AN ABSTRACT OF THE THESIS OF

Robert E. Buckner for the degree of Doctor of Philosophy

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Title: The Effects of Selected Feeding Programs on the Reproductive Performance and Specific Blood Plasma Chemistries of Caged Broiler Breeder Males and Dwarf Breeder Females

Abstract approved: _____
Thomas F. Savage

I. THE EFFECT OF FEEDING PROGRAMS ON REPRODUCTIVE TRAITS AND SELECTED BLOOD CHEMISTRIES OF CAGED BROILER BREEDER MALES:

1. FEED RESTRICTION LEVELS

The effects of five different feeding levels (136, 125, 113, 102, and 91 g/male/day of a 13.1% crude protein (CP), 3167 kcal ME/kg feed) on the reproductive traits of adult broiler breeder males in cages were evaluated from 30 to 60 weeks of age. Individual body weights, semen volume, sperm cells per ejaculate, and fertilizing ability were measured at 30, 40, 50, and 60 weeks of age. To assist in measuring the effect of feed restriction on metabolism during these periods, average hematocrits, plasma cholesterol, total protein, and uric acid levels were analyzed.

Significant ($P<.05$) reductions were observed in average body weights, semen volume, sperm cell numbers per ejaculate, testicular weights, and hematocrits with feed restriction at the 91 g compared to the 136 g feeding level. At 40 weeks of age the percentage of

males producing semen was significantly reduced for the 102 and 91 g compared to the 136 g feeding level. Average plasma cholesterol levels were significantly increased at the 91 g compared to the 136 g feeding level, but no significant effect ($P>.05$) was observed in plasma total protein and uric acid levels. Correlation coefficients were negative for plasma cholesterol to body weights, sperm numbers per ejaculate, and testicular weights but positive for body weights to hematocrits and testicular weights.

II. THE EFFECT OF FEEDING PROGRAMS ON REPRODUCTIVE TRAITS AND SELECTED BLOOD CHEMISTRIES OF CAGED BROILER BREEDER MALES:

2. FREE CHOICE, LOW ENERGY RATIONS OF 9, 7, AND 5 PERCENT CRUDE PROTEIN

Three isocaloric feeds consisting of 9, 7, and 5% CP each containing 2315 kcal ME/kg were fed free choice to individually caged broiler breeder males from 22 to 65 weeks of age. To obtain these protein and energy levels, sand was incorporated into the rations at levels ranging from 26.1 to 33.6% of the feed. The average daily protein intake per male was 18.7, 14.7, and 10.7 g for the 9, 7, and 5% CP, respectively, with an average caloric intake of 480 kcal ME. Individual body weights, semen characteristics, testicular weights, hematocrits, plasma cholesterol, total protein, uric acid and triglyceride levels were evaluated during each 4-week period from 24 to 44 weeks and also at 50 and 65 weeks of age.

Average body weights from 24 to 32 weeks of age were significantly lower for the males fed 5% CP than those fed 9% CP rations. Semen volumes and sperm cell numbers per ejaculate were significantly

reduced only at 24 weeks of age for males fed 5% CP feeds. At 65 weeks of age there were no significant differences among treatments means for body weight, sperm cells numbers per ejaculate, nor testicular weights. Plasma cholesterol levels of males fed the 5% CP diet were significantly higher at 28 and 32 weeks while levels of plasma total protein were decreased at 28 weeks of age. Plasma uric acid levels were consistently and significantly decreased as protein intake was reduced. The results suggest that within the parameters of this study broiler breeder males can be successfully maintained on low energy (2315 kcal/ kg) feeds of 7% CP from 22 to 40 weeks and then 5% CP from 40 to 65 weeks of age.

III. INFLUENCES OF 16 AND 17.5 PERCENT DIETARY PROTEIN AND SUPPLEMENTAL METHIONINE ON THE REPRODUCTIVE TRAITS AND SELECTED PLASMA CHEMISTRIES OF CAGED DWARF (dw) BROILER BREEDER FEMALES

A total of 240 individually caged dwarf (dw) broiler breeder females were fed one of six isocaloric treatment diets (2740 kcal/kg) containing 16 or 17.5% CP to which d,l-methionine (MET) was supplemented at 0, .08, or .15% from 22 to 50 weeks of age. The resulting dietary MET levels ranged from .256 to .424% and total sulfur amino acids (TSAA) ranged from .527 to .718% of the rations. Treatment means were compared for body weights, mortality, total egg production, egg weights, and egg fertility and hatchability resulting from artificial insemination with .05 ml broiler breeder semen. Blood plasma was analyzed at 32, 40, and 50 weeks of age for cholesterol,

uric acid, total protein, and albumin as possible monitors of dietary protein utilization and of the physiological effects of protein and methionine levels on reproductive traits.

There were no significant differences observed among dietary treatment means for body weights, mortality, total egg production, fertility, nor hatchability from 24 to 50 weeks of age. Significant differences were not observed among the treatment means for plasma cholesterol, total protein, and albumin at 32, 40, or 50 weeks of age. Between the two CP levels, plasma uric acid was significantly increased for the females on 17.5% compared to those on 16% CP rations. A consistent although nonsignificant trend of decreased uric acid levels with supplemental methionine was observed only in the females fed 16% CP diets and not in those on 17.5% CP.

Under the conditions of this experiment, protein requirements for caged dwarf broiler breeder females from 22 to 50 weeks of age appear to be satisfied with daily dietary intakes of 20.3 g CP, 325 mg MET, and 670 mg TSAA.

THE EFFECTS OF SELECTED FEEDING PROGRAMS ON THE REPRODUCTIVE PERFORMANCE AND SPECIFIC BLOOD PLASMA CHEMISTRIES OF CAGED BROILER BREEDER MALES AND DWARF BREEDER FEMALES

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Robert E. Buckner

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Associate Professor of Poultry Science in charge of major

Redacted for Privacy

Head of department of Poultry Science

Redacted for Privacy

Dean of Graduate School

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My deepest appreciation to my wife, Vivian for her patience, help, and sacrifice which has made my further education possible, and also to my four sons who have endured my years in graduate school: Sean, David, Thomas, and Matthew. I also thank my parents for their encouragement and support in this endeavor.

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CONTRIBUTION OF AUTHORS

Dr. Josef A. Renden directed and supervised the initial experiment in this study dealing with the effect of restricted feeding of reproductive traits of caged broiler breeder males. Under his guidance, the preliminary course of this study began and under his direction, a basic understanding of broiler breeder management was established.

TABLE OF CONTENTS

LIST OF TABLES

THE EFFECTS OF SELECTED FEEDING PROGRAMS ON THE REPRODUCTIVE PERFORMANCE AND SPECIFIC BLOOD PLASMA CHEMISTRIES OF CAGED BROILER BREEDER MALES AND DWARF FEMALES

CHAPTER I

INTRODUCTION

The growth of the broiler industry in the United States during the past 50 years can be attributed to advances in genetics, nutrition, disease control, and breeder management. This industry has been transformed from a back yard flock endeavor to an industry that produces 4.2 billion broilers each year worth $4.7 billion (Arscott, 1984). The key to success in this very competitive business is summarized in one word -- efficiency, and how to become more efficient in order to be more competitive is the ever present goal. One of the areas of greatest potential for increasing the efficiency of the broiler industry is broiler chick production from breeder flocks. The future direction of breeder management is being debated at this time and two alternatives appear in the offering. The first alternative emphasizes "fine tuning" the present breeder management practices while remaining within, well established procedures. The other viable alternative would require monumental changes in management, nutritional practices, as well as different housing facilities. This latter option which lies at the crossroads of the industry today involves artificial insemination as a basic tool.

Artificial Insemination

Artificial insemination (AI) as a technique for use in poultry was first developed and described by Burrows and Quinn (1937). Today however, only the turkey industry is the practitioner which exclusively utilizes this technique within the poultry industry. Recently, as feed prices have risen and economic pressures on profits have increased, AI is being considered a viable alternative within the broiler industry of this country (McDaniel, 1976).

The reasons for the reluctance of incorporating AI into breeder operations are the changes that would be required in labor cost and training, in equipment and housing facilities, and in modifying nutritional requirements. Most breeder facilities currently do not see the expected returns from the incorporation of AI to offset the initial capital investment (Moultrie, 1982). If AI can prove itself economically as it has in some of the more progressive companies in the United States many feel that its advantages outweighs its disadvantages.

A. Cage management

Integrally associated with AI is the feasibility of using cage systems for housing and managing the breeders. Israel has been practicing AI successfully with broiler breeders for over 25 years. Thummin (1977) cites the following advantages and disadvantages that cage systems (which incorporate AI) offer the industry.

Main advantages are:

- Cleaner hatching eggs produced under more sanitary conditions.
- No floor or nest litter, no direct or indirect contact with droppings.
- Larger eggs and better shells.
- Early detection of culls.
- Reduced broodiness.
- More hatching eggs as a result of all the above.
- Less labour for the production of hatching eggs, aside from labour involved in AI.
- Less feed per egg, (present work has shown a saving of 270 gms of feed for each dozen eggs.
- 75% fewer cocks are required.

Main disadvantages are:

- Increased semi-skilled labour required for AI.
- The 75% of costs saved in raising and feeding less cocks will more than cover the expense of extra labour involved.
- A greater investment in housing due to the installation of cages.

B. Male selection

The decreased number of males required to maintain optimum fertility using AI greatly increases the genetic selection pressure for enhanced breeders efficiency. Employing a natural mating system, the ratio of males required per 1000 females is generally 100; however, with AI using undiluted semen, only 22 males would be required (McDaniel, 1976). Using proper semen dilution procedures (Sexton, 1976) the potential of inseminating 160 hens with 1 ml of semen is feasible. Assuming 0.5 ml the average daily volume

obtainable from selected superior males and with an insemination frequency of every 7 days for hens, two to three males could theoretically be used to inseminate 1000 hens (McDaniel, 1976). In this situation the intense selection pressure for superior males for use as breeders would be self evident.

C. Nutrition

Maintaining breeders in cages and implementing AI would, as previously mentioned, greatly enhance feed efficiency by decreasing the amount of feed required for egg production and reducing the required number of males. Therefore, in areas of the world where feed costs are high, AI has an even greater application.

Cage systems also facilitate the control over feeding levels and programs of the individual breeder, and thereby enhance feed efficiency. Because the males and females are maintained separately under cage management systems, breeder rations can be formulated to the specific nutritional requirements of each. Under natural mating systems, the female's higher nutritional requirements for egg production mandate the breeder diet for both sexes. As a result, there was never a need to develop male oriented rations. Now, however, if males are to be maintained in cages, research is needed to determine the specific nutrient levels required to efficiently produce maximum sperm numbers produced.

