NUTRITIONAL STUDIES WITH CAGED TURKEY BREEDERS

By

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (Continued)

CHAPTER I

INTRODUCTION

One of the most serious economic problems confronting the commercial turkey producer is the high cost of the day-old poult. Poult cost represents approximately 20 percent of the total production cost of market and breeder turkeys. A reduction in poult cost would immediately bring about a significant reduction in overall production cost and increase present profit margins.

A recent innovation in management systems for turkey breeders is the housing of turkey breeder hens in cages. This management system is being used at the present time in Europe and South America. The reasoning upon which this management system is based has been to develop a strain of turkey breeder hens which are adapted to a cage environment and possess a high potential for egg production. These hens are relatively small (6 to 10 pounds) and bred to lay 110 to 150 eggs per hen per year. Small body size makes it possible for these hens to be more efficient in the conversion of feed into eggs than those turkey breeder hens which have been used in the past. Since the breeder hens are housed in laying cages, artificial insemination has to be used to produce fertile hatching eggs. The breeder toms used to produce semen average between 35 and 45 pounds each, and contribute body size as well as other market characteristics which are present to only a limited degree in the breeder hen line(s).

Many difficulties have been encountered in the housing of turkey breeder hens in laying cages. Some of these problems have been mechanical including leg weakness and the inability to adapt to a cage environment. Nutritional problems have received little attention. Very little data are available on the role of dietary nutrients in determining feed and nutrient intake when the turkey breeder hens are maintained in a cage environment. Without basic knowledge of this kind it is difficult to formulate breeder rations which will permit turkey breeder hens to express their full inherent potential for egg production.

The basic objectives of this experiment were to determine with caged turkey breeder hens the effect of dietary energy on feed, and energy intakes, and the subsequent effects upon egg production, egg weight, body weight changes, and reproductive performance.

CHAPTER II

REVIEW OF LITERATURE

Very little data have been reported in the scientific literature pertaining to the nutrient intake requirements of turkey breeder hens, or the effect of dietary energy (kilocalories of metabolizable energy in estimated dietary weight) on feed consumption and nutrient intake. This is true of turkey breeder hens maintained either on the floor or in laying cages. Current data on feed consumption, protein and energy requirements, and the effect of dietary energy and dietary protein on feed consumption and nutrient intakes are summarized in the following discussion.

Feed Consumption

It is essential in the formulation of poultry diets that an accurate estimate of daily feed intake (grams per bird per day) be available to the nutritionist. Poultry diets are formulated on a daily intake basis involving both feed and nutrients, and all of the nutrients necessary for maximum performance must be contained in the daily feed intake. When this formulating system is followed, variation in daily feed intake can determine the nutrients the bird actually consumes per day.

The discussion on feed consumption which follows considers two types of turkey breeder hens. The broad breasted variety which is a

medium to large type turkey, and the mini-hen line (six to ten pounds). The data which pertain to the mini-hen line will provide a better estimate of daily feed intake for the type of turkey breeder hen used in the feeding trial report herein.

Holder (1970) conducted a feeding trial with turkey breeder hens (medium size) to study some of the nutritional requirements of caged turkey breeders. He reported that during these trials average daily feed intake for hens in individual laying cages was approximately 210 grams per hen per day.

Wolford, et. al. (1962), studied the effects of lights on Broad Breasted Bronze hens housed in individual laying cages. He stated that during the experiment the hens consumed an average of 220 grams of feed per hen per day.

Atkinson, et. al. (1967), ran trials with Broad Breasted Bronze and Broad Breasted White hens to study the calcium requirements of breeder turkeys. The average feed consumption during these trials with hens maintained in individual laying cages was approximately 220 grams per hen per day.

In another experiment, Wolford, et. al. (1963), studied individual feed consumption of turkey breeder hens. These research workers used two varieties of turkeys, Beltsville Small White and Broad Breasted Bronze, which were housed in individual laying cages. They reported a daily feed intake of 130 ± 22 grams per hen per day for Beltsville Small White, and 236 ± 54 grams per hen per day for the Broad Breasted Bronze turkey breeder hens. During Trial Two of this experiment, these daily feed intakes were observed: 261 ± 53 and 141 ± 27 grams per hen per day for the Broad Breasted Bronze and Beltsville Small White, respectively.

Ferguson, et. al. (1961), conducted a trial with Beltsville Small White turkey hens to study a B-Vitamin deficiency in mature turkey breeder hens. These turkey breeder hens were reared to maturity on wire floors, and then placed in individual laying cages. An average feed intake of 110 grams per hen per day was reported for the feeding trial.

Energy Level

It has been reported in the scientific literature that chickens eat to meet a specific energy requirement which is dependent upon a number of factors. This tendency to equilibrate energy intake is accomplished irrespective of dietary energy level. The specific energy requirement is expressed in terms of kilocalories of metabolizable energy as contained in estimated dietary weight.

Among the factors which determine this specific energy requirement are the age of the bird, size of the bird, stage of egg production, and the environmental situation involved. All of these factors and others which are related to the actual availability of the dietary nutrients contained in the diet, will influence specific energy requirement.

If turkey breeder hens follow a similar pattern of energy intake, it becomes essential that a valid estimate of this energy requirement be made before adequate diets can be formulated. In this situation, energy intake regulates the intake of other nutrients. The actual intake of nutrients other than energy is determined by energy to nutrient ratios. Therefore, a poor estimate in terms of specific

energy requirements could lead to other nutritional deficiencies such as inadequate protein intake.

