THE ECONOMIC EFFECT OF ADDED FAT IN BROILER RATIONS

By

Dan G. Bigbee

Bachelor of Science

Oklahoma Agricultural and Mechanical College

Stillwater, Oklahoma

1956

Submitted to the faculty of the Graduate School
of the Oklahoma State University
in partial fulfillment of the
requirements for the
degree of
MASTER OF SCIENCE
May, 1958

OKLAHOMA
STATE UNIVERSITY
LIBRARY

NOV 5 1958

THE ECONOMIC EFFECT OF ADDED FAT IN BROILER RATIONS

Thesis Approved:

George W. Newell
Thesis Advisor

John W. West

Dean of Graduate School

409792

ACKNOWLEDGEMENTS

The author wishes to express his appreciation to Dr. George W. Newell and Dr. Rollin H. Thayer for their assistance, suggestions, and criticisms during the planning and conducting of this study and in preparation of this thesis.

Full credit is given for the timely suggestions and assistance of all other staff members of the Poultry Department and to the staff of the College Poultry Farm for the assistance in the collection of data.

Appreciation is also expressed to Dr. Robert Morrison for his aid in the statistical analysis.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

The addition of fat to poultry rations has become widespread in recent years. In the late 1940's soap manufacturers were the prime market for inedible animal fats from the packing industries. The development of detergents for use in home and industry resulted in the loss of this market. In trying to find new uses for these fats, packers looked to the use of inedible animal fat as a feedstuff.

As early as 1943, Fraps found that the addition of cottonseed oil to poultry rations increased feed efficiency. The development of the Connecticut high energy broiler ration in 1947 created a need for a more concentrated source of energy. It was not until the 1950's, however, that feed grade fats were given serious consideration as a source of energy in poultry rations. Although fats provide an excellent source of energy, their use has introduced new problems. Among them are: 1. What kind of fat can be utilized by poultry? 2. Are fats compatible with other feed ingredients? and 3. How will fat affect the utilization of other nutrients?

LITERATURE REVIEW

Rice et al., (1954) Carver et al. (1954), and Sunde (1954) found that hydrogenated fat gave no increase in feed efficiency. Analysis of the feces showed that the hydrogenated fats were not absorbed by the digestive system. Siedler et al. (1955), found no significant difference in the utilization of different grades of animal fats. The fats used were choice white grease, yellow grease, brown grease, prime tallow, No. 2 tallow and fatty acids prepared from choice white grease. March and Biely (1954) conducted experiments with 5.0 and 10 percent levels of cottonseed oil, herring oil and tallow. These workers obtained consistent gains in growth rate with tallow. Cottonseed oil and herring oil in some experiments depressed growth. These workers concluded that this was due to a higher folic acid requirement and was corrected by the addition of folic acid. Aureomycin also corrected this condition in a folic acid deficient basal diet. Better growth response was observed when fat and aureomycin were added to the deficient basal ration.

Yacowitz (1953) found that two and one half, and five percent levels of cottonseed oil gave equal growth responses when added to a corn-solvent soybean oil meal diet. When these rations were supplemented with Procaine Penicillin G, an additional growth response was observed at five weeks. Results of the same magnitude were obtained at ten weeks. The addition of cottonseed oil at 10 and 15 percent levels retarded growth and caused a high incidence of feather picking. Supplementation with pencillin reduced the feather picking.

Sielder and Schweigert (1953); Yacowitz (1953); Sunde (1954); and Runnels (1954) indicated that the use of animal fats in poultry rations improved the utilization of feed by broilers. Bird (1954), in a study of the role of animal proteins and fats in poultry nutrition, noted that 5.0 percent of added fat in broiler diets did not increase growth rate, but did improve feed efficiency.

Donaldson et al., (1956) found that as the ratio of energy to protein was widened, feed efficiency and growth rate were impaired. Sunde (1956) reported that the addition of fat to high protein-low energy rations increased growth and feed efficiency. The author further indicated that as the protein level changed, the optimum ratio of energy to protein also changed.

Biely and March (1954) reported that the addition of fat may be advantageous when relatively high levels of protein are fed. Aitken et al. (1954) fed 10 percent beef tallow at 22 and 25 percent protein levels. These research workers reported an increase in growth rate at the 22 percent protein level. When fat was added to the 25 percent protein ration, there was a highly significant increase in growth rate and an eight percent improvement in feed efficiency.

Harms (1957) reported less total cooking loss, including evaporation and drippings, from broilers fed high energy diets. Donaldson et al. (1956) found that as the ratio of energy to protein in the ration widened, the energy intake and carcass fat deposition were increased and the water content of the carcass decreased. Siedler et al. (1955) reported no difference in eating quality of broilers fed choice brown or yellow grease, or No. 2 tallow.

The literature indicates that the addition of fat at low levels to high protein diets impaired growth and feed efficiency, and that high levels of fat added to high protein diets improved growth and feed efficiency. When low levels of fat were added to relatively low protein diets, there was an improvement in feed efficiency.

Studies on the effect of energy on carcass quality showed that broilers fed high energy rations tended to deposit more carcass fat than those receiving rations lower in energy. There was also some indication of less total cooking loss, including evaporation and drippings, from broilers fed high energy diets. No noticable difference in eating quality has been demonstrated in broilers fed different grades of animal fats.

Much has been said about the economic value of added fat in relation to its ability to improve feed efficiency and, in some cases, rate of growth. Very little research has been done to determine the true economic advantages resulting from the addition of fat to broiler rations. This study, herein reported, was conducted to determine if added fat materially increased returns to the producer. In addition, the effect of different levels of fat on carcass quality, as measured by carcass fat deposition, was also studied.

GENERAL PROCEDURE

The study consisted of four trials in which broiler chicks were grown on the floor to nine weeks of age. Trial one was conducted in the spring, trial two in the summer and trials three and four in the winter. Broiler chicks were randomly assorted into lots and fed rations containing protein levels ranging from 21 to 26.9 percent with added fat levels of 0, 5, 10 and 15 percent. Body weights and feed consumption were recorded at regular intervals in order to measure feed conversion and body weight gain. Random samples of broilers were selected from each treatment for processing. Specific gravity measurements were recorded to determine if the added fat increased the carcass fat deposition.

At the close of each trial a random sample of males and females was taken from each lot. These birds were weighed, New York dressed and placed in water-filled chilling tanks under refrigeration to cool. Viscera were removed by opening the carcass down the back. The eviscerated carcass, minus giblets, was weighed in air; then its weight in water recorded. Care was taken to open the body cavity of the carcass in water, in order to remove any air pockets. From this specific gravity measurement, an estimate of carcass fat deposition was made using the method developed by Rathbun and Pace (1944). Specific gravity was calculated by using the following formula: $\frac{\text{(air weight)}}{\text{(air weight-water weight)}}$.

To present the data contained in this study in a more concise manner the fat-protein combination used will be abbreviated. The abbreviations will contain two numbers. The first number will represent the percent of added fat in the ration. The second number will represent the percent of protein in the ration. For example, (0-22) would be a ration containing zero percent of added fat and twenty-two percent of protein.

TRIAL I

Procedure

Six hundred sexed day-old (New Hampshire x Silver Oklabar) chicks from the Oklahoma Agricultural Experiment Station, were randomly distributed into twelve lots consisting of twenty-five males and twenty-five females. The chicks were wing banded, weighed at the age of one day and reared to nine weeks of age in a radiant heated brooder house.

Ten experimental rations (Table II) were formulated with four added fat levels (0, 5, 10, and 15 percent) and three protein levels (22, 24, and 26 percent) and fed ad libitum to the twelve lots. A graphic design of these combinations is shown in Table I. The combinations (0-26) and (15-22) were not used in this study. Combinations (0-22) and (15-26) were replicated and all other combinations used in this trial were fed to individual lots.

TABLE I

TRIAL ONE - TREATMENT COMBINATIONS

% Added Fat / % Protein	0	5	10	15
22	x*	x	x	-
24	x	x	x	x
26	-	x	x	x*

*replicated

-combination deleted

Body weights and feed consumption were recorded for each lot at 3, 6, 7, 8, and 9 weeks of age. The birds were individually weighed at 3, 6, and 9 weeks, and group weighed by sex at 7 and 8 weeks.