The Dwarf Breeder Female

Economic development towards increasing the efficiency of producing broiler hatching eggs has also been directed to the female.

The development of the dwarf breeder female is an example where a genetic trait with pleiotropic effects has been capitalized upon in an unique manner to reduce the maintenance costs of the breeder female.

A. Advantages and Disadvantages

The dwarfing gene (dw) is a sex-linked recessive trait and can limit the potential body size of the female to 70% of a normal pullet at sexual maturity. The reduced body size reduces the feeding requirements by at least 20% (Merat, 1984). Because feed cost is the single highest expenditure in producing eggs, savings of 20% are substantial.

The principle disadvantages of the dwarf compared to the normal female is the reduced egg size, and market weight of the progeny produced (Khan et al. 1973 and Whiting and Pesti, 1983). When a dw female is mated with a normal (DW) male, the resulting offspring are heterozygous males and hemizygous females. The expression of the dwarfing gene is not completely recessive in the heterozygous males and the market weights for the male progeny are reduced approximately 3.5% (Chambers et al., 1974).

B. Nutrition of Dwarf Females in Cages

The use of the dwarf breeder as a viable alternative in broiler breeder flocks is enhanced through AI, partially because she adapts readily to the cage environment due to her reduced size(Lin et al., 1979). As a result of maintaining the dwarf in cages, not only is

feed efficiency improved but the size of the eggs produced is increased (Renden and Pierson, 1982). Nutritional requirements for maximum reproductive efficiency for the dwarf breeder in the cage environment are not clearly defined at this point, and further research is needed.

Blood Components as Monitors

The broiler industry must always be looking for new and innovative methods of increasing reproductive efficiency. One of these new potentials is the possibility of using blood chemistries in combination with reproductive traits to monitor efforts to obtain maximum efficiency in the biological system. Studies in pathology often use blood parameters as monitors and prognosticators of physiological status, and the chemical assays are readily available in simple, easy to use kits. In addition to monitoring the physiological responses to nutritional regimens, these assays may be used as possible physiological markers to predict a breeders' future reproductive capabilities. If a consistent and reliable relationship could be determined, plasma assays could help in the selection process for the superior breeders and in so doing, maximize reproductive efficiency. These chemistries, however, have not been fully examined within the avian model and additional data are needed to determined the interactions that may exist between nutrition and reproductive physiology.

Objectives

The objectives of the studies contained in this thesis have the common theme of increasing the reproductive efficiency of caged broiler breeder males and dwarf females through nutritional programs that seek to determine minimum nutritional requirements. The specific objective of each individual study include:

1. To determine the effect of five daily feeding levels (136, 125, 113, 102, and 91 g/male) of a breeder ration (13.1% CP, 3167 kcal ME/kg) on the reproductive traits of mature broiler breeder males in a cage environment (Chapter III).

2. To determine the reproductive response of caged broiler breeder males full fed one of three isocaloric ration of 9, 7, or 5% crude protein (Chapter IV).

3. To determine the effects of increasing the dietary protein levels from 16 to 17.5% crude protein in diet without and with supplemental methionine (.08 and .15%) would have on reproductive traits of caged dwarf broiler breeder females (Chapter V).

4. To monitor the effects that different feeding regimens have on selected blood chemistries of caged boiler breeders and to correlate chemistry values with reproductive traits (Chapters III, IV, and V).

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CHAPTER II

REVIEW OF LITERATURE

Artificial insemination (AI) and the dwarf (dw) broiler breeder female have the potential of completely altering present management programs and feeding regimens of the broiler industry. Both AI and the dw breeder are well suited for use in the cage environment. The impact of a cage management system on the nutritional requirements of broiler breeder males and dwarf females, however, has not been clearly defined.

Broiler Breeder Males

The modern broiler has the genetic potential for rapid body weight gain and the accompanying capacity for feed consumption (Brown and McCartney, 1984). These traits are essential in broiler production but if these attributes are not regulated in the parent breeding stock, obesity and reduced reproductive capabilities result. Because of this propensity for body weight gain, a daily restricted feeding program is commonly an integral part of maintaining broiler breeder males (McHose, 1983).

Parker and McSpadden (1943) described the deleterious effects of severe feed restriction on the reproductive traits of Rhode Island Red males as reduced semen volume and fertilizing capacity. Later Parker and Arscott (1964) demonstrated in a classic study, that energy restriction caused reduced semen production, testicular weights, and fertilizing capacity of White Leghorn males. Although

broiler breeder males are significantly larger than males of egg laying breeds, the principles of nutrition should apply to both when body weight differences are considered.

Feed restriction studies with broiler breeder males in floor pens by McCartney and Brown (1980) and Brown and McCartney (1983) determined that the energy requirements for body weight maintenance was 458 kcal ME/day. Energy consumption below 458 kcal resulted in reductions in testicular weights. Nevertheless, maximum semen production was obtained from males fed 390 kcal/day (resulting in a net loss in body weight). In their study, maximum semen volume was not associated with maximum testicular size. The use of feed dilution as a method of restricting nutrient intake has been evaluated in White Leghorn pullets with cellulose and sand at 10, 20, and 30% of the diet by Cherry et al. (1983). Kaolin, as a feed diluent, also has been evaluated in Brown Leghorn cockerels at 10, 20, 30, and 40% of diet (Savory, 1984). Sand and kaolin, both with higher densities than cellulose, did not significantly reduce energy consumption when present at 30% of diet; however, kaolin did reduce energy consumption and resulting mean body weight when fed at 40% of the diet. The low density of cellulose significantly reduced energy consumption at levels of 30% in the diet. Neither of these studies measured the effects of feed dilution on reproduction.

Recommended dietary protein levels for breeder males have yet to be clearly assessed. Energy restriction was shown previously to affect male reproduction in both the light and heavy breeds, yet dietary protein levels were shown by Arscott and Parker (1963) and

(1966) to have no significant adverse effect on the reproductive traits of White Leghorn males maintained on CP levels as low as 6.9%. Wilson et al. (1984) fed broiler breeder males higher levels of dietary protein (from 12 to 18% CP) and observed improved semen production from the males fed the lower dietary protein feeds containing 12 and 14% CP. A minimum dietary protein requirement for broiler breeder males could not be determined within the parameters of their study.

Dwarf (dw) Broiler Breeder Females

The effect of the dwarfing (dw) gene on the anatomy and physiology of the broiler female as well as its potential role in the broiler industry has been reviewed in detail by Guillaume (1976) and recently by Merat (1984). The dwarf female is smaller and consumes less feed than her normal counterpart, and the dietary protein requirements also appear to be different. The total sulfur amino acid requirements for the dwarf breeder have been shown to be higher than for normal females by Guillaume (1973), Larbier and Blum (1975), and Blum et al. (1979). Work by Quisenberry et al. (1969) also suggests that dietary protein requirements are higher for the dwarf than for the normal female. The dwarf broiler breeder in floor pens has been shown to maintain egg production and egg size at dietary protein consumption levels of 17 g / day (290 Kcal ME) by Guillaume (1971) and energy levels of 269 kcal ME / day (16-17 g protein) by Waldroup and Hazen (1975). In current commercial practice, however, the dietary protein level in the diet range from 16 to 17.5%.

One of the limitations of utilizing dwarf broiler breeder females in commercial breeder flocks is the reduced egg size and subsequent chick size at hatching (Khan et al., 1973 and Whiting and Pesti, 1983). Renden and Pierson (1982) demonstrated significant increases in egg size by maintaining the dwarf breeder in cages as compared to floor pens.

Blood Chemistries

Blood chemistries are routinely used to diagnose pathologic conditions; however, these assays could also be used to monitor the physiological effects of different feeding programs. Prior to using blood chemistries effectively in nutritional studies, research is needed to establish reference levels among the different breeds and species (Jimenez, 1982).

Cholesterol in the avian system is an important component of membrane morphology, steroid hormones, and metabolic regulation and its levels in the blood are influenced by many factors. The effect of dietary protein on cholesterol in the blood has been studied in adult White Leghorn males by Kokatnur et al. (1958) and an inverse relationship was observed. This phenomenum which had first been seen in immature chicks has been summarized by Leveille and Sauberlich (1961) but the exact mechanism involved is not completely understood. Other factors that influence cholesterol levels in the blood are fasting or starvation (Hevia and Visek, 1978; and Collado and Tasaki, 1981), thiamine and/or riboflavin deficient diets (Surendranathan and Nair, 1981), or dietary fat and cholesterol (Kokatnur et al., 1958).

Blood components which may be assayed to measure dietary protein utilization and protein catabolism include total blood protein and uric acid levels. Total protein in the blood, as well as its components, albumin, globulins (including fibrinogen), and free amino acids can be general indicators of protein reserves and dietary protein intake (Cohen-Parsons et al., 1983; and Leveille and Sauberlich, 1961). Uric acid is the principle route of nitrogen excretion from protein catabolism and factors that affect uric acid levels in the blood are 1) protein consumption (Garcia Partida et al., 1982), 2) amino acid balance (Miles and Featherston, 1974), 3) starvation (Mishra et al., 1981), and pathogenic infections and fasting (Kiefer, 1979).

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CHAPTER III

THE EFFECT OF FEEDING PROGRAMS ON REPRODUCTIVE TRAITS AND SELECTED BLOOD CHEMISTRIES OF CAGED BROILER BREEDER MALES.

1. FEED RESTRICTION LEVELS[1]

R.E. Buckner, J.A. Renden,[2] and T.F. Savage

Department of Poultry Science

Oregon State University

Corvallis, OR 97331

[1]Oregon Agricultural Experiment Station Technical Paper No. 7225. Research done in partial fulfillment of the requirements for the degree of Doctor of Philosophy, Oregon State University, Corvallis, OR 97331 (Submitted for publication June 23, 1984).

[2]Present address: Department of Poultry Science, Auburn University, Auburn, AL.

ABSTRACT

The effects of five different feeding levels (136, 125, 113, 102, and 91 g/male/day of a 13.1% CP, 3167 kcal/kg ME feed) on the reproductive traits of adult broiler breeder males in cages were evaluated from 30 to 60 weeks of age. Individual body weights, semen volume, sperm cells per ejaculate, and fertilizing ability were measured at 30, 40, 50, and 60 weeks of age. To assist in measuring the effect of feed restriction on metabolism during these periods, mean hematocrits, plasma cholesterol, total protein, and uric acid levels were analyzed.