Robble and Clandinin (1959) reported that average daily feed consumption of turkey breeder hens was little effected by variations in the energy level of the ration. This report indicates that turkey breeder hens do not eat to fulfill an energy requirement, and that dietary energy level has little effect on feed consumption.

Dymsza, Bourcher and McCartney (1954) fed a series of diets which contained graded energy levels ranging from 249 to 880 kilocalories of productive energy per pound. In this study it was found that breeder hens which consumed a diet with a high concentration of energy had a greater calorie intake than those hens fed a diet with a low concentration of energy.

Protein Level

In the formulation of poultry diets, it is imperative that the diet contain an adequate level of protein. Some of the factors which influence the actual protein intake requirement of poultry are: the type of bird, environment, and stage of egg production. Another critical factor which is directly related to the protein intake requirement is protein quality. This term is used to describe the kinds and amounts of essential amino acids which are contained in each gram of protein. Poultry nutritionists balance diets for 18 of the amino acids which have been found to be essential for adequate poultry nutrition. These amino acids must be provided in the diet in proper amounts before maximum productivity from the bird can be achieved.

The need for this accurate estimate of protein intake has been verified in the scientific literature. It has been reported that when diets which contain equivalent energy levels are fed to poultry, those which contain low levels of protein are consumed at a level above normal feed intake. The degree to which feed intake will be increased to meet protein intake requirements is determined by dietary energy level and actual energy intake requirement. These data demonstrate the necessity to have proper calorie to protein ratios in poultry diets if actual protein intake is to meet intake standards.

Holder (1970) reported that turkey breeder hens ate to meet an energy requirement (or some other limiting nutrient factor), and in so doing, restricted protein consumption. Therefore, if this is true, calorie protein ratios should be a major concern in feed formulation.

Anderson (1964) conducted feeding trials using large white females. He used two levels of metabolizable energy and five protein levels. With the lowest dietary protein level, there was a slightly higher average feed and energy consumption than was obtained in the other treatments. This indicates that when high dietary levels of energy are fed protein intake may become a limiting factor. He also found that hens which were fed the high protein-high energy diet consistently consumed less feed than was observed with the hens on the other treatments.

In a second trial, Anderson used the same experimental design with Jersey Buff females and found that an increase in the metabolizable energy level in the diet did result in a significant decrease in feed intake, whereas actual energy consumption remained essentially the same. This work indicates that either energy or protein may become

the limiting factor with turkey breeder hens if careful attention is not given to calorie to protein ratio.

Jensen and McGinnis (1961) conducted experiments with large white breeder turkeys in which several levels of protein were fed. They found no significant effect on reproductive performance due to protein level even when a protein level of 10 percent was fed.

Atkinson, et. al. (1960), ran studies with Broad Breasted Bronze turkey hens fed practical-type laying rations. They reported that maximum egg production and the most efficient feed conversion were obtained with turkey breeder diets which contained 22 percent protein.

Carter, et. al. (1957), found that fertility and hatchability were slightly better when a dietary protein level of 18 percent was used. They compared 16 and 18 percent protein in combination with productive energy levels of 800, 900, and 1,000 calories per pound.

Calcium Level

It is essential that the proper ratios exist between calcium and the other minerals in a poultry diet if mineral metabolism is to proceed at a satisfactory rate. Any imbalance in ratio could lead to severe mineral deficiencies of one kind or another. These deficiencies will be exaggerated in situations where calcium is in great demand, such as growth and egg production.

Problems in egg shell quality have been encountered with turkey breeder hens. These problems include misshaped eggs, a high number of cracked eggs, and a high occurrence of soft shelled eggs. The incidence of these abnormal shell conditions become more prevalent as the hens progress into the laying period. The reason for this

deterioration in egg shell quality is not well understood. Two of the explanations given are: (1) as genetic potential for egg production increases, calcium demands increase, therefore feeding standards are not adequate and need constant revision, and (2) the quality of calcium used in the diets varies in such a way that calcium deficiencies develop.

The following data summarize some of the most recent work reported in establishing calcium requirements for turkey breeder hens. It should be pointed out that these data do not provide actual daily calcium intake values.

Balloun, et. al. (1964), conducted trials with large white turkey hens housed in floor pens. They reported that calcium levels of both 1.5 percent and 3.0 percent depressed hatchability. It was also stated that the 3.0 percent calcium diet required more feed per egg produced. Hens which consumed diets containing 2.0 percent calcium had the best average hatchability.

Arends, et. al. (1967), ran studies with Broad Breasted White breeder hens which were randomly assigned to floor pens. They reported a decrease in hatchability with 3.0 percent calcium in the diet and highest hatchability was observed at a calcium level of 2.25 percent.

Jensen, et. al. (1964), conducted trials with Broad Breasted Bronze hens distributed in floor pens. They reported that 1.5 percent calcium is marginal for egg production. They also found that hatchability was not depressed by a level of 3.25 percent calcium.

CHAPTER III

EXPERIMENTAL PROCEDURES AND METHODS

General Procedure

This experiment consisted of a feeding trial conducted in the turkey cage laboratory on the Oklahoma State University Poultry Farm. The laboratory contains 144 individual wire cages which are arranged in four rows with thirty-six cages per row. Each cage is sixteen inches wide, thirty inches long, and thirty inches tall, and is equipped with an automatic waterer, feeder, and feed storage container. The individual feed storage containers make it possible to weigh the feed separately for each hen.