TABLE II

TRIAL I - COMPOSITION OF RATIONS

Ration	0-22	0-24	5-22	5-24	5-26	10-22	10-24	10-26	15-24	15-26
Ingredients	percent of diet									
Ground yellow corn	52.3	45.2	47.3	40.2	33.1	42.3	35.2	28.1	30.2	23.2
Pulverized oats	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Dehydrated alfalfa meal (17% protein)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Soybean oil meal (44% protein)	22.5	27.0	22.5	27.0	31.5	22.5	27.0	31.5	27.0	31.5
Menhaden fish meal (60% protein)	5.0	6.0	5.0	6.0	7.0	5.0	6.0	7.0	6.0	7.0
Dried Fish solubles	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Meat & bone scrap (50% protein)	3.0	3.6	3.0	3.6	4.2	3.0	3.6	4.2	3.6	4.2
Dried brewers yeast	3.0	3.6	3.0	3.6	4.2	3.0	3.6	4.2	3.6	4.2
Dried whey	2.0	2.4	2.0	2.4	2.8	2.0	2.4	2.8	2.4	2.8

Dicalcium phosphate	1.0	1.0	1.0	1.0	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	0.5	0.5	0.5	0.5
Vitamin supplement VC-55 *1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Trace mineral mix*2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Nicarbazin*3	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Fat*4	0.0	0.0	5.0	5.0	5.0	10.0	10.0	10.0	15.0	15.0
Choline supplement*5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Calorie protein ratio (metabolizable energy)	56:1	49:1	62:1	55:1	49:1	69:1	61:1	54:1	67:1	59:1

FOOTNOTES

1. Vitamin supplement VC-55 provided the following quantities per pound of finished ration: Vit. A 4,000, USP, Vit. D-3 2,000 ICU, riboflavin 30 mgs., pantothenic acid 4.0 mgs., niacin 20.0 mgs., choline 300 mgs., Vit. B-12 3.0 mcrgs., procaine penicillin 2.0 mgs., menadione 3.0 mgs.

2. Trace mineral mix contributed the following per pound of finished ration: manganese 27.5 mgs., iodine 0.88 mgs., cobalt 0.59., iron 18.3 mgs., copper 1.65 mgs., and zinc 1.52 mgs.

3. Nicarbazin, Merck and Company, provided 56.75 mg. of active anti-coccidial agent per pound of finished ration.

4. Fat, Marco B-75, a feed grade fat prepared from cottonseed and soy-bean oils.

5. Choline adds 113.5 mgs. per pound of finished ration.

Results, Trial I

Average Gain

At the 22 percent protein level, the data contained in Table III indicate a decrease in average gains to nine weeks for each 5 percent increase in added fat. Broilers fed ration (5-24) did not gain as well from the sixth to the ninth week, as those fed rations (0-24) and (10-24). Of the broilers fed the 24 percent protein rations, those receiving ration (5-24) made the best gains to three weeks of age. Broilers fed ration (10-24) made the best gain from the sixth week to the close of the trial, of any broilers fed the 24 percent protein rations. Broilers fed ration (15-24) made better gains than those fed rations (0-24) and (5-24), except for the first three weeks of the trial. Broilers receiving the 26 percent protein rations made better gains when the added fat level was increased from 5 to 10 percent. The increase to 15 percent of added fat,at the 26 percent protein level, depressed growth in comparison to the broilers fed the (10-26) ration. Broilers fed the (10-26) ration made the best gains of all broilers in the trial, except for the first three weeks when those fed ration (5-24) made the best gains.

Average gains to nine weeks, for broilers fed zero and five percent added fat, decreased with each increase in percent of protein in the ration. The broilers receiving 10 and 15 percent added fat gave increased average gains to nine weeks for each increase in protein level.

Analysis of variance of average gains to nine weeks (Table IV) indicates they were significantly different, .05 confidence level, due to protein level and fat-protein interaction. The differences in average gains to nine weeks due to the percent of added fat were significant at

the .25 confidence level. Duncan's multiple range test at the .05 confidence level indicates that the significant differences in average gains were between broilers fed rations (10-26) and (15-26) and those fed (10-22), as shown in Table V. A dusty, light green growth developed in the litter after the third week of the trial in the pen containing broilers fed ration (10-22). No attempt was made to identify this growth, and it is not known if it had any adverse effect on the response of the broilers in that pen. Because of this unexplained environmental factor, it is difficult to determine if the differences in average gains were due primarily to treatment effects.

TABLE III

TRIAL ONE - CUMULATIVE BODY WEIGHT GAINS OF BROILERS TO 3, 6, 7, 8, AND 9 WEEKS OF AGE, IN POUNDS

Week / Ration	3	6	7	8	9
0-22	.531	1.570	2.040	2.440	2.856
0-24	.533	1.580	2.039	2.419	2.798
5-22	.552	1.415	1.817	2.255	2.735
5-24	.580	1.439	1.833	2.233	2.672
5-26	.522	1.364	1.723	2.141	2.607
10-22	.527	1.080	1.432	1.851	2.343
10-24	.552	1.664	2.110	2.499	2.901
10-26	.570	1.668	2.129	2.577	2.981
15-24	.519	1.597	2.081	2.509	2.898
15-26	.518	1.627	2.099	2.511	2.952

TABLE IV

TRIAL ONE - ANALYSIS OF VARIANCE OF CUMULATIVE BODY WEIGHT GAINS FOR BROILERS TO NINE WEEKS OF AGE

Source of Variation	df	M.S.	F	
Protein	2	.100625	36.828	P<.05
Fat	3	.053658	1.963	P<.25
Protein X Fat	4	.706105	25.836	P<.05
Lots in Treatment (error)	2	.002733		

TABLE V

TRIAL ONE - DUNCAN'S MULTIPLE RANGE TEST, .05 CONFIDENCE LEVEL, OF CUMULATIVE BODY WEIGHT GAINS FOR BROILERS TO NINE WEEKS OF AGE

p:	2								
Rp:	.318								
	10-22	5-26	5-24	0-24	5-22	0-22	15-24	10-24	15-26	10-26
Ranked Means*	2.343	2.607	2.672	2.735	2.798	2.856	2.856	2.901	2.952	2.981

*Any two means underscored by the same line are not significantly different.

Average Weight

Data contained in Table VI show a decrease in average weight to nine weeks for each 5 percent increase in fat when broilers were fed rations containing 22 percent protein. The average weights for broilers fed 24 percent protein diets did not follow a smooth pattern with each 5 percent increase in added fat. Broilers fed ration (5-24) did not weigh as much as those fed ration (0-24). However, during the first three weeks of the trial, broilers fed ration (5-24) had as good average weight as those fed ration (10-26). Broilers receiving ration (10-24) had better average weight than those fed rations (0-24) and (5-24). Broilers fed ration (15-24) did not have as good average weight as those fed ration (10-24) until the eighth and ninth weeks at the close of the nine week trial, broilers receiving rations (15-24) and (10-24) had equal average weights.

TABLE VI

TRIAL ONE - CUMULATIVE BODY WEIGHT OF BROILERS TO 3, 6, 7, 8, AND 9 WEEKS OF AGE IN POUNDS

Week Ration	3	6	7	8	9
0-22	.62	1.67	2.13	2.53	2.94
0-24	.62	1.67	2.13	2.51	2.88
5-22	.64	1.50	1.90	2.34	2.65
5-24	.65	1.52	1.92	2.32	2.75
5-26	.61	1.45	1.81	2.23	2.70
10-22	.62	1.16	1.49	1.93	2.43
10-24	.64	1.75	2.21	2.59	2.99
10-26	.65	1.75	2.21	2.66	3.07
15-24	.61	1.69	2.17	2.60	2.99
15-26	.61	1.82	2.19	2.60	3.05

Broilers fed ration (5-26) did not have as large an average weight as those fed rations (10-26) and (15-26). Broilers receiving ration (10-26) had the largest average weight of those fed the 26 percent protein diets, except at the sixth week. Broilers fed ration (15-26) had the largest average weight of all birds in the trial at six weeks of age.

Broilers fed the zero percent added fat rations maintained equal average weights through the seventh week of the trial. During the eighth and ninth weeks broilers receiving the (0-24) ration did not have as large an average weight as those fed ration (0-22). The average weight of broilers fed 5 percent added fat was improved when protein was increased from 22 to 24 percent. However, during the eighth week broilers fed ration (5-22) had a slightly larger average weight than those fed ration (5-24). Broilers receiving the (5-26) ration did not have as large an average weight to the eighth week as those fed rations (5-22) and (5-24). At nine weeks of age broilers fed ration (5-26) had a larger average weight than those fed ration (5-22). Each increase in the protein level of the ration gave equal or improved average weight when broilers were fed rations which contained 10 or 15 percent of added fat. During the initial three weeks of the trial, broilers fed the zero and five percent added fat rations had better average weights than those fed the 15 percent added fat rations. From the sixth week to the close of the trial, broilers fed rations (15-24) and (15-26) had better average weights than those fed rations (0-22), (0-24), (5-22), (5-24), and (5-26).

