milo as the cereal grain portion (Table 4). The degree of yellow pigment in the skin of broilers receiving the diet containing yellow corn as the only cereal grain and supplemented with alfalfa and corn gluten meal gave an average live pigmentation score of 3.83, compared with 3.57 for broilers receiving the same diet without supplement. However, the difference was not significant at the 5 percent level of probability.

The pigmentation scores averaged slightly lower for birds of all groups after processing, except for the group receiving 100 percent of the cereal portion of their diet as milo and no alfalfa or corn gluten meal supplement. This difference in pigmentation score between live broilers and eviscerated carcasses is not unusual; it is difficult to measure precisely the skin pigmentation of live broilers. A more accurate score can be obtained with processed, ice-chilled carcasses. It was observed that the male birds were somewhat more deeply pigmented than the females, but the average difference in pigmentation scores between males and females in each group was not significant.

Livability and Feathering. No significant differences were found in the average percent livability or degree of feathering of birds among any of the six groups in Experiment III.

Experiment IV

Procedure. Experiment IV was a combination of battery and floor tests and consisted of 600 chicks randomly assorted into 40 pens (4 pens for testing each of 10 different diets). Each pen consisted of 7 males and 8 females. Before placing the chicks in the brooders, the heating elements were adjusted to the same level and the thermostats regulated to operate within a range of 95-100° F. The temperature was lowered 5 degrees each week for the first 3 weeks. At 4 weeks of age, the four replications of each diet

tested were combined into one pen of 60 chicks and grown to 9 weeks of age on the floor. At 4 and 9 weeks of age, all birds were individually weighed and the feed efficiency calculated. At the end of 9 weeks, each bird was visually scored for deposition of skin pigment and for degree of feathering.

Diets. The basal diet in Experiment IV consisted of the following:

Diet Component	Percent	Diet Component	Percent
Yellow corn	61.1	Defluorinated rock phosphate (34% calcium and 17% phosphorus)	1.0
Soybean oil meal (50% protein)	28.0	Salt	0.5
Fish meal (Menhaden, 60% protein)	2.5	Vitamin mix	0.6
Dried whey	2.5	Nitrofurazone premix	2.5
Ground limestone	1.3	Total	100.0

Per pound of feed the completed diets contained the following:

Diet Component	Amount	Diet Component	Amount
Choline chloride	284 mg.	Procaine penicillin	2 mg.
Manganese sulphate	60 mg.	Riboflavin	0.9 mg.
Arsanilic acid	38 mg.	Vitamin A	1,903 I.U.
Niacin	5 mg.	Vitamin B_{12}	4.8 mcg.
Calcium pantothenate	3 mg.	Vitamin D_3	1,050 I.C.U.

In addition to the basal diet, nine others were formulated. Eight of these were made by replacing 100 percent of the yellow corn with red milo. Six of the eight were supplemented with 3 percent corn gluten meal, 3 percent alfalfa meal or additional vitamin A, or with two or more of these feed supplements in combination. The other two diets contained water-treated milo prepared by placing the whole grain milo in a large vat. Water was bubbled through the milo for 24 hours in an attempt to remove tannic acid and any water-soluble toxins that might be present. The washed milo was dried. The moisture content of the milo, before washing it in water, was 12.24 percent, but was reduced to 10.1 percent after drying. The tenth diet, designated as the control, was formulated using yellow corn as the only source of cereal grain. It contained 3 percent corn gluten meal and 3 percent alfalfa meal. All diets were adjusted to be iso-nitrogenous and iso-caloric by varying the amounts of yellow corn and or milo, soybean oil meal, or by adding animal fat.

Body Weight. The average 4- and 9-week body weights of birds on the 10 different diets in Experiment IV are shown in Table

5. The average weights per bird for the two groups receiving yellow corn were significantly heavier at 9 weeks than those receiving 100 percent milo as the cereal grain. These differences occurred mainly during the last 5 weeks. At the end of 4 weeks the average weights per bird for the chicks receiving the basal diet and the control group were not significantly different from the group receiving the diet containing 100 percent milo, plus alfalfa and corn gluten supplement, or the group containing 100 percent washed milo plus the alfalfa and corn gluten supplements.

The group receiving a diet containing untreated milo as the only cereal grain, no supplements of alfalfa meal or corn gluten, and no additional supply of vitamin A, averaged the lightest at 9 weeks, or 1,270 grams per bird. Additional vitamin A failed to appreciably increase body weight gains of broilers fed diets that contained all milo as the cereal grain.

Feed Efficiency. In Experiment IV, no significant differences were found in the average feed efficiency of birds among any of the 10 groups on different diets, at 4 or 9 weeks (Table 5).

Table 5—Effects of Feeding Diets Containing Milo and Various Supplements on Body Weight, Feed Efficiency, Pigmentation, and Livability, 600 Broilers, Four- and Nine-Weeks Tests, Experiment IV, July to September 1958, *Knoxville, Tennessee.*

Composition of diet			Body weight		Feed used per pound of broiler		Pigmentation score	Livability
Cereal grain as milo	Alfalfa meal	Corn gluten meal	4 weeks (av.)*	9 weeks (av.)*	4 weeks (av.)*	9 weeks (av.)*	(av.)*	(av.)*
%	%	%	Grams	Grams	Lb.	Lb.	No.	%
0	0	0	423a	1,375a	1.73a	2.49a	2.64a	96.7a
0	3	3	427a,c	1,392a	1.66a	2.48a	3.42b	96.7a
100	0	0	396b	1,270b	1.80a	2.63a	1.00c	96.7a
100	3	0	402b	1,310c	1.73a	2.46a	1.84d	98.3a
100	0	3	408b,d	1,308c	1.80a	2.56a	1.78d	98.3a
100x	0	0	407b,d	1,318c	1.73a	2.69a	1.00c	98.3a
100	3	3	416a,c,d,e	1,324c	1.81a	2.67a	2.07e	95.0a
100y	3	3	403b,e	1,274b	1.81a	2.69a	2.25e,f	98.3a
100z	0	0	409b,e,f	1,294b,c	1.72a	2.55a	1.00c	96.7a
100z	3	3	420a,d,f	1,319c	1.66a	2.48a	2.38f	96.7a

*Averages with the same letter symbol are not significantly different from each other at the 5 percent level of probability. Pigmentation score ranged from 1 to 4, with 4 being the most deeply pigmented.

x. Additional 2,000 I. U. vitamin A supplied per pound of feed.

y. Additional 1,000 I. U. vitamin A supplied per pound of feed.

z. Water-treated milo.