Significant ($P<.05$) reductions were observed in mean body weights, semen volume, sperm cell numbers per ejaculate, testicular weights, and hematocrits with feed restriction at the 91 g when compared to the 136 g feeding level. At 40 weeks of age the percentage of males producing semen was significantly reduced for the 102 and 91 g when compared to the 136 g feeding level. Mean plasma cholesterol levels were significantly increased at the 91 g when compared to the 136 g feeding level, but no significant ($P>.05$) effect was observed in plasma total protein and uric acid levels. Correlation coefficients were negative for plasma cholesterol to body weights, sperm numbers per ejaculate, and testicular weights but positive for body weights to hematocrits and testicular weights.

INTRODUCTION

Establishment of the minimum feeding level of a balanced nutritional diet for optimum semen production characteristics of broiler breeder males in cages has yet to be determined. Feeding levels for adult broiler breeder males in floor pens were evaluated by Brown and McCartney (1983) with an energy intake of 458 kcal metabolizable (ME)/day required to maintain body weight. Renden and Pierson (1982) compared broiler breeders maintained in cages and in floor pens, and demonstrated that the cage environment enhanced semen production. Males in both environments were maintained on a restricted feeding program which provided an mean of 358 kcal metabolizable energy (ME)/day. A difference in energy requirements between the two environments might also have contributed to the results obtained.

Parker and Arscott (1964) described the effects of energy restriction on the reproductive traits of Single Comb White Leghorn (SCWL) roosters as reduced testicular weights, semen volumes, and fertilizing capabilities. Protein restriction, on the other hand, could be as low as 6.9% of the feed with no detrimental effect (Arscott and Parker, 1963). These findings suggest that a limited energy intake will affect male reproduction before limited protein.

To establish the nutritional requirements for broiler breeder males in cages, a first step is to restrict feed intake to a level where a deleterious effect on reproduction can be measured. In order to monitor the effect of feed restriction, physiological chemistries would be helpful to determine nutritional status. Bell and Freeman

(1971) and Ross et al. (1978) provide limited references of physiological data for the chicken. The absence of reference levels specific to the adult broiler breeder male necessitates research that establishes these reference levels at different ages and for different nutritional regimens.

The objective of this study was to determine the effect different restricted feeding levels had on reproductive efficiency and selected blood constituents in order to determine optimum feeding levels for the broiler breeder male in a caged environment.

MATERIALS AND METHODS

One hundred and thirty-five commercial broiler breeder males were raised on litter according to the breeder's management guide[3]. At 20 weeks of age, 27 males were randomly assigned to each of five treatment groups and placed in individual cages (30.5 x 45.7 x 46.7 cm) within a positive pressure ventilated house with controlled lighting. Each treatment group was composed of three replicates each containing nine males.

The treatments consisted of five restricted feeding levels: 136, 125, 113, 102, and 91 g/male/day of a breeder ration containing 13.1% crude protein and 3167 kcal ME/kg (Table III.1). Feed allocations were provided daily according to the number of males per row. Feed was evenly distributed in a continuous trough in front of the cages with no provisions made to prevent competitive and disproportionate feeding of more dominant males.

Eight watering periods of 15 min each at two hour intervals were provided during day-light hours. Photo-stimulation was initiated with the light regimen of 14L:10D at 20 weeks of age and maintained throughout the study. At this same age individual body weights were measured, and treatment feeding levels begun. Treatment effects on mean body weights, semen volume, sperm packed cell volumes, and fertilizing capacity were evaluated once during each 10-week period from 30 through 60 weeks of age. Individual semen ejaculates were

[3]Management Guide for the Hubbard White Mountain Male, 1981-1982 ed.

collected directly into graduated centrifuge tubes, and the semen and packed cell volumes were recorded to calculate sperm cell concentrations and numbers per ejaculate.

The fertilizing capability of each sample ejaculate was determined by artificially inseminating four SCWL hens with .05 ml of undiluted semen. Eggs were collected daily, and identified by hen and date laid from days two through eight post insemination. Eggs were candled after 10 days of incubation, and clear eggs were broken out to determine true fertility.

Five males from alternate cages per row (15 per treatment) were selected at 30 weeks of age for blood analyses. Samples were collected once each period using brachial venipuncture with heparinized syringes. Hematocrits were determined, and the blood was centrifuged at 850 x g for 30 min. Plasma was separated and stored at -15C until analyses. Blood plasma chemistries were analyzed following the procedures outlined for the following commercial reagent kits[4]: Cholesterol (Autoflow), Total Protein (Biuret), and Uric Acid (Azino). Males used for blood analysis were sacrificed at 60 weeks of age in order to record individual weights of both testes per male.

Experimental data were analyzed using a factorial design in order to test for interaction between the main effects,

[4]Boehringer Mannheim Diagnostics, Indianapolis, IN.

treatment feeding levels and age. In the absence of significant interaction, significant differences ($P<.05$) among treatment means were compared by period using Duncan's multiple range test. Simple correlation coefficients were used to compare blood chemistries with reproductive traits (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The daily energy and protein intake per male from the different feeding levels and their effects on body weights from 20 through 60 weeks of age are contained in Table III.2. There were no significant differences among the mean 20 week (pre-treatment) body weights. From 40 through 60 weeks of age, however, mean body weights were significantly different among males fed 136, 113, and 91 g per day and corresponded directly to feed intake. By 50 weeks of age, those males fed 136 g/day had attained a free choice feeding status as feed was always present in troughs.

The effect of restricted feeding levels on mean semen volumes and sperm numbers per ejaculate is summarized by age in Table III.3. Mean semen volumes were significantly reduced at 50 weeks for the males fed the 91 g level when compared to the 113 and 136 g feeding levels. Mean sperm numbers per ejaculate were significantly lower from males fed 91 g than those fed 136 g of feed from 30 to 50 weeks. Although the difference was not significant at 60 weeks of age, the trend was still present. The mean sperm cell concentration and fertilizing capability (data not shown) of males producing semen were not significantly different among the treatment means (except for a significant reduction in 30 week sperm concentration for males fed 91 g compared to 136 g).

The effect of feed restriction on the percent of males producing semen during each period and 60 week testicular weights are contained in Table III.4. At 40 weeks of age both the 91 and the 102 g feeding groups had significantly fewer males producing semen than did the 136 g group, but at 50 weeks only the 91 g group was significantly lower. This pattern of reduced feed intake to fewer males producing semen continued throughout the study. Mean testicular weights, which reflected this same trend, were significantly reduced for the males fed 91 g/day.

The physiological response to levels of feed restriction was estimated by measuring levels of selected blood components. Minimal research has been conducted in the area of blood chemistries of poultry with nothing in the literature specific to the mature broiler breeder male. Hematocrit, plasma cholesterol, total protein, and uric acid levels were selected as a starting point to monitor nutritional status because the simplicity of the procedures and because of their possible associations with protein and energy metabolism.

The effects of feed restriction on mean hematocrit and plasma cholesterol by feeding level and age are summarized in Table III.5. Levels of restricted feeding had no significant effect ($P>.05$) upon 30 week hematocrit values, however, significant reductions were observed from 40 to 60 weeks of age for males the fed 91 g compared to the males fed 136 g. The effects of limited feeding on plasma cholesterol levels revealed a general trend of increased cholesterol levels with decreased feed intake at the four ages examined. A

significant increase in plasma cholesterol between males fed 91 and 125 g of feed or greater was noted at the 40 and 60 week periods. Because no significant differences were observed among treatments for plasma total protein and uric acid, only mean levels were listed by age as reference values.

Simple correlation coefficients were calculated to determine if significant relationships exist between reproductive traits and blood components. Correlation coefficients among cholesterol, body weight, sperm cells per ejaculate, and testicular weights are summarized in Table III.6. Significant correlation coefficients which were consistently negative for mean plasma cholesterol to body weight and plasma cholesterol to sperm cell numbers per ejaculate were observed across treatments and age. Positive correlations for body weights and hematocrits were consistently observed (except the 102 g level at 30 weeks). Testicular weights at 60 weeks were negatively correlated with plasma cholesterol levels and positively correlated to body weights with one exception observed for the 136 g level. Correlations of other plasma chemistries with body weights or reproductive traits were neither significant nor consistent.

The effects of the restricted feeding levels evaluated in this study demonstrate that feed intake can be lowered without a loss in reproductive capabilities. Parker and McSpadden, (1943) first evaluated severe feed restriction (between 42 to 72% of free choice) to have a detrimental effect on male fertility. The reproductive traits of the males in this study fed 91 g/day appear to be consistently within or approaching this threshold of reduced fertility.

The results of Brown and McCartney (1983) concluded that the breeder's recommended feeding level (154 g/male /day) of a 17% protein ration provided sufficient energy (458 kcal) to maintain body weight. Those males, maintained in floor pens, were fed 154 g/day and gained 28 g from 30 to 54 weeks of age. At the 85% restricted feeding level of 131 g/day (390 kcal) maximum semen volume was obtained but a net loss in body weight of 294 g occurred over the 24 week period. The caged males of this study fed at the 91 g level (288 kcal) gained 68 g from 30 to 60 weeks of age. These data suggest that males maintained in cages have a much lower energy requirement than males in floor pens.

The feed restriction levels used in this study reduced sperm numbers per ejaculate and reduced testicular weights at 60 weeks of age. The most intense feed restriction level (91 g/day) adversely affected sperm numbers and testicular size. Reduction in testicular weights has also been observed with energy restriction (Parker and Arscott, 1964) and feed restriction (McCartney and Brown, 1980; Brown and McCartney, 1983). In this study feed restriction caused reductions in testicular weights with corresponding reductions in sperm numbers per ejaculate, but no significant effect was noted in sperm cell concentration and fertilizing ability from males producing semen. Testicular weights, however, were not significantly different among treatment groups when expressed as g testes/100 g body weight.

Increased feed restriction in this study caused significant changes in hematocrits and plasma cholesterol levels. The mechanism of how a reduced feeding level would cause an increase in cholesterol

levels in the blood is unknown. Feed deprivation has been shown by Hevia and Visek (1978) to cause temporary increases in cholesterol levels in cockerels during fasting (7 days) and also during the recovery period (8 days). The utilization of fat stores would explain the increase in cholesterol levels during fasting but not during the recovery period. The results of the present study suggest that feed restriction affected cholesterol levels through the same mechanism that reduced body size (perhaps reduced hepatic function and hence reduced cholesterol excretion); the correlations within treatments for cholesterol levels and body weights seem to substantiate this idea.