The building is equipped with four forced-air ventilators and four gas stoves for temperature and ventilation control. The laboratory is supplied with artificial light by incandescent lamps which are controlled by automatic time clocks.

The feeding trial began on February 12, 1971, and ran through May 25, 1971. The turkey breeder hens were thirty-six weeks old at the start of the experiment and fifty weeks old at its termination. The turkeys used in this experiment were small whites (mini-hen line) purchased from River Rest, Incorporated.

The turkeys were raised on the Oklahoma State University Poultry Farm. The females were maintained from day old until twenty-three weeks of age in floor pens on litter. At twenty-three weeks of age,

144 breeder hens were transferred into the turkey cage laboratory and placed in individual wire cages. The males used to provide semen for artificial insemination were obtained from River Rest, Incorporated, and were brought to Stillwater one month prior to the trial. They were maintained in individual pens, on litter, in a separate building throughout the experiment. All turkeys were fed the same diet until the feeding trial was initiated.

Lighting Schedule

Starting at twenty-three weeks of age, the breeder hens had a minimum of nine hours of light. Beginning at thirty-two weeks of age, the breeder hens were placed on fourteen hours of continuous light and ten hours of continuous darkness. The toms were placed on the same lighting schedule when they arrived in Stillwater. Both hens and toms remained on this lighting schedule for the remainder of the experiment.

Artificial Insemination

The hens were first artificially inseminated three days before the experiment began and every two weeks thereafter. Semen from two or more toms was pooled and diluted with commercial turkey semen extender before it was used to inseminate the hens.

Collecting, Storage and Incubation

Eggs were collected twice daily and placed in a refrigerator at a temperature of approximately 50°F. At the end of the day, all eggs were weighed, fumigated, and taken to the egg candling room in the Poultry Science Building on the Oklahoma State University Campus. The

eggs were held until the end of each seven-day period. They were then set in Jamesway Incubators and fumigated again. Eggs were candled and fertile eggs transferred to hatching trays at twenty-four days of incubation. The eggs which appeared clear under the candle were not transferred and were broken out and checked for early embryonic mortality.

Experimental Diets

Three experimental diets were fed during this trial, with each diet being fed to forty-eight breeder hens. Treatments were assigned randomly to the birds so that there would be six birds per diet for the eight block. The diets included three energy levels and one calorie to protein ratio. Arrangement of treatments is shown in Table I. Composition of the three diets used in this study are shown in Table II.

The three levels of energy used were 238, 274, and 310 kilocalories of metabolizable energy per 100 grams of diet for Levels 1, 2 and 3, respectively. The calorie to protein ratio used was 12.0 kilocalories of metabolizable energy per gram of protein.

In order to maintain the desired energy composition in the experimental diets, sand was used. Work done by Harman (1966) and Holder (1970) indicates that sand has no undesirable effects upon the performance of laying hens or caged turkey breeders.

Data Collection and Statistical Analysis

The feeding trial was divided into fourteen periods. Each period was seven days in length. Individual feed consumption data were collected at the end of each period. All hens were weighed individually at the beginning and at the end of the feeding trial. Egg production

TABLE I

ARRANGEMENT OF TREATMENTS

Energy Level Kilocalories per 100 grams		Calorie to Protein Ratio 12:1 (Kilocalories per gram of Protein)
Level (1)	238	Diet 1
Level (2)	274	Diet 2
Level (3)	310	Diet 3

TABLE II

PERCENTAGE COMPOSITION OF EXPERIMENTAL TREATMENT

Ingredient	Treatments		
	Diet 1	Diet 2	Diet 3
		Percent	
Milo	36.42	44.95	27.27
Oats	15.60	5.00	--
Soybean Oil Meal	18.16	22.30	28.22
Meat and Bone Scrap (50%)	4.19	5.14	6.51
Blood Meal (80%)	2.79	3.43	4.34
Corn Gluten	2.79	3.43	4.34
Alfalfa Meal (17%)	1.39	1.71	2.17
Whey, dried	1.39	1.71	2.17
Yeast Culture	1.39	1.71	2.17
dl-Methionine	0.14	0.17	0.22
Tallow	--	2.49	13.84
VMC-60[a]	0.43	0.50	0.56
Salt	0.43	0.50	0.56
Dicalcium Phosphate	2.63	3.02	3.36
Calcium Carbonate	4.09	3.94	4.27
Sand	8.16	--	--
Total	100.00	100.00	100.00

[a]See Table III.

TABLE III

COMPOSITION OF VMC-60

Vitamins and Minerals	Units	Adds per lb. of Finished Ration
Vitamin A	U.S.P.	8,000
Vitamin D_3	I.C.U.	1,200
Vitamin E	I.U.	6
Vitamin K	Mg.	3
Vitamin B_{12}	Mg.	0.008
Riboflavin	Mg.	4
Niacin	Mg.	32
Pantothenic Acid	Mg.	8
Choline Chloride	Mg.	500
Manganese	Mg.	27.7
Iodine	Mg.	0.86
Cobalt	Mg.	0.59
Iron	Mg.	21.8
Copper	Mg.	1.65
Zinc	Mg.	22.7

was recorded daily, and all eggs were weighed individually. A record of fertile eggs and poults hatched for each individual hen for each period was kept.