Skin Pigmentation. The broilers receiving the diets containing yellow corn were the most deeply pigmented. Those receiving milo as the only source of cereal grain, with no alfalfa or corn meal supplement, were practically devoid of pigment. Adding 3 percent alfalfa meal or 3 percent corn gluten meal, or both of these, significantly increased the yellow color in the shanks and breasts of broilers fed these diets. Additional vitamin A was ineffective in increasing skin pigmentation.

Livability and Feathering. No significant differences were found in the average percent livability or degree of feathering of birds among any of the 10 groups in Experiment IV.

The results of feeding experiments I, II, and III, indicate that up to 50 percent of the cereal grain portion of the broiler diet can be replaced by milo with no loss in body weight or efficiency of feed utilization. The economic significance of substituting milo for yellow corn in the broiler ration is illustrated in Table 6. In the following examples it is assumed that the price per hundredweight of yellow corn is equal to the price per hundredweight, as an average, of all other feed ingredients except milo in the ration. Also, it is assumed that not over 50 percent of the cereal grain in the ration would be replaced by milo.

Example 1. By feeding a diet consisting of 45 percent cereal grain, 25 percent of the cereal grain as milo, and yellow corn costing 20 cents per hundredweight more than milo, the total cost of feed ingredients would be reduced 2.25 cents per 100 pounds, or 45 cents per ton.

Example 2. By feeding a diet consisting of 60 percent cereal grain, 50 percent of the cereal grain as milo, and yellow corn costing 50 cents per hundredweight more than milo, the total cost of feed ingredients would be reduced 15 cents per 100 pounds of feed, or $3.00 per ton.

The decision as to whether milo should replace yellow corn in the broiler ration does not depend entirely on the price differential in favor of milo at any given time. Other important factors to be taken into consideration include: 1) relative cost of other feed ingredients; 2) availability of the various feed ingredients; 3) quality of the feed ingredient; 4) degree to which various ingredients in the diet, other than yellow corn and milo, may be substituted; and 5) contributions which might be made by individual feed ingredients.

Table 6—Estimated Reduction in Cost of Feed Ingredients Per 100 Pounds of Broiler Ration at Specified Levels of Cereal Grain and Milo in the Diet, and 10 to 70 Cents Per Hundredweight Price Differentials in Favor of Milo over Yellow Corn.

Amount by which the price of corn exceeds the price of milo per cwt.	Percent cereal grain in the diet									
	45		50		55		60		65	
	Percent cereal grain as milo in the diet									
	25	50	25	50	25	50	25	50	25	50
Cents per cwt.	Reduced cost of feed ingredients In cents per 100 pounds of feed									
10	1.13	2.25	1.25	2.50	1.38	2.75	1.50	3.00	1.63	3.25
20	2.25	4.50	2.50	5.00	2.75	5.50	3.00	6.00	3.25	6.50
30	3.38	6.75	3.75	7.50	4.13	8.25	4.50	9.00	4.88	9.75
40	4.50	9.00	5.00	10.00	5.50	11.00	6.00	12.00	6.50	13.00
50	5.63	11.25	6.25	12.50	6.88	13.75	7.50	15.00	8.13	16.25
60	6.75	13.50	7.50	15.00	8.25	16.50	9.00	18.00	9.75	19.50
70	7.88	15.75	8.75	17.50	9.63	19.25	10.50	21.00	11.38	22.75

Assumption: The price per hundredweight of corn is equal to the price per hundredweight, as an average, of all other feed ingredients except milo in the ration.

CONSUMER ACCEPTANCE OF BROILERS BY DEGREE OF PIGMENTATION

General Procedure for Controlled Grocery Store Experiments

In connection with the feeding experiments I, II, and III, previously discussed, three tests were conducted to determine the nature and extent of consumer acceptance of broilers with differing amounts of skin pigmentation. In each experiment a sample of birds was selected of the same qualities, with a weight range from 1.75 to 3.0 pounds each, the only variation being degree of skin pigmentation. The birds in each test were divided into three groups: 1) birds fed 100 percent milo as the cereal portion of the diet resulting in little or no pigmentation, 2) birds fed 50 percent milo and 50 percent yellow corn and resulting in medium pigmentation, and 3) birds fed the control diet resulting in deep pigmentation. The consumer experiments were conducted in two of the large chain stores located in Knoxville, Tennessee.

In the first experiment, equal numbers of cut-up birds of different degrees of skin pigmentation were displayed at the same

time. The second and third experiments were designed to test consumer acceptance of cut-up broilers where birds of only one degree of skin pigmentation were offered for sale during random 20-minute intervals. In all three experiments, as the birds were sold, they were replaced with like broilers so that customers at all times selected from a mass display. During all three sales experiments, the customer characteristics were observed and recorded. Each customer was interviewed after the purchase of the broiler, and later at the customer's home after the broiler had been consumed.

As previously indicated under the discussion of "General Procedure for Feeding Experiments," the data relating to Experiments I and II in Table 7 were published in an earlier report (footnote No. 1).

Results of Controlled Grocery Store Experiments

In the first experiment birds representing all three degrees of pigment were offered for sale at the same time. There was a significant difference (P .05) in consumer acceptance in favor of the more deeply pigmented bird (Experiment I, Table 7).