Feed deprivation was observed by Kiefer (1979) to cause temporary elevations in uric acid but this occurred during the fasting period with no increase during recovery. The intensity of feed restriction used in this study caused elevations in mean plasma cholesterol but not uric acid levels. These results indicate that significant body reserves were not being used and seems to remove starvation as a probable cause for increased cholesterol levels. Testicular weights were negatively correlated with cholesterol levels and generally positively correlated with body weights (except the 136 g level). This agrees with Arneja et al. (1981) who observed a negative correlation (-.48) between testicular weights and plasma cholesterol in turkeys. Because the restricted feeding levels utilized in this study produced no effect nor trend in uric acid or total protein levels, energy and not protein intake seems to be the primary limiting nutrient.

Except for mean body weights, the minimum feeding level which caused no significant reductions in any of the reproductive traits analyzed was 113 g/male and overall seemed to be the level of most efficient feed utilization. The results of this study summarize and establish reference levels for the plasma chemistries analyzed for caged broiler breeder males across feeding levels and age. Average plasma cholesterol has possible uses in monitoring body weight reductions. Further research, however, in cholesterol and other blood components and parameters is needed before blood chemistries can be used confidently as monitors for nutritional status.

Table III.1. Composition of treatment ration

Ingredient	Percent
Corn	84.52
Soybean meal (47.5%)	5.68
Meat and bone meal (49.5%)	5.00
Alfalfa meal, dehy (17%)	2.50
Deflur. phosphate (32%Ca:18%P)	1.25
Limestone flour	0.50
Salt (iodized)	0.40
Vitamin premix[1]	0.12
Trace mineral mix[2]	0.03
Total	100.00

Calculated Analyses

Crude protein	13.1
Metabolizable energy (kcal/kg)	3167.0
Crude fat	4.0
Crude fiber	2.6
Calcium	1.2
Available phosphorous	0.6
Methionine	0.23
Cystine	0.23
Lysine	0.53

[1]Vitamin mix provides per kg ration: vitamin A, 1980 IU; vitamin D_3, 660 ICU; riboflavin, 2.0 mg; d-pantothenic acid, 3.3 mg; niacin, 13.2 mg; choline, 114.6 mg; vitamin B_{12}, 3.3 mcg; vitamin E, 0.7 IU; vitamin K, 0.33 mg; folic acid, 0.13 mg; ethoxyquin, 0.037 g.

[2]Mineral mix provides per kg ration: Mn, 36 mg; Fe, 12 mg: Cu, 1.2 mg; Zn, 16.5 mg; Co, 0.12 mg.

Table III.2. Mean daily energy and protein intake, and body weight

Daily intake /male[1]			Body weights				
			Age in weeks				
Feed	Energy	Protein	20	30	40	50	60
(g)	(kcal)	(g)	(kg)				
136	431	17.8	2.58 ±.45^{a}	4.18 ±.56^{a}	5.09 ±.46^{a}	5.23 ±.49^{a}	5.35 ±.47^{a}
125	396	16.4	2.65 ±.39^{a}	3.98 ±.57^{a}	4.81 ±.54^{ab}	4.91 ±.56^{ab}	5.12 ±.49^{ab}
113	358	14.8	2.63 ±.31^{a}	3.80 ±.58^{ab}	4.43 ±.69^{bc}	4.53 ±.64^{bc}	4.73 ±.61^{b}
102	323	13.4	2.62 ±.32^{a}	3.41 ±.61^{bc}	4.07 ±.64^{cd}	4.10 ±.71^{cd}	4.29 ±.67^{c}
91	288	11.9	2.66 ±.41^{a}	3.28 ±.73^{c}	3.91 ±.77^{d}	3.83 ±.88^{d}	3.96 ±.87^{c}

[1] 13.1% Crude Protein and 3167 kcal ME per kg.

^{a,b,c,d} Means ± SEM within columns with different lettered superscripts are significantly different ($P<.05$).

Table III.3. Treatment effects on total sperm cell numbers per ejaculate

Feed (g)	Semen volumes: Age in Weeks 30	40	50	60
	(ml)			
136	.44 ±.32[a]	.77 ±.51[a]	.63 ±.34[a]	.66 ±.26[a]
125	.30 ±.32[a]	.59 ±.40[a]	.53 ±.31[a]	.57 ±.34[a]
113	.40 ±.37[a]	.70 ±.55[a]	.55 ±.35[a]	.72 ±.31[a]
102	.28 ±.42[a]	.61 ±.61[a]	.50 ±.44[ab]	.68 ±.43[a]
91	.18 ±.26[a]	.41 ±.60[a]	.22 ±.32[b]	.44 ±.37[a]
	Sperm cells per ejaculate			
	(x 10^9)			
136	1.81 ±1.71[ab]	3.76 ±2.40[ab]	2.60 ±1.94[ab]	3.12 ±1.46[a]
125	1.21 ±1.55[ab]	2.51 ±1.87[ab]	2.32 ±1.44[ab]	2.29 ±1.75[a]
113	1.51 ±1.40[ab]	3.31 ±2.76[ab]	2.29 ±1.57[ab]	3.10 ±2.03[a]
102	1.00 ±1.54[ab]	2.55 ±2.65[ab]	1.72 ±1.87[ab]	2.80 ±1.93[a]
91	0.44 ±0.87[b]	1.34 ±2.02[b]	0.91 ±1.35[b]	1.73 ±1.91[a]

[a,b]Means ±SEM within columns with different lettered superscripts are significantly different ($P<.05$) and includes all males.

Table III.4. Percent males producing semen by age and mean testicular weights

Feed	Age in Weeks 30	40	50	60	Testicular Weights[1]
(g)		(percent)			(g)
136	81.5 ± 6.4[a]	92.6 ±12.8[a]	82.1 ±15.6[a]	94.4 ±10.0[a]	38.7 ± 8.8[a]
125	58.8 ±13.7[a]	84.1 ± 5.7[ab]	84.1 ± 5.7[ab]	86.6 ± 2.9[a]	36.8 ±10.7[a]
113	70.8 ±14.4[a]	80.9 ± 8.3[ab]	80.9 ± 8.3[ab]	95.2 ± 8.3[a]	37.4 ±11.4[a]
102	47.6 ± 6.9[a]	65.3 ± 2.4[b]	68.1 ±18.8[ab]	86.3 ±14.3[a]	31.2 ± 9.6[ab]
91	42.3 ±30.6[a]	47.5 ±13.0[b]	35.0 ± 9.0[b]	71.1 ±18.3[a]	24.5 ±13.3[b]

[a,b]Means ± SEM within columns with different superscripts (based on arcsine conversion analysis) are significantly different ($P<.05$).

[1]Testicular weights taken at 60 weeks of age.

Table III.5. Treatment Effects on Selected Blood Components

Feed (g)	Age in Weeks 30	40	50	60
	Mean hematocrit values (percent)			
136	43.1 ±6.5[a]	46.9 ±3.1[a]	45.5 ±2.9[a]	44.6 ±4.4[a]
125	40.9 ±6.4[a]	45.4 ±2.9[a]	44.1 ±2.6[ab]	42.5 ±4.4[ab]
113	41.7 ±4.8[a]	42.7 ±3.7[ab]	43.8 ±3.5[ab]	41.9 ±2.3[ab]
102	42.5 ±4.9[a]	42.1 ±4.1[ab]	42.0 ±4.7[ab]	41.1 ±4.2[ab]
91	38.9 ±5.5[a]	40.7 ±3.7[b]	40.6 ±4.7[b]	40.1 ±4.2[b]
	Mean plasma cholesterol (mg/dl)			
136	107.0 ±20.0[a]	97.5 ±15.6[b]	103.2 ±18.9[a]	87.0 ±15.6[b]
125	117.5 ±27.1[a]	105.6 ±22.3[b]	108.2 ±24.5[a]	98.7 ±23.9[ab]
113	118.1 ±26.5[a]	115.0 ±25.0[ab]	128.0 ±40.2[a]	99.6 ±23.3[ab]
102	119.8 ±34.3[a]	111.1 ±21.8[ab]	123.1 ±15.7[a]	103.3 ±17.0[ab]
91	127.6 ±32.3[a]	148.6 ±37.0[a]	132.8 ±53.0[a]	116.8 ±28.3[a]
Reference values for mean plasma total protein (PTP) and uric acid (PUA) (mg/dl)				
PTP	3.63 ± .42	3.94 ± .62	4.04 ± .62	3.56 ± .74
PUA	4.43 ±1.10	5.99 ±1.20	6.25 ±1.32	3.92 ±1.03

[a,b]Means ± SEM within columns with different lettered superscripts are significantly different ($P<.05$).

Table III.6. Correlation coefficients of plasma cholesterol (PC), body weights (BW), testicular weights (TW), sperm cells per ejaculate (SCPE), and hematocrits (H)

	BW and PC				TW and BW	TW and PC
	Age in Weeks					
Feed (g)	30	40	50	60	60	60
136	-.44	-.36	-.39	.13	-.41	-.48
125	-.76**	-.65*	-.48	-.59*	.25	-.09
113	-.44	-.58*	-.51*	-.41	.62*	-.05
102	-.86**	-.69*	-.87**	-.77**	.40	-.46
91	-.72**	-.77**	-.64*	-.70*	.92**	-.58*
	PC and SCPE					
136	-.11	-.47	-.11	-.16		
125	-.43	-.20	-.50	-.08		
113	-.56*	-.57*	-.28	-.23		
102	-.74**	-.25	-.45	-.43		
91	-.56*	-.40	-.34	-.68*		
	BW and H					
136	.61	.09	.37	.50		
125	.39	.36	.27	.22		
113	.65*	.64*	.43	.45		
102	-.05	.71**	.60*	.59		
91	.44	.86**	.89**	.73*		

* P<.05
**P<.01

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CHAPTER IV

THE EFFECT OF FEEDING PROGRAMS ON REPRODUCTIVE TRAITS AND SELECTED BLOOD CHEMISTRIES OF CAGED BROILER BREEDER MALES: 2. FREE CHOICE, LOW ENERGY RATIONS OF 9, 7 AND 5 PERCENT CRUDE PROTEIN[1]

R. E. Buckner and T. F. Savage

Department of Poultry Science

Oregon State University

Corvallis, OR 97331

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ABSTRACT

Three isocaloric feeds consisting of 9, 7, and 5% crude protein (CP) each containing 2315 kcal ME/kg were fed free choice to individually caged broiler breeder males from 22 to 65 weeks of age. To obtain these protein and energy levels, sand was incorporated into the rations at levels ranging from 26.1 to 33.6% of the feed. The average daily protein intake per male was 18.7, 14.7, and 10.7 g for the 9, 7, and 5% CP, respectively, with an average caloric intake of 480 kcal ME. Individual body weights, semen characteristics, testicular weights, hematocrits, plasma cholesterol, total protein, uric acid and triglyceride levels were evaluated during each 4-week period from 24 to 44 weeks and also at 50 and 65 weeks of age.