Analysis of variance was calculated for each experimental period using the method developed by Barr and Goodnight at North Carolina State University. The following responses were involved in the analyses: feed consumption, calcium consumption, body weight change, egg production (number of eggs laid, average egg weight, percent egg production), reproductive performance (percent fertile eggs, hatch of eggs set, hatch of fertile eggs, poults hatched), and uniformity trial. In the analysis of variance tables, the term treatment represents three energy levels, each of which involved an equivalent 12 to 1 calorie to protein ratio. Error A is the table x treatment, side x treatment, table x side x treatment, end x treatment, table x end x treatment, side x end x treatment, and table x side x end x treatment sum of squares and is used to test for treatment difference. Error B is period x table, period x side, period x table x side, period x end, period x table x end, period x side x end, and period x table x side x end sum of squares and is used to test effects due to period. Error C is period x table x treatment, period x side x treatment, period x table x end x treatment, period x side x end x treatment, period x table x end x treatment, and period x table x side x end x treatment. Only F values greater than one were placed in the tables.

CHAPTER IV

RESULTS AND DISCUSSION

The results of this experiment will be presented and discussed with respect to the data from individual periods under separate headings designated by each of the following responses: feed consumption, energy consumption, protein consumption, calcium consumption, body weight change, egg production (number of eggs laid, average egg weight, percent egg production) reproductive performance (percent fertile eggs, hatch of eggs set, hatch of fertile eggs, poults hatched) and uniformity trial (Tables IV through XXVII).

Feed Consumption

Feed consumption varied from a low of 109 grams per hen per day to a high of 132 grams per hen per day. Mean values for feed consumption are presented for each treatment by period in Table IV. The overall mean for feed consumption was 118.4 grams per hen per day. This figure is in agreement with those presented by Ferguson, et. al. (1961), for Beltsville Small White turkey hens housed in individual laying cages. They reported an average feed consumption of 110 grams per hen per day.

The statistical analysis of the feed consumption data shows that treatment had a significant effect ($P < .01$) on daily feed intake (Table V). The turkey hens fed the low energy diet (Diet 1) had a

TABLE IV

AVERAGE FEED CONSUMPTION IN GRAMS
PER HEN PER DAY BY PERIOD

Treatment (Diet)	Period														General Mean
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1	62	102	112	139	140	134	145	135	159	127	152	131	146	138	132
2	46	94	90	115	125	109	138	121	137	116	135	121	130	131	114
3	59	100	96	125	116	101	125	117	122	105	124	108	118	125	109

TABLE V

ANALYSIS OF VARIANCE FOR GRAMS
FEED CONSUMPTION

Source of Variation	df	MS	F
Treatment (Diet 1, 2, 3)	2	745,110.5816	16.61**
Error A	14	44,871.2887	
Period	13	587,029.7335	98.68**
Error B	91	6,060.4772	
Period x Treatment	26	13,624.9476	3.58
Error C	182	3,809.8921	

**Significant ($P < .01$)

significantly higher daily feed intake when compared to the other two energy levels. These data demonstrate that hens which consume diets with low levels of energy will increase daily feed intake to a level at which their energy intake requirement is met.

The daily feed intake for Diets 2 and 3 are in close agreement: 114 and 109 grams per hen per day, respectively. Based on the energy content of Diet 3, a daily feed intake of 100 grams per hen per day would be expected. The increase in expected daily feed intake (109 grams) which was observed led to an increase in daily energy consumption when compared to the other two diets. One explanation for this observation would be that the breeder hens have a minimum daily feed intake which is necessary to satisfy a need for volume. If this reasoning is sound, then care should be taken to have the nutrients required for maximum performance contained in a specific volume and weight of feed.

A significant difference ($P < .01$) was found due to period on daily feed intake (Table V). This response would be expected as daily feed intake increases with a rise in egg production. Egg production increased as the feeding trial progressed, so daily feed intake increased.

Energy Consumption

Means for average daily energy consumption are presented in Table VI. Energy consumption varied from a low of 312 kilocalories of metabolizable energy to a high of 339 kilocalories per hen per day. The overall mean for energy consumption was 321 kilocalories of metabolizable energy per hen per day.

TABLE VI

AVERAGE ENERGY CONSUMPTION IN KILOCALORIES
PER HEN PER DAY BY PERIOD

Treatment (Diet)	Period														General Mean
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1	148	243	267	331	334	320	372	321	378	303	362	313	348	329	312
2	125	257	246	315	342	298	379	332	375	318	370	331	356	359	312
3	182	310	296	388	359	312	387	362	376	324	384	335	365	387	339

There were no significant differences in energy consumption due to treatment (Table VII). These data indicate that turkey breeder hens eat toward a particular energy intake level. This indicates that the energy content of the diet will be the limiting factor for intake of other nutrients. This demonstrates the need for an accurate estimate of energy to nutrient ratios for the formulation of turkey breeder diets.

There was a statistically significant difference ($P < .01$) on energy consumption due to period (Table VII). This pattern would follow the variation in feed consumption by period as daily feed intakes determine intake of other dietary nutrients.

Protein Consumption

Protein consumption varied from a low of 26 grams of protein per hen per day to a high of 28 grams of protein per hen per day (Table VIII). The overall mean for protein consumption among the three diets was 27 grams per hen per day.

No significant differences in protein consumption are to be found due to treatment (Table IX). This response would be expected as the diets contained equivalent calorie to protein ratios and the turkey hens ate an equivalent amount of energy per day irrespective of dietary energy level.

There were significant differences ($P < .01$) for both periods and period x treatment on protein intake. The period x treatment interaction is difficult to explain and no apparent reasons can be given. The effect due to period has been explained in the discussion on both feed consumption and energy consumption.