In the second and third experiments broilers of one degree of skin pigmentation were offered for sale during a 20-minute period;

Table 7—Consumer Acceptance of Cut-up Broilers of Different Levels of Skin Pigmentation, Three Retail Grocery Store Experiments, Knoxville, Tennessee, 1957 and 1958.

Experiment	Description		Broiler diet Percent cereal grain as milo		
			100	50	0
I(a)	Broiler pigmentation score (b)	No.	1.15	2.67	5.08
Jan. 1957	Broilers purchased by families	%	23	34	43
II(c)	Broiler pigmentation score (b)	No.	1.19	2.94	4.43
July 1957	Broilers purchased by families	%	34	31	35
III(c)	Broiler pigmentation score (b)	No.	1.00	2.73	3.27
Jan. 1958	Broilers purchased by families	%	39	31	30

(a) In Experiment I, 75 birds of each pigmentation group were mixed and offered for sale during 12-hour periods.

(b) Pigmentation scoring ranged from 1 to 6 in Experiments I and II, and from 1 to 4 in Experiment III. In pigmentation scoring the larger numbers indicate the more deeply pigmented birds. See Tables 1, 2, and 3, for pigmentation score of broiler groups.

(c) In Experiments II and III, a display of broilers of only one degree of pigmentation was offered during 20-minute randomized intervals over 12-hour periods. Each display consisted of 40 broilers. As the broilers were sold they were replaced with other birds of the same degree of skin pigmentation. In all three experiments the factors of quality, price, and package were held constant with weights ranging from 1.75 to 3.0 pounds.

no significant differences at the 5 percent level of probability were found in the percentage of broilers sold according to degree of skin pigmentation for the entire sales. When broilers with the least pigmentation were displayed, less than 1 percent of the customers asked for a yellow-skinned or deeply pigmented bird. Also, in no case where broilers were inspected, but not bought, did any customer indicate that a broiler was not bought because of objection to skin color.

The schedules of information obtained from observations and interviews with customers, during and following each of the experiments, may be summarized as follows: 1) Customers buying broilers at stores used in the experiments were representative of the families of Knoxville with respect to such factors as income, size of family, sex, age, race, and member of family doing the shopping; 2) nearly all (99%) of the customers indicated that they would accept broilers of any degree of pigmentation provided that the birds rated high in quality and there was a choice as to weight; and 3) the more important factors related to broiler quality were fleshing, pinfeathers, cleanliness, odor, package, and general appearance. The latter findings agree with those from a study made in 1955.[2]

Pigmentation of Broilers Sold by 221 Grocery Stores

Variation in Pigmentation. To determine the degree of skin pigmentation of broilers sold throughout the state, inspections were made of broilers sold at 221 stores in 125 towns and cities. The sample of grocery stores was stratified according to such factors as geographic location, type and size of store, size of city, origin of broilers, and method of selling broilers. The number of stores included in the survey, by counties, is shown in Figure 1.

2. Raskopf, B. D., "Consumer Rating of Broilers in Tennessee," Tennessee Agricultural Experiment Station Bulletin No. 255, November, 1956.

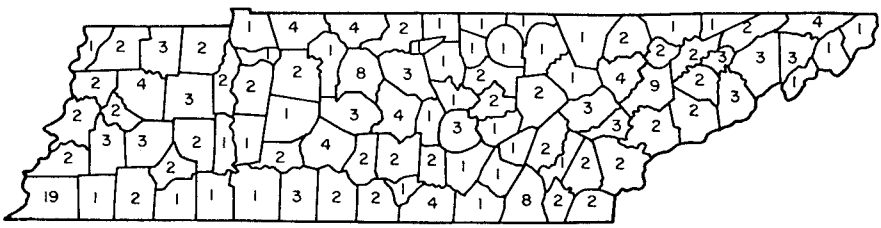

Figure 1. Number of grocery stores included in broiler pigmentation survey, by counties, Tennessee, 1957.

Broilers inspected for pigmentation at each store included birds displayed in show cases and those held in refrigerators. The sample of broilers was taken from the total weekly sales of 221 stores (Appendix V). The broilers inspected at each store were rated according to the percent of birds that fell within each of the five following divisions:

Broiler pigmentation rating scale

None to very light yellow	Very light to light yellow	Light to fairly yellow	Fairly to fairly deep yellow	Fairly deep to deep yellow
1	2	3	4	5

For all stores the proportion of broilers of each skin color sold during 1 week is shown in Figure 2. The proportion of broilers sold during 1 week ranged from 60 percent having little or no yellow pigment at one store in Kingsport and one store in Livingston to 100 percent being fairly deep to deep yellow in color of skin at one store in Morristown (Appendix IV).

Store Characteristics Related to Broiler Pigmentation. Information was obtained at each of the 221 grocery stores included in the survey. The schedules included data on broiler merchandising practices, store and customer characteristics, and variations in the pigmentation of broilers sold.

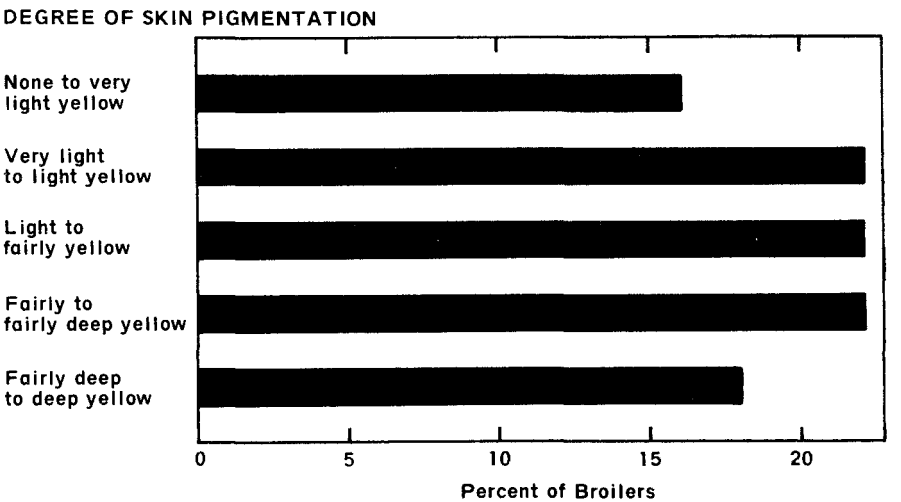

Figure 2. Percent of broilers of various degrees of skin pigmentation sold during 1 week by 221 grocery stores in 125 cities, 95 counties in Tennessee, 1957.