Feed Conversion

When the percent of protein was kept constant, each 5 percent increase in fat improved feed conversion, as shown in Table VII. There were some exceptions to this at different weeks of the trial but in general it was true. The major exception was in the pen where broilers were fed ration (10-22). As mentioned earlier, this pen developed a dusty, light green growth in the litter and its effect on the performance of those broilers is not known.

Broilers fed ration (0-22) utilized feed more efficiently than those fed ration (0-24). However, broilers fed ration (0-24) had a better feed conversion at six weeks than those fed ration (0-22). From the sixth to eighth week of the trial, broilers fed ration (5-24) had better or equal feed conversion than those fed ration (5-22). Broilers fed ration (5-26) converted feed less efficiently throughout the trial than those fed rations (5-22) and (5-24).

With each increase in the percent of protein at the 10 and 15 percent added fat levels, there was a corresponding improvement in feed conversion. One exception was found at the third week when broilers fed ration (15-24) had a better feed conversion than those fed ration (15-26).

Results of the analysis of variance procedure, as shown in Table VIII, indicates there was no significant difference in feed conversions due to the percent of protein in the ration. However, feed conversions are significantly different at the .005 confidence level, due to the level of added fat in the ration. The effect of fat-protein interaction on differences in feed conversion was significant at the .05 confidence level. Duncan's

multiple range test at the .05 confidence level, indicates that feed conversions resulting from feeding 15 percent of added fat were significantly better than those obtained from feeding lower percentages or no added fat, as seen in Table IX.

TABLE VII

TRIAL ONE - CUMULATIVE FEED CONVERSIONS OF BROILERS TO 3, 6, 7, 8, AND 9 WEEKS OF AGE, IN POUNDS OF FEED PER POUND OF GAIN

Week / Ration	3	6	7	8	9
0-22	1.98	2.50	2.54	2.67	2.81
0-24	2.06	2.49	2.59	2.74	2.88
5-22	1.84	2.48	2.52	2.59	2.65
5-24	1.92	2.46	2.48	2.59	2.69
5-26	2.05	2.53	2.60	2.67	2.71
10-22	1.89	2.77	2.65	2.65	2.61
10-24	1.84	2.17	2.27	2.40	2.57
10-26	1.77	2.19	2.24	2.33	2.48
15-24	1.80	2.12	2.11	2.25	2.36
15-26	1.82	2.07	2.12	2.24	2.35

TABLE VIII

TRIAL ONE - ANALYSIS OF VARIANCE OF CUMULATIVE FEED CONVERSIONS FOR BROILERS TO NINE WEEKS OF AGE

Source of Variation	df	M.S.	F	
Protein	2	.00045	2.25	P<.005
Fat	3	.12527	626.35	P<.005
Protein X Fat	4	.00380	19.00	P<.05
Error	2	.00020		

TABLE IX

TRIAL ONE - DUNCAN'S MULTIPLE RANGE TEST, .05 CONFIDENCE LEVEL, OF CUMULATIVE FEED CONVERSIONS FOR BROILERS TO NINE WEEKS OF AGE

p:	2									
Rp:	.09									
	15-26	15-24	10-26	10-24	10-22	5-22	5-24	5-26	0-22	0-24
Ranked Means Conversions *	2.35	2.36	2.48	2.57	2.61	2.65	2.69	2.71	2.81	2.88

*Any two feed conversion underscored by the same line are not significantly different.

Carcass Fat Deposition

The data shown in Table X indicate that more carcass fat was deposited as the added fat content of the ration was increased from zero to ten percent. Broilers fed the rations which contained 15 percent of add fat did not deposit as much carcass fat as those fed the rations which contained 10 percent of added fat. The data contained in Table X are averages of the specific gravities for broilers fed each of the four added fat levels used in this trial.

TABLE X

TRIAL ONE - MEAN SPECIFIC GRAVITIES OF NINE WEEK OLD BROILERS FED DIETS CONTAINING 0, 5, 10, AND 15 PERCENT OF ADDED FAT

Percent Added Fat	0	5	10	15
Specific Gravity	1.0710	1.0702	1.0626	1.0636

The differences in specific gravity means due to added fat level were significantly different at the .005 confidence level, as shown in Table XI. Significantly greater fat deposition was observed for the broilers fed the 10 and 15 percent added fat rations than for those fed the zero and five percent added fat rations, Table XII.

TABLE XI

TRIAL ONE - ANALYSIS OF VARIANCE OF MEAN SPECIFIC GRAVITIES OF NINE WEEK OLD BROILERS FED DIETS CONTAINING 0, 5, 10, AND 15 PERCENT OF ADDED FAT

Source of Variation	df	M.S.	F	
Starve*	2	.000015955	11.057	P<.01
Fat	3	.000056853	39.400	P<.005
Error	6	.000001443		

*This portion of the analysis pertained to another experiment.

TABLE XII

TRIAL ONE - DUNCAN'S MULTIPLE RANGE TEST, .05 CONFIDENCE LEVEL, OF MEAN SPECIFIC GRAVITIES OF NINE WEEK OLD BROILERS FED DIETS CONTAINING 0, 5, 10, AND 15 PERCENT OF ADDED FAT

p:	2	3	4	
Rp:	.00363	.00382	.00392	
	10%	15%	5%	0%
Ranked Means*	1.0626	1.0636	1.0702	1.0710

* Any two means underscored by the same line are not significantly different.

TRIALS II AND III

Procedure

Six hundred sexed, day-old broiler chicks were randomly divided into twelve lots consisting of twenty-five males and twenty-five females each. The chicks were wing banded, weighed at one day-old and reared to nine weeks of age in a radiant heated brooder house.

Six rations as shown in Table XIV, were fed ad libitum to the twelve lots. Four experimental rations were developed containing four added fat levels (0, 5, 10, and 15 percent) and four protein levels (21, 22.8, 24.7, and 26.2 percent). Each of the rations was formulated to have a C/P ratio of 60 calories of metabolizable energy per one percent of protein per pound of feed. The other two treatments (Ex 52 and Ex 54) were standard broiler rations which have been developed at the Oklahoma Agricultural Experiment Station. Table XIII shows a graphic illustration of the added fat-protein combinations used in these trials.

TABLE XIII

TRIAL TWO - TREATMENT COMBINATIONS

% Added Fat / % Protein	0	5	10	15
21	x			
22		x		
24			x	
26				x

The brooder house was divided into two, six lots, blocks with the six treatments randomly distributed in each block.

Feed Consumption and individual body weights were taken each week, to nine weeks in trial two. Group weights without regard to sex and feed consumption were taken at 4, 5, 6, 7, and 8 weeks in trial three. The birds were weighed individually at the ninth week.

TABLE XIV

TRIALS II AND III RATIONS

Ration	0-21	5-22	10-24	15-26	Ex 52	Ex 54
Ingredients	Percent of Diet					
Ground yellow corn	56.8	45.8	34.1	23.2	56.0	56.0
Pulverized oats	5.0	5.0	5.0	5.0	5.0	5.0
Dehydrated alfalfa meal (17% protein)	2.0	3.0	2.0	2.0	2.0	2.0
Soybean oil meal (44% protein)	18.0	24.0	25.5	34.0	22.5	14.5
Menhaden fish meal (60% protein)	5.0	5.0	7.0	6.0	5.0	12.0
Dried fish solubles	3.0	3.0	3.0	3.0	0.0	2.0
Meat and bone scrap (50% protein)	3.0	3.0	4.2	3.6	3.0	2.0
Dried brewer's yeast	3.0	3.0	4.2	3.6	3.0	2.0
Dried whey	2.0	2.0	2.8	2.4	2.0	2.0
Dried butyl solubles	0.0	0.0	0.0	0.0	0.0	0.0
Di-calcium phosphate	1.5	1.5	1.5	1.5	1.5	1.5
Salt	0.5	0.5	0.5	0.5	0.5	0.5
Vitamin supplement*[1]	0.5	0.5	0.5	0.5	0.5	0.5
Trace mineral mix*[2]	0.05	0.05	0.05	0.05	0.05	0.05
Nicarbazine*[3]	0.05	0.05	0.05	0.05	0.05	0.05
Fat*[4]	0.0	0.0	0.0	0.0	0.0	0.0
Choline*[5]	0.1	0.1	0.1	0.1	0.1	0.1
dl-Methionine*[6]	0.0	0.05	0.05	0.05	0.0	0.0
Calorie protein ratio*[7] (metabolizable energy)	60:1	60:1	60:1	60:1	59:1	58:1

FOOTNOTES

Trials II and III

1. Vitamin supplement VC-55 adds the following per pound of finished ration: vit. A 4,00 USP, vit. D-3 2,000 ICU, riboflavin 3.0 mgs., pantothenic acid 4.0 mgs., niacin 20.0 mgs., choline 300 mgs., vit. B-12 3.0 mcrgs., procaine penicillin 2.0 mgs., menadione 3.0 mgs.