TABLE VII

ANALYSIS OF VARIANCE FOR KILOCALORIES OF ENERGY CONSUMPTION

Source of Variation	df	MS	F
Treatment (Diet 1, 2, 3)	2	1,237,430.79	3.32
Error A	14	372,522.57	
Period	13	4,273,410.57	96.05**
Error B	91	44,491.36	
Period x Treatment	26	64,514.51	1.13
Error C	182	57,154.54	

**Significant ($P < .01$)

TABLE VIII

AVERAGE PROTEIN CONSUMPTION IN GRAMS
PER HEN PER DAY BY PERIOD

Treatment (Diet)	Period														General Mean
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1	12.3	20.3	22.3	27.7	27.9	26.7	31.1	26.8	31.6	25.3	30.2	26.1	29.1	27.5	26.0
2	10.5	21.4	20.6	26.3	28.6	24.9	31.7	27.8	31.4	26.6	30.9	27.6	29.8	30.0	26.0
3	15.2	25.9	24.8	32.4	30.0	26.1	32.4	30.3	31.5	27.1	32.1	28.0	30.5	32.3	28.0

TABLE IX

ANALYSIS OF VARIANCE FOR GRAMS
PROTEIN CONSUMPTION

Source of Variation	df	MS	F
Treatment (Diet 1, 2, 3)	2	8,846.3205	3.40
Error A	14	2,601.4912	
Period	13	29,821.0451	96.04**
Error B	91	310.5167	
Period x Treatment	26	449.5663	2.30**
Error C	182	195.4288	

**Significant ($P < .01$)

The daily protein intake figures from the feeding trial give some indication that adequate protein intake was achieved. Diet 3 supported body weight maintenance at a satisfactory level throughout the feeding trial (Table X). The other two diets failed to maintain body weight. The breeder hens fed Diet 3 consumed on the average two grams more protein per day per hen than did the hens fed Diets 1 and 2. This additional protein could have been the factor which led to increased efficiency in body weight maintenance.

Another trend which was not statistically significant was that breeder hens fed Diet 3 had better overall egg production and reproductive performance when compared to the hens fed Diets 1 and 2. This effect could be due to the additional daily protein and energy intakes observed with the breeder hens fed Diet 3.

Calcium Intake

It was noted in this particular feeding trial that egg shell quality and overall egg quality were excellent. The percent of cracked, misshaped, and soft shelled eggs was approximately two percent.

The amount of calcium consumed each day by the breeder hens was 3.53 grams per hen per day. This 3.53 grams represents a general mean for the three diets used in the feeding trial. Based on the actual daily feed intakes, this represents a three percent dietary level of calcium. This is above the 2.0 to 2.25 percent level recommended in the scientific literature for maximum hatchability.

TABLE X

AVERAGE BODY WEIGHT CHANGE IN GRAMS PER HEN
FOR THE ENTIRE EXPERIMENT

Treatment (Diet)	Grams Change
1	-115.59
2	- 12.11
3	+190.36

Body Weight Change

The average body weight changes in grams per hen for the entire feeding trial are presented in Table X. There was a significant difference ($P < .01$) due to treatment on body weight change (Table XI).

These data indicate that the breeder hens fed Diet 3 had higher daily energy and protein intakes and gained in body weight (191 grams). Although the breeder hens consumed equivalent amounts of daily protein and energy when fed Diets 1 and 2, a difference in body weight maintenance was observed. Diet 1 had an average loss of 116 grams per hen, while Diet 2 had an average loss of 12 grams per hen for the feeding trial. This difference could be attributed to the different energy sources of the diets. Diet 2 contained a low level of tallow to supplement the energy content of the diet. Sand was added to Diet 1 in order to regulate dietary weight and lower energy level. Perhaps the sand used in Diet 1 inhibited the normal digestive processes, and reduced the ability of the breeder hens to utilize feed nutrients.

An additional discussion of body weight maintenance will be presented in the section headed Uniformity Trial. Some interesting effects were noted due to location in the Turkey Cage Laboratory.

Egg Production

Number of Eggs Laid

The means for number of eggs laid per hen per period (one week) are presented in Table XII. The general mean for the number of eggs produced was 2.97 eggs per hen per week.

TABLE XI

ANALYSIS OF VARIANCE FOR BODY WEIGHT GAIN

Source of Variation	df	MS	F
Table	1	244,058.6054	2.58
Side	1	245,806.6523	2.60
Table x Side	1	14,027.3304	
End	1	10,153.9062	
Table x End	1	42,327.9942	
Side x End	1	23,775.4677	
Table x Side x End	1	40,325.6547	4.26
Treatment (Diet 1, 2, 3)	2	2,133,209.8540	11.28**
Error	119	11,249,520.7366	

**Significant ($P < .01$)

TABLE XII

AVERAGE NUMBER OF EGGS LAID PER
HEN PER WEEK BY PERIOD

Treatment (Diet)	Period													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	.64	2.20	3.58	4.10	4.29	4.18	2.33	3.50	3.31	3.34	2.81	2.62	2.11	1.95
2	.36	1.15	3.37	4.08	3.75	4.04	2.50	3.65	3.53	3.59	3.16	2.90	2.21	2.67
3	.43	1.47	3.71	4.80	4.21	4.09	2.51	3.52	3.57	3.59	3.63	3.42	2.44	2.62

There were no significant differences in number of eggs laid due to treatment (Table XIII). However, there was a significant difference ($P < .01$) due to period. This response would be expected as the breeder hens increase in rate of egg production as they moved along into the laying period. An interesting point is that period x treatment interaction is significant ($P < .01$) during the trial. This indicates that the treatments were not behaving the same way from period to period.