The conclusions from an analysis of these schedules may be summarized as follows:

1) No significant differences existed in the average degree of pigmentation of broilers sold at stores grouped according to such factors as: geographic location, type and size of store, size of city, customer characteristics such as race, size of family, and family income, and store practices of delivery service, granting credit, and method of selling broilers.

2) The degree of pigmentation of broilers sold was related to the origin of broilers.

3) Of the broilers sold during 1 week by the 221 stores, 77 percent were cut up by the butcher and tray-packed before customer purchase, 10 percent cut up by the butcher after purchase, 7 percent sold as fresh parts, 4 percent sold whole, and less than 2 percent were sold as frozen parts, cut up, or whole (Appendix V).

No significant differences existed in the average degree of skin pigmentation of fresh broilers according to method of sale. However, it was more difficult to score pigmentation of cut-up broilers and broilers sold as parts than whole broilers. Frozen broilers were not inspected for pigmentation because they were sold in sealed packages. About 13 percent of the fresh, already-cut-up broilers were sold tray-packaged, meat-side up, skin-side down. The fact that it is difficult for customers to determine broiler pigmentation in cut-up and frozen birds, and birds packaged meat-side up, may partly account for consumer acceptance of broilers, regardless of degree of pigmentation. This is providing the birds rate high in quality and there is a choice of weights.

4) Only one of the managers of the 221 stores had experienced any difficulty in selling broilers having little or no pigmentation, and only one manager had ever specified degree of skin pigmentation in ordering broilers from processors or wholesalers.

5) At 26 percent of the stores, about 1 percent of the customers asked for a deeply-pigmented broiler. On the other hand, at 23 percent of the stores about 1 percent of the customers asked for a white-skinned broiler. In all these cases the store managers indicated that broilers of satisfactory pigmentation were furnished customers from the supply of birds held in refrigerators.

FACTORS RELATED TO VARIATION IN BROILER PIGMENTATION

Origin of Broilers

Of 120,000 broilers sold during 1 week by the 221 grocery stores included in the survey, about 66 percent were purchased from 25 broiler processors located in Tennessee and produced in the state. The other 34 percent of the broilers originated in Alabama, Georgia, Mississippi, North Carolina, and Virginia.

The average percentage of broilers exhibiting various degrees of skin color obtained from the Tennessee processors, and between the Tennessee processed broilers and those processed in adjoining states, differed widely (Table 8). The variation in skin color of broilers, by origin, may largely be attributed to three factors—breed, method of scald, and feed ingredients in broiler rations. Each of these factors will be discussed separately.

Table 8—Percent of Broilers of Various Degrees of Skin Pigmentation Sold During One Week by 221 Grocery Stores, by Origin of Broilers, Tennessee, 1957.

Tennessee processor	Deg. of skin pigmentation (a)					Tennessee processor	Deg. of skin pigmentation (a)				
	1	2	3	4	5		1	2	3	4	5
No.	Percent of broilers					No.	Percent of broilers				
1	44	24	21	6	5	18	6	15	38	27	14
2	26	24	24	12	14	19	5	23	37	24	11
3	16	22	26	20	16	20	4	23	33	29	11
4	15	33	33	13	6	21	4	22	38	30	6
5	15	19	16	22	28	22	2	19	31	31	17
6	14	24	20	26	16	23	—	26	36	24	14
7	12	36	36	13	3	24	—	25	25	25	25
8	11	—	64	10	15	25	—	10	20	40	30
9	10	30	30	20	10						
10	10	30	30	20	10	Av. (b)	10	20	25	24	21
11	10	20	24	25	21	Other states					
12	10	20	20	30	20						
13	9	33	23	11	24	Va.	44	29	16	6	5
14	8	30	33	21	8	Miss.	23	22	18	23	14
15	7	24	47	20	2	Ga.	36	24	13	16	11
16	7	22	20	24	27	Ala.	15	25	25	19	16
17	7	10	26	27	30	N. C.	12	24	23	23	18
						Av. (b)	29	24	13	18	16

(a) Processors ranked according to least degree of pigmentation of broilers processed. Degree of skin pigmentation: 1 = none to very light yellow, 2 = very light to light yellow, 3 = light to fairly yellow, 4 = fairly to fairly deep yellow, 5 = fairly deep to deep yellow.
(b) Weighted average.

Breed

Hammond and Harshaw in 1941, using 3,840 chicks in six experiments, found that in growing chicks the shank and skin color were influenced by breed.[3] Bird, in 1952 presented data from the Sixth Maine Production and Broiler Test in which all pens were fed the same diet, and the birds were dressed and scored for pigmentation at 14 weeks of age. These data indicated that on the basis of pigmentation score for the dressed carcass that New Hampshires ranked first, Barred Crosses, second, and White Plymouth Rocks, third. Within each breed or cross there was a considerable variation among entries.[4] Collins, Skoglund, and Thayer in 1955 found that breed and strain differences existed in the amount of pigment deposited in the skin of broilers.[5]

Yellow skin in chickens is characteristic of most American breeds, while white skin is characteristic of several European and Mediterranean breeds.[6] The results of crosses between varieties having yellow and those having white skin have been consistent in demonstrating that the gene for white skin is dominant to the gene for yellow skin.[7]

The grocery store sales of broilers that originated in other states averaged lighter in skin pigmentation than did those produced in Tennessee (Table 8). Part of this variation may have been caused by breed differences. In Tennessee the percentage of cross-mated birds in the National Poultry Improvement Plan increased from 54.6 percent of 430,817 birds in the 1956-57 season to 64.4 percent of 400,403 birds in the 1958-59 season. The percentage of cross-mated birds in NPIP averaged lower in Tennessee in two of the seasons than in five other adjoining states (Table 9).