2. Trace mineral mix provided the following per pound of finished ration: manganese 27.5 mgs., iodine 0.88 mgs., cobalt 0.59 mgs., iron 18.3 mgs., copper 1.65 mgs., and zinc 1.52 mgs.

3. Nicarbazine, Merck and Company, adds 56.75 mgs., of active anticoccidial agent per pound of finished ration.

4. Fat, Marco B-75, a feed grade fat prepared from cottonseed and soybean oils.

5. Choline to add 113.5 mgs. per pound of finished ration.

6. dl-Methionine to add 113.5 mgs. of available dl-methionine.

Results, Trial II

Data presented in Table XV indicate that broilers fed the (0-21) ration made the smallest average gains for the nine week trial. These broilers did have better gains than those receiving the (5-22) diet, at three, four, and six weeks, and those fed the (15-26) ration at three, four, five, six, and seven weeks.

Birds fed the (5-22) ration had better average gains than those fed ration (15-26), excluding the first week. After the first week, broilers receiving ration (10-24) made increased average gains over the broilers fed the other three added fat diets. The broilers receiving ration (15-26) made the best gain the first week, after which they declined in relation to the other broilers with some recovery during the eighth and ninth weeks.

Broilers fed Ex 52 gave better gains at the end of the nine week trial than those fed the zero and fifteen percent added fat rations. The second best gains for the second through the sixth week were made by birds receiving Ex 52, when they began to decline in comparison with the other lots.

The broilers receiving Ex 54 made nominal gains the first week then produced the best average gains of all birds up to the conclusion of the trial.

Data contained in Table XVI show that average gains to nine weeks were significantly different at the .05 confidence level due to treatment effects. Duncan's multiple range test at the .05 confidence level, indicate that broilers fed rations Ex 54 and (10-24) made significantly better gains than those fed ration (0-21), Table XVI.

TABLE XV

TRIAL TWO - CUMULATIVE BODY WEIGHT GAINS OF BROILERS FROM ONE TO NINE WEEKS OF AGE, IN POUNDS

Week / Ration	1	2	3	4	5	6	7	8	9
0-21	.107	.272	.501	.787	1.019	1.319	1.638	1.804	2.261
5-22	.121	.295	.498	.765	1.009	1.329	1.647	1.950	2.400
10-24	.118	.295	.509	.783	1.041	1.352	1.711	1.976	2.421
15-26	.125	.284	.500	.732	.966	1.268	1.597	1.890	2.318
Ex 52	.118	.303	.528	.799	1.041	1.365	1.678	1.972	2.389
Ex 54	.117	.306	.553	.868	1.119	1.473	1.766	1.974	2.454

TABLE XVI

TRIAL TWO - ANALYSIS OF VARIANCE OF CUMULATIVE BODY WEIGHT GAINS FOR BROILERS TO NINE WEEKS OF AGE

Source of Variation	df	M.S.	F	
Replications	1	.009243	2.65	P<.250
Treatments	5	.022098	6.34	P<.05
Error	5	.03484		

TABLE XVII

TRIAL TWO - DUNCAN'S MULTIPLE RANGE TEST, .05 CONFIDENCE LEVEL, OF CUMULATIVE BODY WEIGHT GAINS FOR BROILERS TO NINE WEEKS OF AGE

p:	2	3	4	5		
Rp:	.151	.156	.158	.159		
	0-21	15-26	Ex 52	5-22	10-24	Ex 54
Ranked Means*	2.261	2.318	2.389	2.400	2.421	2.454

* Any two means underscored by the same line are not significantly different.

Average Weight

The average weights contained in Table XVIII follow a pattern similar to that found for average gains. Broilers fed ration (0-21) had the lowest average weight of all birds at the close of the trial. However, broilers fed the (0-21) ration had better average weight than those fed rations (5-22), (10-24), and (15-26), at the end of the fourth week; rations (5-22) and (15-26), at the end of the fifth week; and ration (15-26) at the end of the sixth and seventh weeks. Broilers fed ration (5-22) had better average weight than those receiving the (0-21) ration, except at the fourth and fifth weeks. The broilers fed ration (5-22) also had better average weight at the second and the fourth to ninth weeks, than those fed ration (15-26).

After the fourth week broilers receiving the (10-24) ration had the best average weight of all broilers fed the added fat rations. The broilers fed ration (15-26) had the best average weight the first week, after which they declined in relation to the broilers fed the other rations in the trial.

Broilers receiving the Ex 52 ration had better average weight, from the second to the sixth week, than those fed the added fat rations. From the seventh to the ninth week, broilers fed ration Ex 52 did not have as good average weight as broilers fed ration (10-24). Broilers fed ration Ex 54 had a nominal first week average weight, after which they had the largest average weight of all birds in the trial.

TABLE XVIII

TRIAL TWO - CUMULATIVE BODY WEIGHT OF BROILERS FROM ONE TO NINE WEEKS OF AGE, IN POUNDS

Week / Ration	1	2	3	4	5	6	7	8	9
0-21	.201	.366	.594	.881	1.112	1.413	1.732	1.899	2.363
5-22	.215	.392	.595	.862	1.106	1.425	1.743	2.046	2.471
10-24	.210	.389	.602	.876	1.134	1.446	1.805	2.070	2.514
15-26	.221	.381	.596	.828	1.074	1.365	1.694	1.986	2.414
Ex 52	.211	.396	.621	.894	1.133	1.458	1.771	2.064	2.481
Ex 54	.213	.401	.649	.946	1.215	1.570	1.864	2.071	2.552

Feed Conversion

The broilers fed ration (0-21) utilized feed less efficiently than those fed the other rations in the trial, as indicated in Table XIX. However, broilers fed the (0-21) ration did utilize feed more efficiently the first and third weeks than those fed ration (5-22). Broilers fed ration (5-22) had a better feed conversion than those fed ration (0-21) at the second and the fifth to ninth weeks, and ration Ex 54 the eighth and ninth weeks.

Except for the fourth, fifth and sixth weeks, broilers fed the (15-26) ration had the best feed conversion of all the broilers in the trial. Broilers fed ration Ex 52 had a better feed conversion each week of the trial than those receiving rations (0-21) and (5-22). During the second week, broilers fed ration Ex 52 had a better feed conversion than those fed rations (10-24) and Ex 54. Broilers receiving ration Ex 52 had a better feed conversion than those fed ration (15-26) during the fifth week of the trial.

On the seventh, eighth and ninth weeks, broilers fed ration Ex 52 had a better feed conversion than those receiving ration Ex 54.

The broilers fed ration Ex 54 had the best feed conversion from the third to the sixth week of all the broilers in the trial. Excluding the first week, broilers receiving the Ex 54 ration had better feed conversion than those fed ration (0-21). Broilers fed ration Ex 54 had a better feed conversion the second and seventh weeks than those fed ration (5-22).

TABLE XIX

TRIAL TWO - CUMULATIVE FEED CONVERSIONS OF BROILERS FROM ONE TO NINE WEEKS OF AGE, IN POUNDS OF FEED PER POUND OF GAIN

Week / Ration	1	2	3	4	5	6	7	8	9
0-21	1.64	1.81	1.94	2.00	2.19	2.29	2.42	2.70	2.65
5-22	1.81	1.67	1.97	2.00	2.17	2.24	2.35	2.46	2.48
10-24	1.57	1.70	1.86	1.93	2.07	2.16	2.26	2.39	2.39
15-26	1.29	1.55	1.78	1.90	2.11	2.17	2.26	2.35	2.33
Ex 52	1.60	1.60	1.86	1.95	2.10	2.19	2.31	2.43	2.45
Ex 54	1.68	1.62	1.78	1.86	2.06	2.15	2.33	2.51	2.49

The feed conversions for each treatment were found to be significantly different at the .025 confidence level, Table XX.