Average Egg Weight

There were no significant differences in average egg weight due to treatment or treatment x period (Table XIV). However, a significant difference ($P < .01$) was found due to period. This would be expected as the turkey breeder hens produce larger eggs as they progress into the laying period (Table XV).

The average egg weight varied from a low of 56.8 grams per egg to a high of 58.9 grams per egg. The general mean for average egg weight was 57.5 grams.

Percent Egg Production

There were no significant differences in percent egg production due to treatment. Significance ($P < .01$) was found due to both period and period x treatment interaction (Table XVI). The effect due to period is explained by the fact that as the period progressed, the breeder hens increased in egg production. The egg production peaked and was then followed by a gradual decline in egg production. Period x treatment interaction suggests that the treatments did not behave in the same manner from period to period.

TABLE XIII

ANALYSIS OF VARIANCE FOR NUMBER OF EGGS LAID

Source of Variation	df	MS	F
Treatment (Diet 1, 2, 3)	2	1.4821	
Error A	14	1.7200	
Period	13	27.1185	76.03**
Error B	91	.3567	
Period x Treatment	26	.5964	2.14**
Error C	182	.2785	

**Significant ($P < .01$)

TABLE XIV

ANALYSIS OF VARIANCE FOR
AVERAGE EGG WEIGHT

Source of Variation	df	MS	F
Treatment (Diet 1, 2, 3)	2	149.4047	
Error A	14	397.8385	
Period	13	5689.8027	67.21**
Error B	91	84.6595	
Period x Treatment	26	122.1348	1.50
Error C	182	81.3668	

**Significant ($P < .01$)

TABLE XV

AVERAGE EGG WEIGHT IN GRAMS
PER HEN PER EGG

Treatment (Diet)	Period													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	21.67	37.56	61.25	65.87	69.98	70.51	57.14	61.91	64.98	66.35	61.42	61.83	49.68	46.48
2	17.06	24.13	58.37	65.09	63.97	69.85	61.53	67.36	68.22	64.67	65.42	61.29	50.41	58.65
3	12.55	31.02	61.26	71.60	68.84	68.57	65.01	62.64	66.72	67.75	67.55	67.76	57.08	55.07

TABLE XVI

ANALYSIS OF VARIANCE FOR PERCENT EGG PRODUCTION

Source of Variation	df	MS	F
Treatment (Diet 1, 2, 3)	2	.0302	1.85
Error A	14	.0163	
Period	13	.5534	76.86**
Error B	91	.0072	
Period x Treatment	26	.0122	2.14**
Error C	182	.0057	

**Significant ($P < .01$)

The means for percent egg production are presented in Table XVII. The general mean for percent egg production was 42.5 percent.

Reproductive Performance

Percent Fertile Eggs

The general mean for percent fertile eggs was 39.2 percent. The table of means for percent fertile eggs per treatment per week is presented in Table XVIII. The low fertility observed during this feeding trial could be due to one of three factors. Daily protein intake during the feeding trial was below the anticipated level for turkey breeder hens. This low level of protein intake could have had an effect on fertility as protein in adequate amounts is essential for normal reproduction. Another factor which could have influenced reproductive performance was the number of turkey males available for collecting semen. As the feeding trial progressed, the number of males decreased from seven to four. It was very difficult to collect sufficient amounts of semen for proper dilution. From Period 6 until the termination of the trial, the amount of semen available for dilution was below that amount recommended for maximum fertility. Finally, the technique used during the insemination procedure will affect fertility. It is the opinion of the author that the amount of semen available, rather than the other two factors, was the main contributing factor toward the low reproductive performance observed during the feeding trial. This reasoning is substantiated by the means for percent fertile eggs presented in Table XVIII. During Periods 3-5 fertility began to approach the values generally found in the scientific literature. However, beginning with Period 6, fertility began to

TABLE XVII

PERCENT EGG PRODUCTION PER HEN PER WEEK

Treatment (Diet)	Period													
	1	2	3	4	5	6	7	8	9	10	11	12	13	**14**
1	9.16	31.46	51.10	58.59	61.27	59.75	33.31	50.07	47.23	47.78	40.15	37.36	30.16	**27.79**
2	5.13	16.38	48.17	58.22	53.52	57.75	35.70	52.13	50.36	51.28	45.24	41.41	31.51	**38.17**
3	6.17	21.02	52.98	68.56	60.10	58.41	35.91	50.26	51.04	51.28	48.06	48.82	34.89	**37.41**

TABLE XVIII

PERCENTAGE OF FERTILE EGGS PER
TREATMENT PER WEEK

Treatment (Diet)	Period													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	13.95	30.19	61.47	63.71	66.26	62.17	39.43	36.91	29.10	25.63	25.19	28.27	26.24	21.46
2	1.89	19.05	64.66	58.84	60.92	56.15	32.22	43.07	37.46	26.73	35.39	32.20	31.78	32.75
3	4.21	27.49	63.50	71.12	64.55	55.92	46.49	41.85	33.34	37.62	32.58	34.84	30.01	28.48

decline, and it continued to decline until the feeding trial was terminated.

There were no significant differences due to treatment or treatment x period interaction for percent fertile eggs (Table XIX). There was a significant difference ($P < .01$) for percent fertile eggs due to period.

The reason for this could be two-fold. Turkey breeder hens generally begin with a rather low percent fertility and reach a peak in fertility about the time egg production peaks. Fertility will then begin a slow decline for the remainder of the breeding season. The other reason would be due to those factors which were discussed above.