Average body weights from 24 to 32 weeks of age were significantly ($P<.05$) lower for the males fed 5% CP than those fed 9% CP rations. Semen volumes and sperm cell numbers per ejaculate were significantly reduced only at 24 weeks of age for males fed 5% CP feeds. At 65 weeks of age there were no significant differences ($P>.05$) among treatments means for body weight, sperm cells numbers per ejaculate, nor testicular weights. Plasma cholesterol levels of males fed the 5% CP diet were significantly higher at 28 and 32 weeks while levels of plasma total protein were decreased at 28 weeks of age. Plasma uric acid levels were consistently and significantly decreased as protein intake was reduced. The results suggest that within the parameters of this study broiler breeder males can be successfully maintained on low energy (2315 kcal/ kg) feeds of 7% CP from 22 to 40 weeks and then 5% CP from 40 to 65 weeks of age.

INTRODUCTION

Efficient management of broiler breeder males for use in artificial insemination (AI) programs favors the removal of the male from the common feed troughs and the hen-oriented diets of natural mating systems. Diets specifically formulated for male breeders should maximize efficiency of sperm cell production because through AI programs, the genetic potential of superior males can be distributed over greater numbers of hens. The nutritional requirements and recommendations of caged broiler breeder males, however, are very sparse.

Brown and McCartney (1983) demonstrated that the broiler breeder male is endowed with a high potential capacity for feed consumption and to prevent excessive weight gain and to improve semen production, energy intake must be reduced by restricting feed consumption. Buckner et al. (1985) reported that the reproductive capabilities of caged broiler breeder males could be maintained on a restricted daily intake of 113 g of a 13% crude protein (CP) ration. This work suggested that significant reductions in the amounts of dietary energy and protein fed males in cages are possible. Arscott and Parker (1963) in earlier research with Single Comb White Leghorn (SCWL) roosters demonstrated that male reproductive traits could be maintained on 6.9% CP, free choice diets. These studies suggest that low protein diets may be feasible to maintain the reproductive traits of the male broiler breeder but energy intake would need to be controlled.

If the energy intake of broiler breeder males could be limited by diluting the feed with an inert ingredient such as sand, the need for daily restricted feeding could be discontinued and could result in labor savings by providing free choice diets. Cherry et al. (1983) observed that a diet containing 20% sand, fed free choice to SCWL hens did not significantly reduce the energy intake. To date, sand-diluted diets have not been evaluated on broiler breeder males.

The objective of this study was to determine the influence on the reproductive traits of caged broiler breeder males full fed isocaloric, low energy, breeder rations containing 9, 7, and 5% CP levels, and to correlate selected blood plasma chemistries with the physiological effect of feeding low energy/low protein rations.

MATERIALS AND METHODS

Hubbard broiler breeder males were raised on litter from day-old to 20 weeks of age according to the breeder's recommendations[2]. At 20 weeks of age, twenty males were randomly assigned to each of three treatment groups and placed in individual cages (30.5 x 45.7 x 46.7 cm). Photo stimulation was initiated at 20 weeks of age using a 10D:14L program in a windowless, positive-pressure ventilated building. From 20 to 22 weeks of age prior to the feeding of the experimental rations, the males were allowed to adapt to the caged environment. Water was provided in continuous "U" shaped plastic troughs for 15- minute intervals beginning with the onset of light and then repeated every 2 hours until the end of the light period.

Each treatment group consisted of four replicates of five males each. The feed treatments consisted of free choice, isocaloric breeder rations containing either 9, 7, or 5% CP with 2315 kcal/kg ME and are described in Table IV.1. The protein levels were obtained by the addition of sand to the diet at levels ranging from 26 to 34% for the 9 to 5% CP diets. Vitamin premix, trace minerals, and the ratios of amino acid levels to protein content were held relatively constant. Individual feed consumption within treatment replicates were determined from the total feed consumed per replicate and adjusted daily for mortality at 4-week intervals from 22 to 40 weeks then between 41-50, and again from 51-65 weeks of age.

[2]Management Guide for the Hubbard White Mountain Male, 1981-1982.

Individual male body weight and semen characteristics per male were measured at 24, 28, 32, 36, 40, 44, 50, and 65 weeks of age. The evaluation of semen characteristics consisted of collecting individual ejaculates in graduated centrifuge tubes, measuring semen and packed cell volumes, and then calculating sperm cell concentrations and numbers per ejaculate. All males were ejaculated manually twice each week to maintain semen production.

At 22 weeks of age, 15 males from each treatment group were chosen at random and identified as donors for use in blood analyses. Concurrently with the evaluation of semen characteristics, a 4-ml blood sample was collected from each identified male between 1300 and 1400 hrs by brachial venipuncture into evacuated heparinized tubes. The tubes were stored in ice until hematocrits were determined and subsequently centrifuged at 1500 x g for 15 minutes. The plasma samples were then separated and stored in air-tight tubes at -15 C until analyses. Those males identified as donors for the blood study were sacrificed at 65 weeks of age and weights of both testes recorded. Plasma samples were analyzed according to the procedures described by Buckner et al. (1985) with an addition of an enzymatic triglyceride assay[3].

Experimental data were analyzed using a two factorial design with main effects of protein level and age. In the absence of significant interaction ($P>.05$), treatment means were compared by

[3]Boehringer Mannheim Diagnostics, Indianapolis, IN.

age using the new Duncan's multiple range test. Pearson's correlation coefficients were calculated to detect significant relationships among reproductive traits and blood plasma chemistries (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The effects of full feeding the low protein diets on the mean daily feed consumption and subsequent protein intake by age are summarized in Table IV.2. Maximum daily feed consumption for the 3 feeds occurred between 25 and 28 weeks of age (during February), and then feed consumption steadily declined with age. A significant ($P<.05$) and unexplained reduction in feed consumption occurred at 40 weeks of age for the males on the 7% CP ration. The mean cumulative feed consumption, however, for the entire study was not significantly different among the 3 treatment groups. Although daily cumulative feed consumption per male did not differ significantly, the cumulative daily protein intake by treatments were significantly different among the 3 treatment groups.

The influence of feed treatments on mean body weights from 24 to 65 weeks and testicular weights at 65 weeks of age are summarized in Table IV.3. Mean body weights were significantly less for the males fed 5% CP diets than those on the 9% CP from 24 through 32 weeks of age, but during the remainder of the study there were no significant differences observed. Mean testicular weights at 65 weeks of age were not significantly different among treatment groups when compared either in total weight or as a percent of live body weight.

The effect of reduced protein consumption on semen volume and sperm numbers per ejaculate from 24 to 65 weeks of age are summarized in Table IV.4. A significant reduction in semen volume was observed only at 24 weeks of age for the males fed 5% CP compared to those on

the 9% CP. Also at 24 weeks of age, a significant reduction in sperm cell numbers per ejaculate between the males fed 5 and 7% CP was observed. A nonsignificant trend of reduced sperm numbers with decreasing dietary protein was observed through 40 weeks of age. At 50 weeks of age the sperm numbers for the 7% group was significantly lower than the 9% group and appears to reflect the unexplained reduction in feed consumption which occurred during the previous period.

The low protein feeds were also observed to affect the metabolism in the breeder males as monitored by blood plasma constituents. The effect of reduced dietary protein on hematocrits, plasma cholesterol, total protein, and uric acid are summarized in Table IV.5. The 9% protein ration resulted in significantly higher hematocrit values compared to either the 7 or 5% rations between 28 and 36 weeks, while a nonsignificant trend continued throughout the remainder of the study. Mean plasma cholesterol levels of the males on the 5% CP diets were significantly increased at 28 and 32 weeks of age. A nonsignificant trend of increased plasma cholesterol levels with decreasing dietary protein intake was noted from 32 to 40 weeks of age.

Significantly reduced plasma total protein levels were observed for males fed 5% CP compared to the 9% CP diet at 28 weeks. A nonsignificant trend of decreased plasma total protein levels with decreased dietary protein consumption was noted throughout the remainder of the study.

Mean plasma uric acid levels from 24 through 50 weeks of age were significantly lowered among the 3 treatment as the dietary protein levels declined. At 65 weeks differences in uric acid levels were significant only between the 9 and 5% CP diets but the continuity of the pattern was maintained.

Mean plasma triglyceride levels in the males fed 5% CP group were significantly increased at 24 weeks of age (9%, 61.3; 7%, 60.1; and; 5%, 70.1 mg/dl). During the remainder of the study (data not presented) neither significant differences nor trends were observed among mean trigyceride levels.

Correlation coefficients were calculated to determine if significant relationships exist between reproductive traits and blood components. The coefficients determined were neither significant nor consistent across treatments or age to establish reliable relationships. Correlation coefficients for testicular weights to plasma cholesterol, total protein, and uric acid as well as plasma cholesterol to total protein, uric acid, and body weights at 65 weeks of age are shown in Table IV.6. These data illustrate that the 5% CP diet influenced the magnitude and direction of the correlation coefficients for testicular weights to plasma cholesterol and uric acid, as well as for plasma cholesterol to total protein relationships

Throughout the duration of the study, mean daily feed intakes were similar for all treatment groups which indicated that the broiler breeder males were consuming for their energy requirements. Factors that may have had an effect on mean feed consumption and

concurrent protein intake were seasonal changes in temperature and palatability of feed ingredients. Because the experiment began in December when the in-house temperatures were cooler (15 - 20 C), the resulting stimulus to feed consumption cannot be ignored. Feed consumption as affected by palatability, on the other hand, did not appear to play a significant roll among treatment groups. The 5% CP ration contained 6% added fat to maintain its isocaloric status with the other treatment feeds. Cherry (1982) demonstrated that for a period of 14 days, the addition of dietary fat at 10% of the feed, significantly increased feed consumption for cellulose-diluted diets. In this study, the consumption of the 5% CP ration which contained the supplemented fat, was slightly higher than the other treatment rations for approximately the first half of the study, but slightly lower for the last half.

The results of this study suggest that by using a form of phase feeding, caged broiler breeder males may be successfully maintained on sand-diluted diets of 7% CP (2315 kcal ME/kg) fed free choice from 22 to 40 weeks of age. It would appear that after 40 weeks of age the diets could be reduced to 5% CP through 65 weeks of age. Within the parameters of this experiment, the phase feeding regimen described above could easily be incorporated into an automated feeding system.

Of the blood chemistries evaluated in this study, plasma uric acid levels consistently reflected protein consumption by monitoring nitrogen excretion levels. Plasma cholesterol, on the other hand,

appeared to reflect differences in male body weights. None of the blood chemistries were found to be reliable monitors of reproductive traits within the parameters measured in this experiment. Further research is necessary to identify other possible blood constituents which may be reliable monitors of male reproductive capabilities.