Duncan's multiple range test (at the .05 confidence level) indicated that the feed conversion for the (0-21) treatment was significantly different from those for the other treatment as seen in Table XXI.

TABLE XX

TRIAL TWO - ANALYSIS OF VARIANCE OF CUMULATIVE FEED CONVERSIONS FOR BROILERS TO NINE WEEKS OF AGE

Source of Variation	df	M.S.	F	
Replications	1			
Feed Conversion	5	.02356	8.47	P<.025
Error	5	.00278		

TABLE XXI

TRIAL TWO - DUNCAN'S MULTIPLE RANGE TEST, .05 CONFIDENCE LEVEL, OF CUMULATIVE FEED CONVERSIONS FOR BROILERS NINE WEEKS OF AGE

p:	2	3	4	5		
Rp:	.135	.139	.141	.142		
	15-26	10-24	Ex 52	5-22	Ex 54	0-21
Ranked Means*	2.33	2.39	2.45	2.48	2.49	2.65

*Any two means underscored by the same line are not significantly different.

Carcass Fat Deposition

The specific gravity means presented in Table XXII indicate that each five percent increase in added fat from zero to ten percent gave a very slight increase in carcass fat deposition. The broilers fed ration (15-26) deposited only slightly less carcass fat than those fed rations (5-22) and (10-24). Broilers receiving rations Ex 52 and Ex 54 deposited carcass fat in about the same amounts as those fed ration (0-21). The data in Table XXIII indicate that the specific gravity means for each treatment were significantly different at the .25 confidence level.

TABLE XXII

TRIAL TWO - MEAN SPECIFIC GRAVITIES OF NINE WEEK OLD BROILERS FED RATIONS CONTAINING 0, 5, 10, AND 15 PERCENT ADDED FAT AND STANDARD RATIONS EX 52 AND EX 54

Percent Added Fat	0	5	10	15	Ex 52	Ex 54
Specific Gravity	1.0646	1.0624	1.0622	1.0629	1.0643	1.0632

TABLE XXIII

TRIAL TWO - ANALYSIS OF VARIANCE OF MEAN SPECIFIC GRAVITIES OF NINE WEEK OLD BROILERS FED RATIONS CONTAINING 0, 5, 10, AND 15 PERCENT OF ADDED FAT AND STANDARD RATIONS EX 52 AND EX 54

Source of Variation	df	M.S.	F	
Replicate	1	.0001827	7.070	P<.01
Specific Gravity	5	.00003918	1.516	P<.25
Error	113	.00002584		

Results, Trial III

Average Gain

The data contained in Table XXIV show that the broilers fed ration (0-21) made the smallest gain of all the broilers in the trial. Broilers fed ration (5-22) made larger gains from the sixth to the ninth week than those fed ration Ex 54.

From the fifth to the seventh week and at the ninth week, broilers fed ration (5-22) made better average gains than those fed ration Ex 52.

Broilers fed ration (10-24) made the largest gains throughout the trial in comparison to the broilers fed the other rations. Broilers fed ration (15-26) made better gains, excluding the eighth week, than those fed ration (5-22). With the exception of the fourth and the eighth weeks,

broilers fed ration (15-26) had better gains than those fed ration Ex 52. Broilers fed ration (15-26) made better gains from the fifth to the ninth week than those receiving the Ex 54 ration.

The broilers fed rations Ex 52 and Ex 54 made better gains to the fourth week than those fed rations (0-21), (5-22), and (15-26). After this period, broilers fed ration Ex 52 made better gains at eight weeks than those fed rations (5-22) and (15-26).

TABLE XXIV

TRIAL THREE - CUMULATIVE BODY WEIGHT GAINS OF BROILERS FROM FOUR TO NINE WEEKS OF AGE

Week Ration	4	5	6	7	8	9
0-21	.726	1.089	1.443	1.869	2.267	2.772
5-22	.779	1.170	1.550	2.011	2.474	2.945
10-24	.832	1.244	1.654	2.079	2.558	3.015
15-26	.780	1.177	1.558	2.045	2.468	2.954
Ex 52	.796	1.163	1.509	1.958	2.520	2.870
Ex 54	.781	1.152	1.513	1.915	2.379	2.810

The average gains for treatments were significantly different at the .25 confidence level, Table XXV.

TABLE XXV

TRIAL THREE - ANALYSIS OF VARIANCE OF CUMULATIVE BODY WEIGHT GAINS FOR BROILERS TO NINE WEEKS OF AGE

Source of Variation	df	M.S.	F	
Replications	1	.000024		
Treatments	5	.031768	2.57	P<.25
Rep X Treatment (error)	5	.012324		

Average Weight

The data contained in Table XXVI show that the broilers fed ration (0-21) had the least average weight of all broilers in the trial. The broilers fed ration (5-22) had a better average weight during the fifth, sixth, seventh and ninth weeks, than those fed ration Ex 52. Broilers receiving ration (5-22) had better average weight from the fifth to the ninth weeks than those fed ration Ex 54.

The best average weight throughout the trial was made by broilers fed ration (10-24). Broilers fed ration (15-26) had a better average weight, excluding the eighth week, than those fed ration (5-22). Broilers receiving ration (15-26) had a larger average weight the fifth, sixth, seventh, and ninth weeks than those fed ration Ex 52. Broilers fed ration (15-26) had a better average weight, throughout the trial than those fed ration Ex 54.

The broilers fed ration Ex 52 had a larger average weight throughout the trial than those fed ration Ex 54. At the fourth and eighth weeks, broilers receiving ration Ex 52 had a better average weight than those fed rations (5-22) and (15-26). Broilers fed ration Ex 52 had a better average weight throughout the trial than those fed ration (0-21).

TABLE XXVI

TRIAL THREE - CUMULATIVE BODY WEIGHT OF BROILERS FROM FOUR TO NINE WEEKS OF AGE

Week / Ration	4	5	6	7	8	9
0-21	.816	1.178	1.533	1.959	2.357	2.861
5-22	.871	1.262	1.626	2.104	2.567	3.038
10-24	.922	1.335	1.744	2.170	2.649	3.106
15-26	.873	1.270	1.652	2.139	2.561	3.048
Ex 52	.893	1.260	1.607	2.056	2.618	2.967
Ex 54	.871	1.242	1.603	2.000	2.469	2.901

Feed Conversion

Data contained in Table XXVII show that feed conversion was improved by each 5 percent increase in added fat. Broilers fed ration (15-26) had the best feed conversion of all broilers in the trial. The broilers fed ration Ex 54 had a better feed conversion throughout the trial than those fed ration (0-21). Except for the eighth week, broilers fed ration Ex 54 had a better feed conversion than those fed ration Ex 52. Broilers receiving ration Ex 52 had a better feed conversion, the fifth and eighth weeks, than those fed ration (0-21).

TABLE XXVII

TRIAL THREE - CUMULATIVE FEED CONVERSIONS OF BROILERS FROM FOUR TO NINE WEEKS OF AGE

Week / Ration	4	5	6	7	8	9
0-21	2.01	2.15	2.32	2.46	2.63	2.72
5-22	1.92	2.15	2.20	2.32	2.44	2.56
10-24	1.85	1.83	1.95	2.14	2.27	2.43
15-26	1.76	1.83	1.93	2.04	2.22	2.40
Ex 52	2.02	2.11	2.36	2.48	2.50	2.74
Ex 54	1.99	2.11	2.25	2.41	2.53	2.69

The feed conversions to nine weeks for each treatment were significantly different as seen in Table XXVIII at the .005 confidence level. Duncan's multiple range test at the .05 confidence level, indicate that broilers fed rations (10-24) and (15-26) had significantly better feed conversions than the broilers fed the other rations, Table XXIX.

TABLE XXVIII

TRIAL THREE - ANALYSIS OF VARIANCE OF CUMULATIVE FEED CONVERSIONS FOR BROILERS TO NINE WEEKS OF AGE

Source of Variation	df	M.S.	F	
Replications	1	.00750		
Treatment	5	.04510	19.42	P<.005
Error	5	.00232		

TABLE XXIX

TRIAL THREE - DUNCAN'S MULTIPLE RANGE TEST, .05 CONFIDENCE LEVEL, OF CUMULATIVE FEED CONVERSIONS FOR BROILERS TO NINE WEEKS OF AGE

p:	2	3	4	5		
Rp:	.123	.127	.129	.130		
	4	3	2	6	1	5
Ranked Means*	2.40	2.43	2.56	2.69	2.72	2.74

*Any means underscored by the same line are not significantly different.