Hatch of Eggs Set

The general mean for hatch of eggs set per treatment was 26.3 percent. The table of means for hatch of eggs set per treatment per week are presented in Table XX.

There was a significant difference ($P < .01$) for hatch of eggs set due to period (Table XXI). The reason for this response being present is related to loss of fertility. Hatch of eggs set is based upon the total number of eggs set during each period, and as fertility decreases, so will hatch of eggs set. There were no significant differences due to either treatment or period x treatment interaction.

Hatch of Fertile Eggs

The mean for hatch of fertile eggs per treatment per week are presented in Table XXII. These data demonstrate that as the feeding

TABLE XIX

ANALYSIS OF VARIANCE FOR PERCENT FERTILE EGGS

Source of Variation	df	MS	F
Treatment (Diet 1, 2, 3)	2	.0294	
Error A	14	.0982	
Period	13	.7188	22.68**
Error B	91	.0317	
Period x Treatment	26	.0209	1.05
Error C	182	.0199	

**Significant ($P < .01$)

TABLE XX

PERCENT HATCH OF EGGS SET PER
TREATMENT PER WEEK

Treatment (Diet)	Period													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.09	20.85	31.36	44.22	53.05	49.21	26.55	26.20	20.30	12.30	13.18	14.81	10.63	13.68
2	.08	9.24	33.03	39.28	44.75	46.62	29.50	34.72	28.07	15.91	23.05	19.92	14.55	17.71
3	.34	19.95	41.36	53.20	50.86	42.39	36.74	30.23	22.96	22.24	23.02	25.31	19.05	14.74

TABLE XXI

ANALYSIS OF VARIANCE FOR HATCH OF EGGS SET

Source of Variation	df	MS	F
Treatment (Diet 1, 2, 3)	2	.0633	1.01
Error A	14	.0629	
Period	13	.4897	21.20**
Error B	91	.0231	
Period x Treatment	26	.0151	1.13
Error C	182	.0134	

**Significant ($P < .01$)

TABLE XXII

PERCENT HATCH OF FERTILE EGGS
PER TREATMENT PER PERIOD

Treatment (Diet)	Period 1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.09	27.01	40.89	57.70	62.10	61.89	34.59	39.77	34.78	20.81	17.22	18.10	14.11	17.98
2	.10	11.24	37.24	49.69	59.46	65.57	39.77	52.82	35.38	22.08	34.98	28.46	20.67	25.24
3	.62	23.27	43.90	64.33	63.17	52.83	43.21	38.91	31.50	31.72	32.58	30.09	24.42	17.95

trial progressed, fertility decreased. The general mean for hatch of fertile eggs was 34.1 percent.

There were no significant differences due to treatment or treatment x period (Table XXIII). A significant effect ($P < .01$) for hatch of fertile eggs due to period was present. The hatch of fertile eggs by period would follow the same pattern as hatch of eggs set in that fertility decreased as the feeding trial progressed.

Poults Hatched

There were no significant differences due to treatment or treatment x period for poults hatched. A significant difference ($P < .01$) for period was again present (Table XXIV). The means for poults hatched per hen per periods are presented in Table XXV.

Uniformity Trial

Data from previous feeding trials conducted in the Turkey Cage Laboratory located on the Oklahoma State University Poultry Farm indicated that blocking of experimental units would be required in order to account for differences due to location within the facility. For this reason, a uniformity trial was conducted in conjunction with the feeding trial to study any patterns of variation present in the laboratory due to cage location.

In Table XXVI is presented the arrangement of cages used during the feeding trial. The cages are located on two tables, which were designated as Tables 1 and 2. Each of the two tables was further identified in terms of two sides, and two ends designated as sides 1 and 2, and ends 1 and 2. Within each of the tables, there were four

TABLE XXIII

ANALYSIS OF VARIANCE FOR HATCH OF FERTILE EGGS

Source of Variation	df	MS	F
Treatment (Diet 1, 2, 3)	2	.0351	
Error A	14	.0744	
Period	13	.7488	30.07**
Error B	91	.0249	
Period x Treatment	26	.0257	1.07
Error C	182	.0241	

**Significant ($P < .01$)

TABLE XXIV

ANALYSIS OF VARIANCE FOR NUMBER OF POULTS HATCHED

Source of Variation	df	MS	F
Treatment (Diet 1, 2, 3)	2	1.4222	1.69
Error A	14	.8398	
Period	13	10.3050	27.56**
Error B	91	.3739	
Period x Treatment	26	.2331	1.30
Error C	182	.1788	

**Significant ($P < .01$)

TABLE XXV

AVERAGE NUMBER OF POULTS HATCHED
PER HEN PER PERIOD

Treatment (Diet)	Period													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	0.02	0.64	1.31	1.94	2.18	1.99	0.75	1.00	0.73	0.48	0.50	0.41	0.30	0.35
2	0.00	0.29	1.35	1.87	1.67	1.88	0.91	1.21	1.03	0.61	0.83	0.71	0.53	0.57
3	0.02	0.50	1.69	2.52	2.26	1.92	0.98	1.19	0.88	0.88	0.94	0.93	0.54	0.47

TABLE XXVI

CAGE PLAN FOR TURKEY CAGE LABORATORY

End 2

Block 7		Block 6		Block 3		Block 2
01	18		01	18		
02	17		02	17		
03	16		03	16		
04	15		04	15		
05	14		05	14		
06	13		06	13		
07	12		07	12		
08	11		08	11		
09	10		09	10		
10	09		10	09		
11	08		11	08		
12	07		12	07		
13	06		13	06		
14	05		14	05		
15	04		15	04		
16	03		16	03		
17	02		17	02		
18	01		18	01		