Table IV.1. Feed composition of treatment rations

Ingredients	Rations (%CP) 9%	7%	5%
		(percent)	
Corn	58.29	60.68	51.43
Sand, silicate (#70 grade)	26.08	27.69	33.60
Barley	5.00	5.00	5.00
Animal fat	.01	.50	5.97
Soybean meal (47.5%)	7.13	2.48	.0
Alfalfa dehy. (17%)	.5	.5	.5
Defl. phosphorus (32%Ca,18%P)	1.96	2.0	2.0
Limestone flour	.3	.3	.6
Salt	.25	.25	.25
Vitamin premix[1]	.4	.4	.4
Trace minerals mix[2]	.07	.07	.07
Biotin (Rovamix-H)[3]	.01	.01	.02
Lysine	.0	.12	.16
Feed analysis (calculated)			
Crude protein	9.10	7.10	5.10
Metab. energy (kcal/kg)	2308	2312	2314
Fat, animal	2.47	3.00	8.08
Calcium	.80	.80	.90
Phosphorous, available	.43	.43	.41
Amino acids analysis (actual)			
Arginine	.473	.304	.226
Alanine	.805	.665	.488
Glycine	.608	.471	.333
Histidine	.225	.153	.122
Isoleucine	.339	.261	.169
Leucine	.937	.780	.571
Lysine	.389	.256	.269
Methionine	.152	.148	.113
Cystine	.178	.101	.049
Phenylalanine	.364	.282	.198
Tyrosine	.268	.214	.164
Proline	.744	.671	.489
Serine	.588	.434	.301
Threonine	.395	.295	.209
Valine	.426	.364	.239

[1]Provided per kg ration: vitamin A, 6600 IU; vitamin D_3, 2200 ICU; riboflavin, 6.6 mg; d-pantothenic acid, 11.0 mg; niacin, 44.0 mg; choline, 381.9 mg; vitamin B_{12}, 1.1 mcg; vitamin E, 2.2 IU; vitamin K, 1.1 mg; folic acid, .44 gm; ethoxyquin, .12 g.

[2]Provided per kg ration: Mn, 84 mg; Fe, 28 mg; Cu, 2.8 mg; Zn, 38.5 mg; Co, .28 mg.

[3]Provided gratuitously by Hoffmann La-Roche, Inc., Nutley, NJ.

TABLE IV.2. Mean daily feed consumption and resulting protein consumption of treatment rations[1]

Protein Level	Age in Weeks 24	28	32	36	40	50	65	Cumulative mean
				Mean daily feed consumption (g)				
9%	213 ±17^{a}	245 ±29^{a}	227 ±28^{a}	239 ±23^{a}	220 ±25^{ab}	172 ±49^{a}	190 ±14^{a}	205 ±11^{a}
7%	207 ± 9^{a}	242 ±17^{a}	234 ± 8^{a}	226 ±16^{a}	186 ±13^{b}	194 ±27^{a}	186 ±44^{a}	207 ±25^{a}
5%	218 ±16^{a}	272 ±14^{a}	245 ± 8^{a}	259 ± 7^{a}	241 ±17^{a}	174 ±30^{a}	183 ±35^{a}	214 ±15^{a}
				Mean daily protein consumption (g)				
9%	19.4±1.6^{a}	22.3±2.6^{a}	20.7±2.6^{a}	21.8±2.1^{a}	20.1±2.3^{a}	15.7±4.5^{a}	17.3±1.3^{a}	18.7±1.0^{a}
7%	14.7± .6^{b}	17.2±1.2^{b}	16.6± .5^{b}	16.1±1.1^{b}	13.2± .9^{b}	13.8±1.9^{ab}	13.2±3.1^{ab}	14.7±1.8^{b}
5%	11.1± .8^{c}	13.9±1.2^{b}	12.5± .4^{c}	13.2± .4^{b}	12.3± .8^{b}	8.9±1.5^{b}	9.3±1.8^{b}	10.9± .8^{c}

[1]Statistical analysis based on average feed consumption per male per replicate

^{a,b,c}Means ±S.E. within columns with different superscripts are significantly different ($P<.05$).

TABLE IV.3. The effects of treatment diets on mean body weights and 65 week, total testicular weights per male at various ages

Protein Level	Mean body weights							Mean testicular weights
	24wk	28wk	32wk	36wk	40wk	50wk	65wk	65wk
				(kg)				(g)
9%	4.21±.31[a] (20)	4.80±.49[a] (20)	5.12±.51[a] (20)	5.47±.55[a] (20)	5.38±.69[a] (19)	5.54±.45[a] (15)	5.60±.39[a] (14)	36.2 ±11.4[a] (12)
7%	3.81±.43[b] (19)	4.46±.30[b] (19)	4.77±.35[ab] (19)	5.05±.50[b] (18)	4.98±.45[a] (17)	5.24±.50[a] (16)	5.53±.54[a] (16)	34.2 ±14.4[a] (12)
5%	3.81±.35[b] (20)	4.34±.32[b] (20)	4.64±.32[b] (20)	5.11±.49[ab] (20)	5.23±.48[a] (19)	4.98±.94[a] (17)	5.65±.57[a] (15)	39.0 ± 6.1[a] (10)

[a,b]Means ±S.E. within columns with different superscripts are significantly different ($P<.05$).
()=number males per treatment.

Table IV.4. The effects of treatment diets on mean semen volume and sperm cells per ejaculate per male at various ages

Protein Level	24wk	28wk	32wk	36wk	40wk	44wk	50wk	65wk
				Semen volumes (ml)				
9%	.58 ±.26^{a}	.60 ±.28^{a}	.94 ±.38^{a}	1.05 ±.29^{a}	.96 ±.29^{a}	.86 ±.33^{a}	.83 ±.36^{a}	.69 ±.37^{a}
7%	.53 ±.23^{ab}	.61 ±.28^{a}	.92 ±.38^{a}	.94 ±.29^{a}	.82 ±.29^{a}	.68 ±.33^{a}	.61 ±.36^{a}	.58 ±.37^{a}
5%	.41 ±.23^{b}	.55 ±.36^{a}	.88 ±.37^{a}	.85 ±.48^{a}	.85 ±.43^{a}	.78 ±.38^{a}	.69 ±.37^{a}	.61 ±.39^{a}
				Sperm cell numbers per ejaculate ($\times 10^{9}$)				
9%	1.36± .84^{ab}	3.44±2.13^{a}	4.8 ±2.29^{a}	4.64±1.75^{a}	4.59±2.92^{a}	3.93±1.86^{a}	2.69±1.46^{a}	2.60±1.99^{a}
7%	1.56±1.07^{a}	3.25±2.18^{a}	4.28±2.11^{a}	4.26±1.95^{a}	4.59±1.76^{a}	3.02±1.80^{a}	1.38± .99^{b}	2.25±1.94^{a}
5%	.72± .77^{b}	2.57±1.96^{a}	4.04±2.08^{a}	3.79±2.58^{a}	3.52±2.10^{a}	3.53±2.54^{a}	1.75±1.52^{ab}	2.79±1.73^{a}

^{a,b}Means ±S.E. within columns (total males) with different superscripts are significantly different ($P<.05$).

TABLE IV.5. The effects of treatment diets on mean hematocrit, plasma cholesterol, total protein, and uric acid

Protein Level	Age in wks 24	28	32	36	40	44	50	65
				hematocrit (percentage)				
9%	32.6±2.9[a]	46.3±4.4[a]	47.9±3.3[a]	46.8±3.1[a]	45.7±8.7[a]	47.8±2.7[a]	44.2±2.0[a]	44.8 ±2.7[a]
7%	32.1±3.7[a]	41.6±4.9[b]	41.9±4.4[b]	42.2±3.6[b]	45.1±3.9[a]	44.5±3.8[b]	42.8±2.7[a]	41.9 ±5.4[a]
5%	30.4±3.9[a]	41.9±4.1[b]	41.7±4.4[b]	42.4±3.2[b]	44.9±3.1[a]	44.5±2.8[b]	42.3±4.1[a]	43.2 ±2.9[a]
				cholesterol (mg/dl)				
9%	90.4±12.9[a]	91.7±22.8[b]	90.3±23.0[b]	89.0±17.3[a]	99.2±25.9[a]	92.7±30.8[a]	105.6±25.1[a]	121.1±37.1[a]
7%	97.4±20.8[a]	100.9±27.7[ab]	102.9±28.8[ab]	104.2±33.1[a]	114.5±23.3[a]	118.5±31.4[a]	101.2±18.7[a]	118.1±26.4[a]
5%	99.1±14.1[a]	123.9±14.5[a]	117.9±14.7[a]	109.2±18.9[a]	119.3±19.4[a]	111.1±27.9[a]	112.0±21.9[a]	118.0±16.1[a]
				total protein (mg/dl)				
9%	2.58±.41[a]	3.45±.53[a]	3.39± .66[a]	4.16± .57[a]	3.89±.51[a]	4.42±.53[a]	4.53± .91[a]	4.53± .96[a]
7%	2.35±.30[a]	3.10±.83[ab]	3.28±1.06[a]	3.95±1.71[a]	4.18±.60[a]	4.03±.80[a]	3.99±1.05[a]	4.69±1.59[a]
5%	2.31±.46[a]	2.85±.56[b]	2.94± .95[a]	3.17±1.03[a]	3.97±.79[a]	3.82±.60[a]	3.97±1.82[a]	4.06±1.62[a]
				uric acid (mg/dl)				
9%	5.37±1.21[a]	6.78±1.36[a]	6.80±1.74[a]	6.11±1.31[a]	6.85±1.55[a]	6.80± .72[a]	6.44±1.35[a]	5.64±2.25[a]
7%	4.05± .93[b]	5.78±1.48[b]	5.01±1.42[b]	4.93±1.39[b]	5.76±1.15[b]	5.11±2.11[b]	4.62±2.01[b]	4.24±1.34[ab]
5%	3.27±1.08[c]	4.37±1.03[c]	3.32± .96[c]	3.53± .95[c]	3.91± .66[c]	3.80± .80[c]	3.25± .60[c]	3.56± .98[b]

[a,b,c]Means ±S.E. within columns with different superscripts are significantly different ($P<.05$).