Carcass Fat Deposition

The data contained in Table XXX indicate that the amount of carcass fat deposited was increased by each five percent increase in added fat content of the ration. Broilers fed rations Ex 54 and Ex 52 deposited carcass fat in about the same amounts as those fed ration (5-22).

The specific gravity means for the treatments were significantly different at the .25 confidence level, Table XXXI.

TABLE XXX

TRIAL THREE - MEAN SPECIFIC GRAVITIES OF NINE WEEK OLD BROILERS FED RATIONS CONTAINING 0, 5, 10, AND 15 PERCENT OF ADDED FAT AND STANDARD RATIONS EX 52 AND EX 54

Ration	0	5	10	15	Ex 52	Ex 54
Specific Gravity	1.0651	1.0637	1.0619	1.0590	1.0629	1.0637

TABLE XXXI

TRIAL THREE - ANALYSIS OF VARIANCE OF MEAN SPECIFIC GRAVITIES OF NINE WEEK OLD BROILERS FED RATIONS CONTAINING 0, 5, 10, AND 15 PERCENT OF ADDED FAT AND STANDARD RATIONS EX 52 AND EX 54

Source of Variation	df	M.S.	F	
Replications	1			
Treatment	5	.000043	1.59	$P<.25$
Error	53	.000027		

TRIAL IV

Procedure

Six hundred broiler chicks were housed in a gas-heated, tile brooder house as described in trials two and three. Group weights without regard to sex and feed consumption were recoreded at 4, 5, 6, 7, and 8 weeks and individual weights on the ninth week.

The chicks were fed six experimental rations ad libitum. Rations (10-26) and (15-26) used in this trial were the same as those shown in Table II. The standard ration was Ex 54 as shown in Table XIV. Birds in treatment one were fed ration (10-26) throughout the nine week trial. Birds in treatment two received ration (15-26) throughout the nine week trial. Birds in treatment three were fed ration (10-26) for six weeks and ration (15-26) for the remainder of the nine week trial. Birds in treatment four received Ex 54 throughout the nine week trial. Birds in treatment five received Ex 54 for six weeks and ration (10-26) for the remainder of the nine week trial. Birds in treatment six were fed Ex 54 for six weeks and ration (15-26) for the remainder of the nine week trial. The treatments were randomly assigned to lots as described in trials two and three. A graphic illustration of the treatment combinations is shown in Table XXXII.

TABLE XXXII

TRIAL FOUR - TREATMENT COMBINATION

Treatment / Week	1	2	3	4	5	6
1	(10-26)	(15-26)	(10-26)	Ex 54	Ex 54	Ex 54
2	"	"	"	"	"	"
3	"	"	"	"	"	"
4	"	"	"	"	"	"
5	"	"	"	"	"	"
6	"	"	"	"	"	"
7	"	"	(15-26)	"	(10-26)	(15-26)
8	"	"	"	"	"	"
9	"	"	"	"	"	"

Results, Trial IV

The change to the finisher rations did not affect the growth pattern established prior to their use in the trial, as shown in Tables XXXII, XXXIV, and XXXV. The broilers fed the (15-26) finisher ration throughout the trial made the greatest gains during the trial and had the best feed conversion after the fifth week of all broilers in the trial. Broilers fed rations (10-26) and (15-26) did not make as good gains after the fourth week as broilers fed ration (10-26) throughout the trial. However, the broilers fed rations (10-26) and (15-26) had an improved feed conversion by the end of the trial over those fed ration (10-26) throughout the trial.

Broilers receiving the Ex 54 and (10-26) rations made slightly better gains by the end of the trial than those fed Ex 54 throughout the trial. Except for the fifth week, broilers fed the Ex 54 and (15-26) rations made

the poorest gains of all birds in the trial. Broilers fed Ex 54 plus the finisher rations had better feed conversions after the fifth week than those receiving Ex 54 throughout the trial.

Broilers fed the (15-26) finisher ration throughout the trial or as a finisher did not deposit carcass fat as well as those fed the other rations used in the trial. The change to the (15-26) ration appeared to reduce carcass fat deposition. Broilers fed ration (10-26) throughout the trial or as a finisher had the greatest deposition of carcass fat of all broilers in the trial.

TABLE XXXIII

TRIAL FOUR - CUMULATIVE BODY WEIGHT GAINS OF BROILERS FROM FOUR TO NINE WEEKS OF AGE, IN POUNDS

Week Rations	4	5	6	7	8	9
10-26	.816	1.193	1.526	1.941	2.414	2.913
15-26	.878	1.287	1.650	2.075	2.549	3.079
10-26 15-26	.820	1.176	1.466	1.916	2.312	2.875
Ex 54	.756	1.126	1.490	1.860	2.301	2.801
Ex 54 10-26	.751	1.060	1.462	1.839	2.300	2.826
Ex 54 15-26	.734	1.072	1.403	1.835	2.269	2.790

TABLE XXXIV

TRIAL FOUR - CUMULATIVE BODY WEIGHT OF BROILERS FROM FOUR TO NINE WEEKS OF AGE, IN POUNDS

Weeks / Rations		4	5	6	7	8	9
10-26		.906	1.287	1.617	2.031	2.505	3.004
15-26		.964	1.373	1.737	2.161	2.636	3.166
10-26	15-26	.908	1.265	1.554	2.005	2.401	2.964
Ex 54		.848	1.218	1.582	1.952	2.393	2.893
Ex 54	10-26	.843	1.151	1.553	1.930	2.392	2.918
Ex 54	15-26	.823	1.161	1.492	1.924	2.358	2.879

TABLE XXXV

TRIAL FOUR - CUMULATIVE FEED CONVERSIONS OF BROILERS FROM FOUR TO NINE WEEKS OF AGE, IN POUNDS OF FEED PER POUND OF GAIN

Week / Rations		4	5	6	7	8	9
10-26		1.54	1.74	1.92	2.07	2.22	2.36
15-26		1.59	1.76	1.91	2.05	2.17	2.29
10-26	15-26	1.72	1.87	2.07	2.18	2.34	2.34
Ex 54		1.93	2.11	2.23	2.39	2.52	2.59
Ex 54	10-26	1.96	2.12	2.15	2.27	2.41	2.46
Ex 54	15-26	1.97	2.08	2.23	2.30	2.39	2.47

TABLE XXXVI

TRIAL FOUR - MEAN SPECIFIC GRAVITIES OF NINE WEEK OLD BROILERS FED FINISHER RATIONS VS NON FINISHER RATIONS

Ration	10-26	15-26	(10-26)15-26)	Ex 54	Ex 54(10-26)	Ex 54(15-26)
Specific Gravity	1.0615	1.0640	1.0633	1.0639	1.0622	1.0658

The data in Tables XXXVII and XXXVIII indicate that the use of finisher rations reduce the amount of net income after feed cost. In each treatment where a finisher ration was used, there was less return over feed cost in comparision to non-finisher treatments.

The inconsistency of the data and poor design of the trial make it impossible to draw any definite conclusions as to the use of fat in finisher rations. At study in which more fat levels are used and more attention is given to protein requirements probably would give more conclusive evidence for or against the use of fat in finisher rations.

TABLE XXXVII

TRIAL FOUR - FEED CONSUMPTION, COST AND RETURN OVER FEED COST, NINE WEEK AVERAGE WEIGHTS, AT DIFFERENT PRICE LEVELS

Rations	Feed Consumption	Feed Cost	Live Price, Cents Per Pound				
			18	19	20	21	22
	lbs.	cwt	cents per bird				
10-26	6.89	5.71	14.6	17.6	20.6	23.6	26.6
15-26	7.06	6.04	14.4	17.5	20.7	23.9	27.1
10-26 15-26	6.91	5.88	12.5	15.5	18.4	21.4	24.4
Ex 54	7.28	5.00	15.6	18.5	21.4	24.2	27.1
Ex 54 10-26	6.93	5.36	15.2	18.1	21.0	23.9	26.9
Ex 54 15-26	6.88	5.52	13.5	16.4	19.3	22.2	25.0

TABLE XXXVIII

TRIAL FOUR - FEED CONSUMPTION, COST AND RETURNS OVER FEED COST FOR THREE POUND BROILER, AT DIFFERENT PRICE LEVELS

Rations	Feed Consumption	Feed Cost	Live Price, Cents Per Pound				
			18	19	20	21	22
	lbs.	cwt	cents per bird				
10-26	6.75	5.71	15.4	18.4	21.4	24.4	27.4
15-26	6.53	6.04	14.5	17.5	20.5	23.5	26.5
10-26 15-26	6.98	5.88	12.9	15.9	18.9	21.9	24.9
Ex 54	7.53	5.00	16.3	19.3	22.3	25.3	28.3
Ex 54 10-26	7.13	5.36	15.7	18.7	21.7	24.7	27.7
Ex 54 15-26	7.17	5.52	14.4	17.4	20.4	23.4	26.4

DISCUSSION

This study confirmed in general the work reported by Combs et al. Donaldson et al, Yacowitz, Sunde, Carver et al., and others.