End 1

Block 8		Block 5		Block 4		Block 1
01	18		01	18		
02	17		02	17		
03	16		03	16		
04	15		04	15		
05	14		05	14		
06	13		06	13		
07	12		07	12		
08	11		08	11		
09	10		09	10		
10	09		10	09		
11	08		11	08		
12	07		12	07		
13	06		13	06		
14	05		14	05		
15	04		15	04		
16	03		16	03		
17	02		17	02		
18	01		18	01		

Side 1	Side 2
Table 1	

Side 1	Side 2
Table 2	

blocks with eighteen laying cages per block. By numbering these cages from one to eighteen, it was possible to locate each hen within a particular block.

Each of the response variables for which values were tabulated during the feeding trial were adjusted for location related to "table," "side," "end," and all of the possible interactions. Some interesting facts were obtained, and a summary of what was observed during the feeding trial is given in the following paragraphs.

The data presented in Table XXVII are the means for body weight change in grams per hen per block for the feeding trial. It should be emphasized at this point in the discussion that a significant difference ($P < .01$) in body weight change due to treatment was present (Table XI). However, the data presented in Table XXVII show that the change in body weight was affected by the location of the breeder hens within the Turkey Cage Laboratory. It can be seen that there is a trend in body weight change which is related to diet. In order of magnitude of change produced, the diets are ranked: (1) Diet 3, (2) Diet 2, and (3) Diet 1. This trend holds true with varying degrees of similarity in five of the eight blocks. There are deviations from this pattern in Blocks 4, 5, and 8. One possible explanation for this inconsistency is that the main entrance to the Turkey Cage Laboratory is located directly adjacent to and inbetween Blocks 4 and 5. The variance in body weight gain could be due to increased activity by the attendant in this particular area. A second factor is that during the feeding trial, a greater number of turkey breeder hens were removed by mortality from Blocks 4 and 8 than were removed from the other blocks. The fact that fewer experimental units were involved could have affected the data obtained.

TABLE XXVII

DISTRIBUTION OF BODY WEIGHT CHANGES IN GRAMS
FOR DURATION OF THE FEEDING

End 1

Block 8

Table 1

	Diet	Weight Change
Side 1	1	-124
	2	-187
	3	-212
Side 2	1	+ 16
	2	- 71
	3	- 76

Block 5

Block 4

Table 2

	Diet	Weight Change
Side 1	1	+120
	2	+ 13
	3	+537
Side 2	1	-260
	2	- 21
	3	+273

Block 1

End 2

Block 7

Diet	Weight Change
1	- 73
2	+115
3	+228
1	-431
2	+ 46
3	+ 81

Block 6

Block 3

Diet	Weight Change
1	- 40
2	- 28
3	+ 63
1	- 48
2	- 22
3	+261

Block 2

Some interesting effects were noted also for daily feed consumption. It appears from the data that "side" had an effect on daily feed consumption. Turkey breeder hens located on Side 1 consumed more feed per hen per day than did the hens located on Side 2. The reasons for this are not obvious at the present time. If the physical layout of the laboratory is considered, each "side" has one area toward a window, and another area toward the center aisle. The only possible explanation is that along the north wall of the laboratory, all of the weighing and fumigating of hatching eggs is done. This work is performed each day, and possibly the added movement in this area or the vapor from the fumigating closet could have affected the daily feed intake figures.

There appears to be no location effect on either egg production or reproductive performance. There were no significant differences due to location for any of the response variability within these two categories.

This uniformity trial data indicate a need for continual blocking of all experiments conducted in the Turkey Cage Laboratory. Some possible recommendations which could help overcome this need for blocking are as follows: (1) weighing of the hatching eggs should be performed at some other location, (2) fumigation should be performed outside the laboratory, and (3) heating should be provided in a more uniform manner. There is a temperature gradient in the laboratory due to location of the gas stoves which are used for heating.

CHAPTER V

SUMMARY AND CONCLUSION

A feeding trial was conducted to determine the effect of dietary energy level on feed intake, protein intake, body weight change, number of eggs laid, total egg weight, average egg weight, percent egg production, and reproductive performance for turkey breeder hens maintained in a cage environment. Three experimental diets were used. These diets contained three energy levels and one calorie to protein ratio.

1. Feed Consumption. With the type of diets used in this experiment, an average feed consumption of 118 grams per hen per day can be expected.

2. Energy Consumption. The hens consumed approximately 321 kilocalories of metabolizable energy per hen per day. Energy level had no effect on energy consumption. It did have an effect on feed consumption.

3. Protein Consumption. Protein consumption for the entire feeding trial was approximately 27 grams per hen per day. Since the same calorie to protein ration was used with all three energy levels, protein intake may have been limited. Additional research will be needed to determine protein intake requirements.

4. Calcium Consumption. An average calcium intake of 3.53 grams per hen per day was observed. The general shell quality was excellent during the feeding trial.

5. Body Weight Change. Diet 3 produced a weight gain of 191 grams per hen during the feeding trial. It appears that the additional intake of nutrients by the breeder hens being fed Diet 3 resulted in this positive weight gain.

6. Egg Production. There were no significant effects due to treatment on egg production.

7. Reproductive Performance. Reproductive performance was below normal during the feeding trial. None of the diets used had any significant effect on reproductive performance.

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