Method of Scald

In the sub-scald method of dressing the temperature of the scald water is raised to 138 degrees F. This high temperature

3. Hammond, J. C., and Harshaw, H. M., "Some Factors Influencing Shank and Skin Color in the Growing Chicken," **Poultry Science**, Volume 20, pages 437-444, 1941.

4. Bird, F. H., "The Problem of Pigmentation in Broilers," **Cooperative Poultryman**, Volume 17, No. 12, pages 8-9 and 134-155, 1952.

5. Collins, W. M., Skoglund, W. C., and Thayer, S. C., "Breed and Strain Differences in Shank Pigmentation in Growing Chickens," **Poultry Science**, Volume 34, pages 223-228, 1955.

6. **Standard of Perfection for Domesticated Land and Water Fowl**, American Poultry Association, Inc., Co-operative Printing Co., 1953.

7. Jull, Morely A., **Poultry Breeding**, John Wiley and Sons, page 115, 1952.

Table 9—Chicken Breed Distribution in Tennessee and Five Adjoining States, Based on Participation in the National Poultry Improvement Plan, 1956-57 to 1958-59 Seasons.

State	Birds	Cross-mated	White Rocks	New Hamp-shires	Rhode Island Reds	White Leg-horns	Other breeds & Incross-mated
	No.		Percentage distribution, 1956-57 season				
Va.	1,328,748	82.8	7.3	3.6	0.8	2.1	3.4
Ga.	3,134,493	71.6	14.6	0	0.6	2.7	10.5
Miss.	637,583	64.1	29.5	1.1	0.6	4.5	0.2
N. C.	2,876,168	61.5	32.2	1.2	3.5	1.2	0.4
Tenn.	430,817	54.6	19.4	5.1	3.9	8.2	8.8
Ala.	1,051,757	49.9	44.5	0.9	0.8	3.0	0.9
	No.		Percentage distribution, 1957-58 season				
Va.	1,141,808	87.3	4.0	2.2	1.0	2.9	2.6
Ga.	3,590,899	72.2	10.6	4.5	0.3	5.0	7.4
Miss.	786,835	80.8	10.4	0.5	0.3	6.5	1.5
N. C.	2,854,735	86.9	5.4	0.8	4.1	1.5	1.3
Tenn.	383,038	61.4	7.9	4.3	2.6	11.3	12.5
Ala.	1,066,717	72.9	17.0	2.0	0.9	3.3	3.9
	No.		Percentage distribution, 1958-59 season				
Va.	1,214,006	87.0	4.1	1.2	1.0	4.2	2.5
Ga.	4,748,162	80.8	11.6	1.2	0.2	6.1	0.1
Miss.	1,287,912	85.8	8.8	0.1	0.2	4.0	1.1
N. C.	3,818,065	91.9	3.4	0.4	1.9	2.0	0.4
Tenn.	400,403	64.4	5.7	5.4	3.3	11.1	10.1
Ala.	1,406,282	78.4	14.6	0.2	0.6	3.3	2.9

Source: **Breed Distribution of NPIP Participating Flocks, by States,** Animal Husbandry Research Division, Agricultural Research Service, U.S.D.A., 1957 and 1959.

removes the epidermal layer of skin including the skin pigment. Broilers scalded by this method tend to have a pinkish, glossy appearance and become sticky to the touch. The birds become darker in color after drying and upon exposure to the air. A previous study indicates that sub-scalded broilers having little or no skin pigment are acceptable to consumers where the birds rate high in quality factors and where they are marketed immediately after processing.[8]

The sub-scald method is the least common procedure used for dressing broilers in Tennessee. Of the 25 firms (Table 8), 6 used

8. Raskopf, B. D., "Consumer Rating of Broilers in Tennessee," Tennessee Agricultural Experiment Station Bulletin No. 255, November, 1956.

this system; but they handled only 4 percent of the broilers sold by the 221 stores included in the survey.

Feed Ingredients in the Broiler Ration

Another important factor affecting the degree of skin color in broilers is the presence or absence of carotenoid pigments in the feed ingredients of broiler diets. Xanthophylls are a group of carotenoid pigments. Sources of xanthophyll in poultry feeds are primarily yellow corn, corn gluten meal, alfalfa meal, or added xanthophyll concentrates.[9] Milo is deficient in carotenoid pigments.

Other Factors

The amount of pigmentation in the skin of broilers is related to the amount of xanthophyll in the diet, but this relationship can also be affected by other factors discussed, such as heredity and method of scald, other feed ingredients, disease, or environment. Culton and Bird in 1941 reported a pigment-inhibiting factor in meat scraps, fish meal, and soybean oil meal which prevented the deposition of pigment in the skin.[10] Hammond and Harshaw in 1941 found a pigment-depressing factor due to the presence of cod liver oil in the diet.[11]

Collins, Skoglund, and Thayer in 1955 reported that certain poultry diseases influenced the degree of skin pigmentation. Bleaching of the shanks was one of the early indications of coccidiosis, while respiratory diseases also modified the degree of shank pigmentation. In a study using five strains of New Hampshires, these investigators also found that environment influences shank color. In this study the four experiments reported were staggered over several months in order to observe possible effects of season upon broiler response.[12]

9. Ferguson, F. M., "Evaluation of Xanthophyll Sources for Pigmentation of Broilers and Egg Yolks," **Feeds Illustrated**, September, 1952.