The addition of fat at low levels to high protein diets inhibited growth and feed efficiency. When low levels of fat were added to low protein rations there was an improvement in feed conversion and a slight increase in growth rate. The greatest benefit derived from the addition of low levels of fat was improved feed utilization.

High levels of fat can be added to balance rations containing high levels of protein by maintaining recommended C/P ratios. Birds fed 24 and 26 percent protein diets made better gains when 10 percent fat was added to the diet.

The addition of 15 percent fat to high protein diets resulted in the best feed conversion. When 15 percent of fat was added to the high protein rations used in this study, there was a reduction in rate of growth. Feed conversion was improved by each five percent increase in added fat.

In summer weather, broilers fed standard rations made as good gains as those fed rations to which fat had been added. Feed conversion was improved by the addition of fat to broiler rations during the summer, but rate of growth was much slower than in cool weather. The ability of added fat in broiler rations to improve growth rate was better expressed during the winter, but feed conversion was much better during the summer. Broilers fed ration Ex 54 made their best gains and feed conversions in the

summer, while those fed ration Ex 52 did their best in the winter. Ex 54 contained 23 percent of protein and Ex 52 contains 22 percent of protein. The ability of one ration to express itself better in one season of the year than another indicated that nutrient requirements may be different from one season to another.

There was no significant difference in the amount of carcass fat deposited by broilers fed added fat rations or standard high energy rations. A slight improvement in carcass fat deposition was obtained when high levels of fat were added to broiler rations. Broilers fed low levels of fat or standard rations deposited carcass fat in about equal amounts.

The addition of fat, as an energy source, to broiler rations has resulted in better feed utilization and greater rate of growth. These advances have not come without increased costs per unit of feed. This increased cost is not due to fat alone, but to higher protein requirements as well. High levels of protein are necessary to obtain the greatest benefit from added fat; this in turn increases the cost of feed.

As the fat and the protein levels were increased, the major portion of the increased cost was protein. For each 5 percent increase in fat, when the protein level was kept constant, the feed cost was increased by 33 cents per cwt. This was the net cost of fat after the replacement value of the corn had been subtracted from the total value of the fat. When fat was increased 5 percent and protein was increased 2 percent, the increased cost due to fat was nine cents and protein was forty cents. The increased cost from ration (0-22) to ration (5-22), due to fat alone, was thirty-three cents. The increased cost from ration (0-22) to ration (10-24), due to fat, was forty-two cents and due to protein was forty cents. As the fat and protein levels were increased from (0-22) to (15-26) the increased cost due to fat was fifty-one cents and that due to protein was eighty cents.

To establish some economic input and output comparisons between the rations used in this study the following assumptions were made: 1. the calculated feed cost was representative of the actual cost of the feed, 2. the live weight price of broilers was 18, 19, 20, 21, and 22 cents per pound. Using these assumptions and the average weight and feed consumption data obtained during each trial a net return per bird over feed cost was calculated.

The net returns per bird shown in Tables XXXIX, XL, and XLI indicate that in each trial broilers fed one of the non-added fat rations gave the greatest returns over feed cost to the producer. In trial one the differences in labor income for ration (0-22) and the other rations in the trial ranged from one to seven cents per bird. Ration Ex 52 gave the greatest labor income in trials two and three with the differences ranging from twenty-nine to eighty cents and twenty-two to sixty-two cents per bird, respectively. In trial one this could mean ten to seventy dollars additional income per thousand broilers. Similar figures for trial three would be twenty-two to sixty-two dollars additional labor income per thousand broilers sent to market. Comparing this data from trials two and three there is further information to indicate that the advantages of added fat in broiler rations is better expressed in cooler seasons of the year. The variation in returns over feed cost was greater in trial two than in trial three.

Because of changes in ration composition a valid comparison between trial one and the other trials can not be made. Trials two and three are identical except for season of the year and can be compared in all relationships. With the exception of the 18 cent live price level the returns

obtained in trial three were larger than those in trial two. This again substantiates the ability of added fat to better express its advantages in cool weather.

For those who may sell their broilers on a live weight basis rather than at a given age, these data were interpolated and extrapolated to bring all broilers to a common three pound average weight. These data are presented in Tables XLII, XLIII, and XLIV. This interpretation of the data changed the relative positions of some rations in regard to labor income but did not effect the position of the non-added fat rations. When the range of net returns within each trial are compared, trials one and two are seen to have a narrower spread than trial three.

The comparison of the three pound average weight returns with the nine week average weight returns indicates that selling on a weight basis will give equal or greater returns than selling at a given age. For example, selling those broilers fed ration (0-22) in trial one at a three pound average weight, returns to the producer would have been increased by 1.2 cents per bird. This would amount ot twelve dollars additional labor income per thousand broilers. For ration Ex 52 in trial two, this would amount to thirty-nine dollars and in trial three, twelve dollors additional income per thousand broilers sold.

From this data it can be concluded that by proper management of feeding and marketing habits a broiler producer can affect the returns received from his broiler operation.

TABLE XXXIX

TRIAL ONE - FEED CONSUMPTION, COST AND RETURN OVER FEED COST, NINE WEEK AVERAGE WEIGHTS, AT DIFFERENT LIVE PRICE LEVELS

Ration	Feed Consumption	Feed Cost	Live Price, Cents Per Pound 18	19	20	21	22
	lbs.	cwt	cents per bird				
0-22	8.03	4.73	15	18	21	24	27
0-24	8.08	4.89	12	15	18	21	24
5-22	7.25	5.06	14	17	20	22	25
5-26	7.08	5.38	10	13	16	18	21
10-22	6.12	5.39	11	13	15	18	20
10-24	7.48	5.55	12	15	18	21	24
10-26	7.39	5.71	13	16	19	22	25
15-24	6.86	5.88	13	16	19	22	25
15-26	6.95	6.04	13	16	19	22	25

TABLE XL

TRIAL TWO - FEED CONSUMPTION, COST AND RETURN OVER FEED COST, NINE WEEK AVERAGE WEIGHTS, AT DIFFERENT LIVE PRICE LEVELS

Ration	Feed Consumption	Feed Cost	Live Price, Cents Per Pound 18	19	20	21	22
	lbs.	cwt.	cents per bird				
0-22	5.88	4.73	14.6	17.0	19.3	21.7	24.1
5-22	5.96	5.27	13.0	15.5	18.0	20.4	22.9
10-24	5.79	5.83	11.4	13.9	16.4	18.9	21.4
15-26	5.41	6.08	10.4	12.9	15.3	17.7	20.1
Ex 52	5.86	4.50	18.2	20.7	23.2	25.7	28.1
Ex 54	6.12	5.00	15.3	17.8	20.4	22.9	25.5

TABLE XLI

TRIAL THREE - FEED CONSUMPTION, COST AND RETURN OVER FEED COST, NINE WEEK AVERAGE WEIGHTS, AT DIFFERENT LIVE PRICE LEVELS

Ration	Feed Consumption	Feed Cost	Live Price, Cents Per Pound				
			18	19	20	21	22
	lbs.	cwt.	cents per bird				
0-22	7.54	4.73	15.8	18.6	21.5	24.4	27.3
5-22	7.56	5.27	14.9	17.9	20.9	24.0	27.0
10-24	7.34	5.83	13.2	16.3	19.4	22.5	25.6
15-26	7.09	6.08	11.8	14.8	17.9	20.9	24.0
Ex 52	7.88	4.50	18.0	20.9	23.9	26.9	29.8
Ex 54	7.50	5.00	14.7	17.6	20.5	23.4	26.3