Table IV.6. Treatment effects on correlation coefficients at 65 weeks for testicular weights (TW), plasma cholesterol (PC), plasma total protein (PTP), plasma uric acid (PUA), and body weight (BW)

Protein level	TW with:			PC with:		
	PC	PTP	PUA	PTP	PUA	BW
9%	-.56*	.11	-.44	.40	.87**	-.11
7%	-.65*	-.41	-.51	.58*	.61*	-.55*
5%	.25	-.07	.58*	-.47	.39	-.29

*=P<.05
**=P<.01

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CHAPTER V

INFLUENCES OF 16 AND 17.5 PERCENT DIETARY PROTEIN AND SUPPLEMENTAL METHIONINE ON THE REPRODUCTIVE TRAITS AND SELECTED PLASMA CHEMISTRIES OF CAGED DWARF (dw) BROILER BREEDER FEMALES[1]

R. E. Buckner and T. F. Savage

Department of Poultry Science

Oregon State University

Corvallis, OR 97331

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ABSTRACT

A total of 240 individually caged dwarf (dw) broiler breeder females were fed one of six isocaloric diets (2740 kcal/kg) containing 16 or 17.5% crude protein (CP) to which d,l-methionine (MET) was supplemented at 0, .08, or .15% from 22 to 50 weeks of age. The resulting dietary MET levels ranged from .256 to .424% and total sulfur amino acids (TSAA) ranged from .527 to .718% of the rations. Treatment means were compared for body weights, female mortality, total egg production, egg weights, and egg fertility and hatchability resulting from artificial insemination with .05 ml broiler breeder semen. Blood plasma was analyzed at 32, 40, and 50 weeks of age for cholesterol, uric acid, total protein, and albumin as possible monitors of dietary protein utilization and of the physiological effects of protein and methionine levels on reproductive traits.

There were no significant differences ($P>.05$) observed among the dietary treatment means for body weight, mortality, cumulative egg production, fertility, or hatchability from 24 to 50 weeks of age. Significant differences were not observed among the treatment means for plasma cholesterol, total protein, and albumin at 32, 40, or 50 weeks of age. Between the two CP levels, plasma uric acid was significantly ($P<.05$) increased for the females on 17.5% compared to those on 16% CP rations. A consistent although nonsignificant trend of decreased uric acid levels with supplemental methionine was observed only in females fed 16% CP diets and not in those on 17.5% CP.

Under the conditions of this experiment, protein requirements for cage broiler breeder females from 22 to 50 weeks of age appear to be satisfied with daily dietary intakes of 20.3 g CP, 325 mg MET, and 670 mg TSAA.

INTRODUCTION

The sex-linked dwarf (dw) breeder female, due to her reduced body size and greater feed efficiency for egg production, has the potential of improving the economics of broiler hatching eggs as reviewed by Guillaume (1976) and Merat (1984). The dw broiler breeder female, because of her size, has also been shown to adapt more readily to the cage environment than the normal sized breeder female (Lin et al., 1979) and, therefore, may be better suited for the production of hatching eggs using artificial insemination (AI) programs. One of the dw gene limitations is the reduction in egg size and consequent chick weight at hatching (Chambers et al., 1974; and Whiting and Pesti, 1983). Renden and Pierson (1982), however, demonstrated that by housing the dw female in cages instead of in floor pens, egg size could be significantly increased, and thereby enhance the dwarf as a viable and efficient breeder for the commercial broiler industry.

In order to fully implement the dwarf, the feeding requirements need to be ascertained. Dietary crude protein (CP) levels for the dw broiler breeder have yet to be fully defined, and the full impact of the cage environment on nutrition should be evaluated. According to Guillaume (1973), Larbier and Blum (1975), and Blum et al. (1979), the total sulfur amino acid (TSAA) requirement in the diet of the dw breeder is greater than the normal broiler breeder female in order to maintain a larger egg size. The optimum dietary CP levels for the dw breeder may also be greater than that of the normal sized breeder

(Quisenberry et al., 1969). In commercial practice, the recommended dietary CP levels range from 16 to 17.5% with the belief that 1) the dwarf requires more dietary protein than the normal size breeder female, and 2) to insure a good nutrient margin of safety. To establish the protein requirements for dw broiler breeder females in cages, the CP and TSAA levels that result in maximum reproductive traits need to be determined.

The objectives of this study were to compare the effects of feeding 16 and 17.5% CP rations supplemented without and with .08 or .15% d,l methionine (MET), on the reproductive traits and blood plasma chemistries of dw broiler breeder females in cages from 22 to 50 weeks of age.

MATERIALS AND METHODS

Commercial dw broiler breeder females were raised from day-old to 20 weeks of age in floor pens covered with wood-shaving litter according to the breeder's recommendations[2]. At 20 weeks of age, 40 females were randomly assigned to each of six treatment groups and placed in individual cages (30.5 x 45.7 x 46.7 cm). A stimulatory photo period of 10D:14L was provided within the windowless, positive pressure, ventilated building. Water was available for eight 15-min periods at 2 hr intervals during the light period in U-shaped water troughs. Females were allowed to adapt to the cage environment two weeks prior to beginning the feeding treatments.

At 22 weeks of age, the 40 females within each treatment group (consisting of four replicates of 10 birds each) were fed one of six isocaloric diets (2740 kcal ME/kg) consisting of 16 or 17.5% CP. Both CP levels were supplemented without and with .08 or .15% d,l methionine (MET) (Table V.1). Daily feeding levels for treatment diets began at 91 g feed /female and continued through 23 weeks of age. During successive weeks this level was increased to 104, 113, 118, 122, and then maintained on 127 g/female from 28 through 50 weeks of age. Feed was evenly distributed along a continuous trough in the front of the cage. Mortality, feed allocations per replicate, and individual egg production were recorded daily.

[2]Management Guide for the Hubbard Minipac, 1982-1983 ed.

To evaluate the dietary influence, if any, upon fertility and hatchability, females were artificially inseminated weekly with .05 ml pooled, undiluted broiler breeder semen. Every fourth week from 30 through 50 weeks of age, eggs were collected from days 2 through 8, post-insemination, and prior to incubation, mean egg weight by female was determined. After 10 days of incubation, eggs were candled and those with an apparent lack of embryonic development were removed, identified by cage number of female, opened, and examined macroscopically to determine true percent fertility. Eggs that did not hatch after 21 days of incubation were examined as to cause, and percent hatchability of fertile eggs (HFE) per female was calculated.

Fifteen females from each treatment group which had been chosen at random at 22 weeks of age and identified as donors were used for the blood analysis study. At 32, 40, and 50 weeks of age and between 9 and 11 hrs after lights on, a 4-ml blood sample was collected from each identified donor by brachial venipuncture into evacuated, heparinized tubes. Blood samples were stored in ice until centrifugation at 1500 x g for 15 min. Plasma was separated and stored in air-tight tubes at -15 C until analyses. The plasma samples were analyzed according to procedures described by Buckner et al. (1984) for cholesterol, uric acid, total protein, and albumin (bromcresol green)[3].

[3]Boehringer Mannheim Diagnostics, Indianapolis, IN.

Experimental data were analyzed using a factorial design. Significant differences ($P<.05$) among treatment means at each age were compared using Duncan's multiple range test. Pearson's correlation coefficients were calculated to detect significant relationships among reproductive traits and plasma chemistries (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The performance data on the effects of feeding 16 and 17.5% CP diets without and with supplemental MET are summarized in Table V.2 for mean body weight and egg size at 32 and 50 weeks of age,and cumulative egg numbers, fertility, and HFE from 28 to 50 weeks of age. There were no significant differences ($P>.05$) among treatments for mean body weight, egg weight, cumulative egg numbers, percent fertility, or HFE throughout the study (28 to 50 weeks of age). The percent hen-day egg production by week for treatment means (data not shown) followed the breeder's predicted egg production curve from onset of lay through peak egg production. No significant difference was noted in percent mortality between the CP treatment groups (1.7% for the 16% and 0% for the 17.5% CP diets) from 20 through 50 weeks of age.

The effects of dietary CP levels and supplemental MET on plasma chemistries at 32, 40, and 50 weeks of age are summarized in Table V.3. Although an interesting trend for plasma cholesterol was observed, decreasing levels with added MET, there were no significant differences among treatment means.

Plasma uric acid levels were significantly different between the 16% and 17.5% CP means at 32 and 50 weeks of age. The mean plasma uric acid levels for the 16% CP supplemented with .15% MET were significantly lower than the 17.5% CP supplemented with .08% MET for the three ages evaluated. A consistent, nonsignificant trend of reduced plasma uric acid levels with supplemented MET was observed

only among the means for the 16% CP group. No significant differences or trends were observed among treatment means for plasma total protein or albumin.

The results of this feeding study indicated that mean body weights, mortality, egg size, egg production, fertility, and HFE were not significantly influenced by either increasing CP from 16 to 17.5% or supplementing MET levels in the diet. In this study the unsupplemented 16% CP ration provided the female 20.3 g CP and 670 mg TSAA/ day. Studies by Guillaume (1971) and Waldroup and Hazen (1975) confirm the results of this study and, in fact, indicate that the dw broiler breeder can maintain egg production and egg size at even lower CP levels, i.e., 17 g CP and 640 mg TSAA/female/day. The energy consumption of the females in the present study (348 kcal ME/female/day) maintained body weights from 22 to 40 weeks of age within the recommended guidelines of the breeder, but from 40 to 50 weeks of age, mean body weights exceeded the recommended weights for dw females maintained in floor pens. Body weight gain after maximum, hen-day egg production (i.e., 38 weeks of age) would indicate a need for increased feed restriction in order to prevent excess fat deposition (Buckner et al., 1982).

There were no significant or consistent correlation coefficients observed among plasma chemistries (cholesterol, uric acid, total protein, and albumin) with egg production parameters (body size, egg size, and egg numbers). The effects of dietary MET and CP levels on correlation coefficients between body weights and egg size are summarized in Table V.4. These significant correlation

coefficients reconfirm the relationship of female body weights and resulting egg weights (Jaffé, 1968). It appears from these data that at both CP levels with .08% supplemental MET, a reduction was observed in the correlation of female body weight to egg weight.

Supplemental MET slightly reduced plasma cholesterol levels within the 16 and 17.5% CP groups, while supplemental MET reduced plasma uric acid levels only within the 16% CP group. No effect was observed in total protein nor albumin levels by either CP or MET. The interesting but nonsignificant trend observed among treatment means suggests that increasing dietary MET levels reduces avian plasma cholesterol. Shapiro and Freedman (1955) reported that adding MET to MET-deficient diets of rats decreased the serum cholesterol levels. In the present study the MET levels in the diets were within the breeder's recommended levels for MET and TSAA. Further research, however, is needed in this area of blood chemistry and nutritional interrelationship with MET to fully understand this phenomenon.