10. Culton, T. G. and Bird, H. R., "Effect of Certain Protein Supplements on Inhibiting Pigment Deposition in Growing Chicks," **Poultry Science**, Volume 20, pages 432-436, 1941.

11. Hammond, J. C., and Harshaw, H. M., "Some Factors Influencing Shank and Skin Color in the Growing Chicken," **Poultry Science**, Volume 20, pages 437-444, 1941.

12. Collins, W. M., Skoglund, W. C., and Thayer, S. C., "Breed and Strain Differences in Shank Pigmentation in Growing Chickens," **Poultry Science**, Volume 34, pages 223-228, 1955.

APPENDIX I

Acreage and Production of Sorghum Grain, 12 States, Southern Region and U. S., 1948-57 Average and 1958 and 1959.

State	Acreage harvested			Yield per acre			Production		
	Av. 1948-57	1958	1959	Av. 1948-57	1958	1959	Av. 1948-57	1958	1959
	Thousand acres			Bushels			Thousand bushels		
Tex.	4,809	7,692	7,307	23.6	35.5	38.0	113,524	273,066	277,666
Okla.	754	710	696	14.3	26.0	27.0	10,778	18,460	18,792
N. C.	52	100	106	26.5	32.5	33.0	1,378	3,250	3,498
Ark.	43	106	49	22.4	31.0	28.0	963	3,286	1,372
Ky.	17	44	27	36.4	45.0	46.3	618	1,980	1,251
Tenn.	22	59	39	24.0	32.0	32.0	529	1,888	1,246
Ga.	29	37	39	20.0	24.0	25.0	581	888	975
Ala.	31	38	33	18.0	24.0	25.0	559	912	825
Miss.	11	56	22	23.4	30.0	31.0	257	1,680	682
S. C.	8	18	17	18.1	25.0	23.0	145	450	391
La.	4	20	8	23.5	32.0	34.0	94	640	272
Va.	10	10	6	30.2	35.0	32.0	302	350	192
12 States	5,790	8,890	8,349	22.4	34.5	36.8	129,728	306,850	307,162
U. S.	9,784	16,658	15,575	21.8	36.6	37.2	213,109	610,376	579,178

Source: Compiled from **Crop Production, 1959 Annual Summary**, Agricultural Marketing Service, U.S.D.A.

APPENDIX II

Monthly Prices Received by Farmers for Yellow Corn and Sorghum Grain Per 100 Pounds, 11 Southern States and U. S., 1956 to 1959.

	Grain	J	F	M	A	M	J	J	A	S	O	N	D	Av.
							Cents per 100 pounds, 1956							
11 states[1]	Corn	196	206	212	223	234	242	243	242	236	220	221	225	225
	Sorghum	188	191	198	208	215	223	228	230	212	203	209	212	210
U. S.	Corn	207	211	214	236	248	254	255	259	254	213	216	218	232
	Sorghum	178	181	184	193	202	202	207	215	203	207	211	214	200
							Cents per 100 pounds, 1957							
11 states[1]	Corn	234	239	242	242	244	244	244	243	228	215	213	219	234
	Sorghum	211	210	210	211	208	203	204	195	179	175	175	182	197
U. S.	Corn	220	213	214	216	220	218	220	220	205	189	176	176	207
	Sorghum	213	209	207	204	199	189	172	166	157	143	142	156	180
							Cents per 100 pounds, 1958							
11 states[1]	Corn	223	230	237	242	248	251	253	250	226	208	200	205	231
	Sorghum	189	191	200	205	208	208	210	205	189	182	180	185	214
U. S.	Corn	166	171	179	200	205	213	211	211	202	186	168	182	191
	Sorghum	163	162	169	177	176	176	182	172	168	157	163	168	169
							Cents per 100 pounds, 1959							
11 states[1]	Corn	212	217	221	225	228	230	228	221	207	191	191	194	214
	Sorghum	192	195	197	202	203	204	201	190	178	173	174	175	190
U. S.	Corn	182	186	189	202	205	207	202	202	195	177	175	171	191
	Sorghum	173	175	176	180	185	185	178	161	152	148	151	150	168

1. 11 states include Alabama, Arkansas, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, and Texas.

Sources: **Crops and Markets, 1957 and 1958** and **Agricultural Prices, 1958 and 1959**, Agricultural Marketing Service, U.S.D.A.

APPENDIX III

Broiler Production and Estimated Feed Requirements, 13 States, Southern Region, 1956 to 1959.

State	1956	1957	1958	1959
		Number of broilers produced (000)		
Ga.	222,780	261,000	292,119	303,031
Ark.	99,271	110,191	133,331	163,997
Ala.	82,473	103,875	131,640	158,248
N. C.	94,087	106,352	134,600	137,400
Tex.	100,116	100,826	114,855	115,193
Miss.	52,855	66,597	85,424	107,629
Va.	62,904	61,646	63,495	53,971
Tenn.	17,854	21,068	29,074	27,620
La.	15,716	17,428	20,479	21,647
Ky.	12,211	14,409	18,500	17,575
S. C.	13,359	15,690	17,561	16,924
Fla.	11,830	10,884	11,319	10,413
Okla.	5,824	6,523	6,653	5,260
Total	791,280	896,489	1,059,050	1,138,908
		Live weight of broilers produced (000 lb.)		
Ga.	690,618	835,200	934,781	1,000,002
Ala.	255,666	332,400	421,248	522,218
Ark.	277,959	319,554	399,993	508,391
N. C.	291,670	329,691	444,180	453,420
Tex.	300,348	302,478	344,565	357,098
Miss.	153,280	206,451	264,814	333,650
Va.	201,293	191,103	196,834	167,310
Tenn.	53,562	67,418	95,944	88,384
La.	48,720	52,284	63,485	69,270
Ky.	39,075	46,109	61,050	57,998
S. C.	38,741	50,208	57,951	54,157
Fla.	35,490	33,740	35,089	33,322
Okla.	16,890	20,221	20,624	16,832
Total	2,403,312	2,786,857	3,340,558	3,662,052
		Estimated feed requirements (tons)		
Ga.	897,803	1,085,760	1,215,215	1,300,000
Ala.	332,366	432,120	547,622	678,883
Ark.	361,347	415,420	519,991	660,908
N. C.	379,171	428,599	577,434	589,446
Tex.	390,452	393,222	447,935	464,227
Miss.	199,264	268,386	344,258	433,745
Va.	261,681	248,434	255,734	217,503
Tenn.	69,631	87,643	124,727	114,899
La.	63,336	67,969	82,531	90,051
Ky.	50,798	59,942	79,365	75,397
S. C.	50,363	65,270	75,336	70,404
Fla.	46,137	43,862	45,616	43,189
Okla.	21,957	26,287	26,811	21,882
Total	3,124,306	3,622,914	4,342,575	4,760,534