TABLE XLII

TRIAL ONE - FEED CONSUMPTION, COST AND RETURN OVER FEED COST FOR THREE POUND BROILERS, AT DIFFERENT LIVE PRICE LEVEL

Ration	Feed Consumption	Feed Cost	Live Price, Cents Per Pound				
			18	19	20	21	22
	lbs.	cwt.	cents per bird				
0-22	7.99	4.73	16.2	19.2	22.2	25.2	28.2
0-24	8.20	4.89	13.9	16.9	19.9	22.9	25.9
5-22	8.07	5.06	13.2	16.2	19.2	22.2	25.2
5-24	7.80	5.22	13.3	16.3	19.3	22.3	25.3
5-26	7.93	5.38	11.3	14.3	17.3	20.3	23.3
10-22	7.91	5.39	11.4	14.4	17.4	20.4	23.4
10-24	7.21	5.55	13.9	16.9	19.9	22.9	25.9
10-26	7.01	5.71	13.9	16.9	19.9	22.9	25.9
15-24	6.69	5.88	14.6	17.6	20.6	23.6	26.6
15-26	6.62	6.04	14.0	17.0	20.0	23.0	26.0

TABLE XLIII

TRIAL TWO - FEED CONSUMPTION, COST AND RETURN OVER FEED COST FOR THREE POUND BROILERS AT DIFFERENT LIVE PRICE LEVELS

Ration	Feed Consumption	Feed Cost	Live Price, Cents Per Pound 18	19	20	21	22
	lbs.	cwt.	cents per bird				
0-22	7.55	4.73	18.2	21.2	24.2	27.2	30.2
5-22	7.21	5.27	16.0	19.0	22.0	25.0	28.0
10-24	6.91	5.83	13.7	16.7	19.7	22.7	25.7
15-26	6.95	6.08	11.7	14.7	17.7	20.7	23.7
Ex 52	7.08	4.50	22.1	25.1	28.1	31.1	34.1
Ex 54	8.36	5.00	13.2	16.2	19.2	22.2	25.2

TABLE XLIV

TRIAL THREE - FEED CONSUMPTION, COST AND RETURN OVER FEED COST FOR THREE POUND BROILERS AT DIFFERENT LIVE PRICE LEVELS

Ration	Feed Consumption	Feed Cost	Live Price, Cents Per Pound 18	19	20	21	22
	lbs.	cwt.	cents per bird				
0-22	7.88	4.73	16.7	19.7	22.7	25.7	28.7
5-22	7.31	5.27	15.4	18.4	21.4	24.4	27.4
10-24	6.84	5.83	14.1	17.1	20.1	23.1	26.1
15-26	6.73	6.08	13.1	16.1	19.1	22.1	25.1
Ex 52	7.73	4.50	19.2	22.2	25.2	28.2	31.2
Ex 54	7.66	5.00	15.7	18.7	21.7	24.7	27.7

This study indicated that the addition of fat to broiler rations was not economically practical under the present conditions. Producers could make a wider net profiet over feed cost with standard high energy rations. The gains and feed efficiency resulting from the addition of fat were not large enough to increase the income after feed cost.

Basic knowledge of energy-protein relationships in broiler rations is too incomplete to say that the addition of fat as an energy source will never be profitable. The availability of fat has made more energy available in poultry rations to utilize higher levels of protein more efficiently. Additional work needs to be done to establish the levels of fat and protein which will give maximum feed efficiency and rate of growth.

SUMMARY AND CONCLUSIONS

A study was made of the economic effect of added fat in broiler rations. Four trials were conducted to measure the influence of climatic conditions on the use of added fat. Rations were formulated using 0, 5, 10, and 15 percent of added fat at protein levels ranging from 21 to 26 percent. These rations were fed broiler chicks for a nine week period. The birds were weighed and feed consumption was measured at regular intervals.

At the end of each nine week trial, a sample from each lot was slaughtered and specific gravity measurements taken to estimate carcass fat deposition.

Net returns over feed cost were calculated from the body weight and feed consumption measurements.

The conclusions resulting from these data are as follows:

1. From the standpoint of adding fat to a broiler ration, each 5 percent increase in fat improved feed efficiency.
2. In 22 percent protein rations the addition of 5 percent of fat improved feed efficiency.
3. In 24 and 26 percent protein rations 5 percent of added fat inhibited growth and feed efficiency.
4. In 24 and 26 percent protein rations the addition of 10 percent of fat produced the greatest increase in growth rate.
5. In 24 and 26 percent protein rations the addition of 15 percent of fat resulted in a slight reduction in growth rate.

6. Ten and 15 percent added fat levels give a slight improvement in carcass quality.
7. The increased growth and feed efficiency resulting from added fat are better expressed in the cool seasons of the year.
8. Under present conditions it is not economically practical to add fat to broiler rations.
9. Protein represents fifty percent or more of the increased cost of added fat rations.
10. Under Oklahoma conditions, a good high energy ration will give more profit to the producer than one containing added fat.

BIBLIOGRAPHY

Aitken, J.R., G.S. Sunblad, and U.G. Hundsaker, 1954. Beef tallow as a source of energy in broiler rations. Poultry Sci. 33:1038, Abstract.

Biely, J., and B. March, 1954. Fat studies in poultry. 2. Fat supplements in chick and poultry rations. Poultry Sci. 33:1220-1227.

Bird, H.R., 1954. Role of animal fats in poultry nutrition. Feedstuffs 26(2):30-32, 54-55, 57-58.

Carver, D.S., E.E. Rice, R.E. Gray, and P.E. Mone, 1955. The utilization of fats of different melting points added to broiler feeds. Poultry Sci. 34:544-546.

Donaldson, W.E., G.F. Combs, and G.L. Romoser, 1956. Studies on energy levels in poultry rations. 1. The effect of calorie-protein ratio of the ration on growth, nutrient utilization, and body composition of chicks. Poultry Sci. 35:1100-1105.

Fraps, G.S., 1943. Relation of the protein, fat, and energy of the ration to the composition of chickens. Poultry Sci. 22:421-424.

Harms, R.H., May, 1957. Proper nutrition increases broiler meat yields. Poultry Processing and Marketing, pp. 10, 28.

March, B.E. and J. Biely, 1954. The nutritive value of fats of different origin in chick starters. Poultry Sci. 33:1069, Abstract.

March, B.E. and J. Biely, 1956. Fat studies in Poultry. 5. The effect of dietary fat level on the choline requirement of the chick. Poultry Sci. 35:545-549.

Rice, E.E., P.E. Mone, R.E. Gray, R.G. Holleman, jr., and J.F. Beuk, 1954. The value of fats as a feedstuff. Jour. Amer. Oil Chemists Soc. 31:56-59.

Runnels, T.D., 1954. The value of animal fat in combination with various other ingredients in broiler rations. Poultry Sci. 33:1090, Abstract.

Siedler, A.J. and B.S. Schweigert, 1953. Effect of feeding graded levels of fat with and without choline and antibiotic B_{12} supplements to chicks. Poultry Sci. 32:449-454.

Siedler, A.J., H.E. Scheid, and B.S. Schweigert, 1955. Effect of different grades of animal fats on the performance of chicks. Poultry Sci. 34:411-414.

Sunde, M.L., 1954. The effects of fats and fatty acids on feed conversion in chicks. Poultry Sci. 33:1084, Abstract.

Sunde, M.L., 1956. Relationship between protein level and energy level in chick rations. Poultry Sci. 35:350-354.

Yacowitz, H., 1953. Supplementation of corn-soybean oil meal rations with penicillin and various fats. Poultry Sci. 32:930, Abstract.

VITA

Dan G. Bigbee

Candidate for the Degree of

Master of Science

Thesis: THE ECONOMIC EFFECT OF ADDED FAT IN BROILER RATIONS

Major Field: Poultry Marketing

Biographical:

Personal data: Born in Walters, Oklahoma, April 16, 1930, son of Daniel C. and Maggie Lou Bigbee.

Education: Graduated in 1948 from Walters High School, Walters, Oklahoma; received the Bachelor of Science degree from Oklahoma Agricultural and Mechanical College, with a major in Poultry Husbandry, in May, 1956; completed the requirements for the Master of Science degree in September, 1957.

Experiences: Instructor, Infantry School Detachment, Fort Benning, Georgia, Army, February, 1952 to May, 1953; Graduate teaching assistant in Poultry Husbandry, February, 1956 to February, 1957; Research assistant in Poultry Marketing, February, 1957 to September, 1957.

Organizations: Spur and Comb; Alpha Zeta; Phi Sigma; Aggie Society; National Collegiate Poultry Club.