Source: Compiled from **Poultry and Egg Situation, 1957-60**, Agricultural Marketing Service, U.S.D.A.

APPENDIX IV

Percent of Broilers of Various Degrees of Skin Pigmentation Sold During One Week by 221 Grocery Stores in 125 Cities, 95 Counties, Tennessee, 1957.

(Cities listed according to size of population)

Store location	Pigmentation					Store location	Pigmentation				
	1	2	3	4	5		1	2	3	4	5
City	Percent of broilers					City	Percent of broilers				
Memphis	30	30	30	10	0	Knoxville	10	10	60	10	10
	20	40	30	10	0	(Cont.)	0	10	40	40	10
	20	30	30	20	0		0	0	70	15	15
	20	30	30	10	10						
	20	30	30	10	10	Oak Ridge	10	0	0	30	60
	20	30	30	10	10		0	0	0	100	0
	10	40	40	10	0	Jackson	10	30	40	20	0
	10	40	40	10	0		0	20	30	30	20
	10	40	30	20	0						
	10	30	50	10	0	Johnson City	50	25	0	0	25
	10	30	40	20	0		10	20	30	20	20
	10	30	40	10	10		10	10	30	30	20
	10	30	40	10	10						
	10	30	40	10	10	Kingsport	60	30	10	0	0
	10	30	30	20	10		40	40	20	0	0
	10	30	30	20	10		0	20	20	30	30
	10	30	30	20	10						
	10	30	30	10	20	Bristol	10	10	30	30	20
						Clarksville	30	30	20	20	0
Nashville	20	40	20	20	0		20	20	40	20	0
	20	30	20	20	10		0	20	20	30	30
	20	20	20	20	20		0	20	20	20	40
	20	20	20	20	20						
	20	20	20	20	20	Fountain City	5	5	35	30	25
	10	30	40	20	0		0	0	50	35	15
	0	20	30	30	20	Murfreesboro	20	20	20	20	20
	0	10	30	40	20		10	20	20	30	20
							0	20	30	30	20
Chattanooga	30	30	20	20	0		0	20	20	30	30
	30	30	20	10	10						
	30	30	20	10	10	Morristown	10	30	30	20	10
	30	20	20	20	10		0	5	15	70	10
	20	20	30	20	10		0	0	0	0	100
	10	20	20	30	20						
	10	10	30	30	20	Cleveland	20	30	30	10	10
	10	10	20	30	30		10	20	20	30	20
Knoxville	30	30	20	10	10	Columbia	20	20	20	20	20
	20	30	30	10	10		10	20	20	30	20
	10	40	20	20	10		10	10	20	30	30
	10	20	50	20	0		0	20	20	40	20

APPENDIX IV (Continued)

Store location	Pigmentation 1	2	3	4	5
City	Percent of broilers				
Dyersburg	0	30	30	20	20
Elizabethton	10	20	30	20	20
Shelbyville	10	20	20	30	20
	0	10	20	30	40
Paris	0	10	20	40	30
	0	0	50	50	0
Greeneville	30	30	20	10	10
	30	30	20	10	10
	10	20	30	20	20
Athens	20	30	30	10	10
Lebanon	10	20	30	30	10
	10	20	30	20	20
	0	25	25	25	25
Maryville	0	30	50	0	20
Union City	10	10	30	30	20
McMinnville	20	30	10	30	10
	10	30	30	20	10
	10	10	30	30	20
Tullahoma	10	10	20	30	30
Humboldt	10	30	30	20	10
	10	20	40	30	0
	0	30	30	30	10
Cookeville	10	30	30	30	0
Springfield	30	10	30	10	20
	20	20	20	10	30
	10	30	30	20	10
	0	10	10	20	60
Harriman	20	10	30	30	10
Alcoa	0	20	35	35	10
LaFollette	20	30	30	20	0
Pulaski	20	20	20	20	20
	0	20	20	30	30
Franklin	20	20	20	20	20
	0	20	30	40	10
	0	20	30	30	20

Store location	Pigmentation 1	2	3	4	5
City	Percent of broilers				
Fayetteville	20	20	30	20	10
	0	20	20	30	30
Lawrenceburg	10	20	30	20	20
	0	20	20	30	30
	0	0	30	30	40
Lewisburg	0	20	30	40	10
	0	0	30	30	40
Lenoir City	10	0	35	40	15
Gallatin	20	20	20	20	20
	10	30	20	30	10
Brownsville	10	20	30	20	20
	0	30	30	20	20
	0	20	30	30	20
Covington	0	20	80	0	0
	0	10	40	40	10
Sparta	30	30	20	10	10
	10	20	30	30	10
Rockwood	0	0	0	100	0
Sweetwater	0	35	35	30	0
Martin	0	30	40	20	10
Winchester	20	20	20	20	20
	0	20	20	40	20
Newport	20	30	30	10	10
	10	30	30	20	10
	10	30	30	20	10
Trenton	0	20	60	20	0
McKenzie	0	30	40	20	10
Clinton	0	10	40	40	10
	0	0	0	100	0
Jefferson City	10	50	30	0	10
Loudon	0	20	30	0	50
	0	0	0	100	0
Lexington	0	20	50	20	10
	0	20	30	30	20

APPENDIX IV (Continued)

Store location	Pigmentation 1	2	3	4	5
City	Percent of broilers				
Erwin	20	30	20	20	10
Dickson	20	40	20	20	0
	20	20	20	20	20
Ripley	0	20	40	40	0
Etowah	40	40	20	0	0
Dayton	50	25	25	0	0
So. Pittsburg	20	40	30	10	0
Rogersville	20	30	30	10	10
	10	30	30	20	10
Henderson	10	30	40	15	5
	0	30	50	20	0
Bolivar	10	30	30	20	10
Manchester	0	20	20	40	20
Crossville	10	30	30	20	10
	10	10	30	30	20
Jamestown	30	30	20	10	10
Livingston	60	40	0	0	0
Huntingdon	30	30	20	10	10
Monterey	10	40	40	10	0
Camden	10	30	30	20	10
	0	40	20	40	0
Tiptonville	10	20	40	30	0
Waverly	10	30	20	20	20
	10	20	40	20	10
Cowan	10	20	20	30	20
Halls	0	20	30	30	20
Somerville	10	40	40	10	0
Selmer	10	40	40	10	0
Newbern	0	30	40	20	10
Spring City	30	20	20	20	10

Store location	Pigmentation 1	2	3	4	5
City	Percent of broilers				
Greenfield	0	10	40	40	10
Hohenwald	0	0	20	40	40
	0	0	20	20	60
Savannah	0	10	20	40	30
Parsons	0	10	50	40	0
Kingston	0	25	30	30	15
Sevierville	0	40	30	0	30
Carthage	30	30	30	10	0
Whitwell	0	0	20	20	60
Smithville	30	30	20	10	10
Jellico	20	30	30	10	10
Centerville	0	10	20	30	40
Alamo	0	0	40	60	0
Madisonville	20	30	30	10	10
Tracy City	10	30	30	20	10
Sewanee	10	20	30	20	20
Mountain City	30	30	20	10	10
New Tazewell	20	30	30	10	10
Huntsville	10	30	30	20	10
Gatlinburg	0	0	0	100	0
Bells	0	40	30	30	0
Obion	0	30	40	20	10
Bruceton	0	30	30	20	20
Lafayette	10	20	30	20	20
Collierville	10	20	40	30	0
Waynesboro	0	20	20	20	40
Celina	0	30	50	10	10
Hartsville	20	20	20	20	20
Ducktown	10	20	30	20	20

APPENDIX IV (Continued)

Store location	Pigmentation				
	1	2	3	4	5
City	Percent of broilers				
Gleason	0	20	20	30	30
Ashland City	0	20	40	20	20
Woodbury	10	30	30	10	20
Gainesboro	20	20	20	30	10
Copperhill	30	30	20	10	10
Pikeville	30	30	20	10	10
Dunlap	0	10	60	30	0
Erin	10	30	30	20	10
Linden	10	30	30	20	10
Dover	10	30	20	30	10
Whiteville	10	20	30	30	10
Spencer	20	40	20	20	0
Dandridge	0	65	0	35	0
Rutledge	10	20	20	30	20
	5	60	10	15	10
Sneedville	20	30	20	20	10
Maynardville	30	0	35	0	35
	0	0	0	100	0
Lynchburg	0	20	20	40	20
Wartburg	10	30	30	20	10
Byrdstown	20	15	30	15	20
Decatur	10	30	30	20	10

Pigmentation rating groups: 1 = none to very light yellow, 2 = very light to light yellow, 3 = light to fairly yellow, 4 = fairly to fairly deep yellow, 5 = fairly deep to deep yellow.

APPENDIX V

Characteristics and Practices of 221 Grocery Stores Included in Broiler Pigmentation Survey, Tennessee, 1957.

Item		Number	%
1. Location of stores:	Middle Tennessee	83	38
	East Tennessee	78	35
	West Tennessee	60	27
2. Type of store:	Independent	118	53
	Chain	103	47
3. Size of store:	Small—weekly sales under $5,000	64	29
	Medium—weekly sales $5,000 to $9,999	54	24
	Large—weekly sales $10,000 and over	103	47
4. Population of 125 cities served by 221 stores:	White	1,277,897	84
	Negro	243,409	16
5. Size of family in areas served by stores, average		3.8	
6. Annual income per family in areas served by stores		$2,389	
7. Stores having delivery service and granting credit		75	34
8. Origin of fresh broilers sold during one week:	Tennessee	78,000	65
	Georgia	18,000	15
	Mississippi	14,400	12
	Alabama	4,800	4
	Virginia	3,600	3
	N. Carolina	1,200	1
9. Method of selling broilers			
Fresh, already cut up:	Stores	170	77
	Broilers sold weekly	94,000	77
Fresh, cut up by butcher after purchase:	Stores	128	58
	Broilers sold weekly	12,500	10
Fresh parts:	Stores	125	57
	Broilers sold weekly	8,500	7
Fresh, purchased whole (carried home):	Stores	207	94
	Broilers sold weekly	5,000	4
Frozen parts:	Stores	82	37
	Broilers sold weekly (a)	1,100	1
Frozen, cut up:	Stores	35	16
	Broilers sold weekly (a)	400	(b)
Frozen, whole:	Stores	24	11
	Broilers sold weekly (a)	250	(b)
10. Volume of broilers tray-packed:	Skin-side up	77,850	64
	Meat-side up	16,150	13
11. Stores where some customers asked for:			
Yellow-skinned broilers		58	26
White-skinned broilers		50	23

(a) Frozen broilers given in live broiler equivalent.
Frozen broilers were not inspected for pigmentation.

(b) Less than 1 percent.

Source of data on population, size of family, and family incomes: **1950 United States Census of Population**, P-B42, Bureau of the Census, U. S. Department of Commerce, 1952.