The effect of dietary treatments on plasma uric acid levels indicate that even though the higher CP and MET levels had no effect on reproductive traits, nitrogen excretion was affected. Dietary protein levels have been shown to affect plasma uric acid levels in broilers (Garcia Partida et al., 1982) and in broiler breeder males (Buckner and Savage, 1984). The data from this study suggests that protein within the 16% CP diets was being utilized more efficiently at the higher MET levels resulting in lower nitrogen excretion. This idea would concur with Miles and Featherston (1974) who used uric acid excretion to determine amino acid requirements. These data

also suggest that the dw females in this study could utilize higher levels of TSAA than reproductive traits (i.e., egg production and egg weights) would indicate. One other possible explanation for the changes in uric acid levels could be explained by different pathways of nitrogen excretion. As 80% of nitrogen excreted is in the form of uric acid and approximately 15% ammonia (Griminger, 1976), changes in the diet that may affect the acid-base balance can shift the excretion direction to uric acid, ammonia, or urea (Skadhauge, 1983).

Cohen-Parsons et al. (1983) measured the effect on total protein and free amino acid levels in blood from breeder turkey females fed different levels of dietary CP and supplemental MET. The blood protein levels, which reflect the demand on protein reserves during the laying season, varied as to the level of deficiency in CP and MET. The plasma total protein and albumin levels observed in this study were not affected by treatment diets and indicate sufficient dietary CP and MET levels were maintained for egg production demands throughout the study.

Under the conditions of this study, no beneficial effect on the reproductive traits of caged broiler breeder females resulted from increasing CP levels above 16% CP which provided daily intakes of MET and TSAA of 325 mg and 670 mg, respectively.

Table V.1. Feed ingredient and composition of unsupplemented treatment rations

Ingredients	16% CP	17.5% CP
	percent	
Barley, Pacific Coast	20.17	15.68
Corn, yellow	50.86	51.48
Soybean meal, (47.5%CP)[1]	14.32	18.19
Meat and bone meal (49.5%CP)	5.00	5.00
Alfalfa dehy. (17%CP)	2.50	2.50
Deflur. phos. (32%Ca,18P%)	1.00	1.00
Limestone flour	3.15	3.15
Oystershell	2.50	2.50
Salt	.25	.25
Vitamin premix[2]	.20	.20
Trace mineral mix[3]	.05	.05
Total	100.00	100.00
Calculated analysis		
Protein, crude[4]	16.0	17.5
Energy, ME (kcal/kg)	2742	2739
Linoleic acid	1.16	1.15
Fiber, crude	3.34	3.20
Fat	3.14	3.12
Calcium	3.15	3.15
Phosphorous, avail.	.57	.57
Methionine, basal	.256	.279
supplemented with .08% MET	.333	.356
supplemented with .15% MET	.412	.424
Cystine	.272	.297
Lysine	.785	.890

[1]Methionine supplemented rations replace soybean meal with d,l methionine (98%) at .08 and .15% of ration.

[2]Vitamin premix provides per kg ration: vitamin A, 3300 IU; vitamin D_3, 1100 ICU; riboflavin, 3.3 mg; d-pantothenic acid, 5.5 mg; niacin, 22.0 mg; choline, 190.0 mg; vitamin B_{12}, 5.5 mcg; vitamin E, 1.1 IU; vitamin K, .55mg; folic acid, .22 mg; ethoxyquin, .06 g.

[3]Trace mineral mix provides per kg ration: Mn, 50mg; Fe, 2 mg; Cu .2 mg; Zn, 27.5 mg; Co .2 mg.

[4]Crude protein levels were verified using Kjeldahl assay.

Table V.2. Treatment effects on mean body and egg weight at 32 and 50 weeks of age and cumulative egg production, percent fertility, and hatchability from 28 to 50 weeks of age[1]

Dietary treatments	Body weights		Egg weights		Egg production	Fertility	Hatchability
	32 wk	50 wk	30 wk	50 wk	24-50 wk	28-50 wk	28-50 wk
(%CP+ MET)	(kg)	(kg)	(g)	(g)	(No. eggs)	(%)	(%)
16	2.42 ±.22	2.92 ±.33	58.1 ±2.7	64.1 ±3.4	116.1 ±21.0	90.6 ±7.4	91.2 ±8.2
16+.08	2.45 ±.21	2.99 ±.29	58.7 ±4.3	64.4 ±4.2	114.5 ±28.0	93.8 ±6.8	90.4 ±7.4
16+.15	2.41 ±.20	2.88 ±.28	58.6 ±3.3	64.9 ±4.3	121.5 ±28.6	91.8 ±9.0	92.8 ±6.6
Mean	2.43 ±.21	2.93 ±.30	58.5 ±3.5	64.5 ±4.0	117.4 ±26.0	92.1 ±7.7	91.5 ±7.4
17.5	2.42 ±.22	2.89 ±.31	58.6 ±4.6	64.0 ±4.1	117.7 ±20.2	93.8 ±9.2	93.2 ±4.6
17.5+.08	2.42 ±.25	2.88 ±.33	58.7 ±3.7	64.7 ±3.9	116.7 ±20.3	92.4 ±8.0	93.2 ±8.8
17.5+.15	2.44 ±.21	2.92 ±.27	58.2 ±3.9	64.4 ±3.8	118.9 ±20.9	94.8 ±6.2	92.8 ±6.6
Mean	2.43 ±.23	2.89 ±.31	58.5 ±4.0	64.4 ±3.9	117.8 ±20.4	93.7 ±7.8	93.1 ±6.7

[1]Means ±S.E. in each column are not significantly different (P>.05).

Table V.3. The effect of treatment diets on plasma cholesterol and uric acid levels with reference values for total protein and albumin at 32, 40, and 50 weeks of age

Treatments	32 wk	40 wk	50 wk
(%CP+ MET)		Mean plasma cholesterol (mg/dl)	
16	166.5 ±56.4	196.4 ±64.7	143.2 ±46.8
16+.08	137.1 ±37.4	174.9 ±49.4	134.3 ±63.3
16+.15	137.1 ±36.1	208.9 ±62.1	134.7 ±40.9
Mean	146.9 ±45.5	193.4 ±58.7	137.4 ±50.2
17.5	162.7 ±59.9	217.3 ±92.9	182.1 ±76.0
17.5+.08	156.8 ±47.3	197.1 ±67.6	145.6 ±48.4
17.5+.15	146.8 ±52.3	145.9 ±47.6	146.0 ±63.5
Mean	155.4 ±52.6	186.8 ±69.4	157.9 ±64.6
		Mean plasma uric acid (mg/dl)	
16	8.87 ±1.99^{b}	9.41 ±2.10^{b}	7.20 ±1.37^{ab}
16+.08	7.89 ±1.72^{ab}	8.36 ±1.92^{ab}	7.16 ±1.67^{ab}
16+.15	7.32 ±1.25^{a}	7.78 ±1.32^{a}	6.17 ± .99^{a}
Mean	8.03 ±1.77^{A}	8.52 ±1.78^{A}	6.84 ±1.42^{A}
17.5	8.54 ±1.26^{ab}	8.74 ±1.52^{ab}	6.90 ±1.27^{ab}
17.5+.08	8.72 ±1.44^{b}	9.84 ±1.26^{b}	7.79 ± .90^{b}
17.5+.15	8.88 ±1.59^{b}	9.00 ±1.78^{ab}	7.07 ± .88^{ab}
Mean	8.71 ±1.41^{B}	9.19 ±1.52^{A}	7.25 ±1.08^{B}
		Mean plasma total protein (mg/dl)	
16 Mean	4.61±.70	5.05 ±1.06	5.72 ±.78
17.5 Mean	4.49±.63	5.00 ± .75	5.60 ±.88
		Mean plasma albumin (mg/dl)	
16 Mean	1.96 ±.46	2.07 ±.34	2.37 ±.36
17.5 Mean	1.84 ±.45	1.99 ±.29	2.24 ±.35

a,b/A,B Means ±S.E. within columns with different superscripts are significantly different ($P<.05$); the absence of superscripts indicate no significant difference ($P>.05$).

Table V.4. The influence of dietary CP and MET on correlation coefficients of hen body weight and egg weight

Dietary treatments	32 wk	40 wk	50 wk
(%CP+ MET)			
16	.53**	.35*	.39*
16+.08	.14	.22	-.05
16+.15	.64**	.64**	.44**
17.5	.63**	.51**	.50**
17.5+.08	.25	.28	.15
17.5+.15	.46**	.35*	.15

* P<.05
**P<.01

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CHAPTER VI

SUMMARY AND CONCLUSION

Within the parameters and conditions of these studies the following nutritional recommendations were established and nutritional effects on specific blood components observed.

1. Restricted Feeding of Broiler Breeder Males

The minimum daily feeding level of the five different levels studied (136, 125, 113, 102, and 91 g/male/day), which consistently maintained reproductive traits (i.e., semen volume, sperm cells per ejaculate, and fertilizing capacity), was determined to be 113 g/male of the breeder ration (13.1% CP and 3176 kcal/kg ME). The daily energy and protein consumption at this feeding level was 358 kcal ME and 14.8 g/male, respectively. This daily nutrient intake was sufficient for semen and sperm cell production without significant increases in percent of males not producing semen.

Decreasing feeding levels increased plasma cholesterol levels and decreased hematocrit levels as well as body and testicular weights. Significant negative correlation coefficients were observed between plasma cholesterol levels with body weight, sperm cell production, and testicular weights. Positive correlations were observed between hematocrit levels and body weight.

2. Dietary Protein Restriction in Broiler Breeder Males

The effects of full feeding the three isocaloric diets containing 9, 7, or 5% CP were evaluated in broiler breeder males in cages. No significant differences were observed between the males fed the 9 and the 7% CP rations in their ability to maintain semen and sperm cell production from 24 to 40 weeks of age. From 40 through 65 weeks of age, however, the 5% CP ration was sufficient to maintain reproductive traits.

Reduced dietary protein from 9 to 5% in the diet caused increases in plasma cholesterol and decreases in plasma total protein by 28 weeks of age while a nonsignificant trend continued through 40 weeks of age. Reduced protein intake, however, reduced hematocrit and uric acid levels throughout the study. Correlation coefficients were neither significant nor consistent to establish relationships between blood chemistries and reproductive traits.

3. Protein and Methionine Levels for Dwarf Broiler Breeder Hens

The effects of feeding caged dwarf broiler breeder females 16 and 17.5% CP rations without and with supplemental methionine at .08 and .15% of ration, were evaluated from 24 to 50 weeks of age on reproductive traits. There were no significant effects nor trends observed in egg production, egg size, fertility, hatchability of fertile eggs, or mortality from increasing CP level above 16% or increasing methionine levels above the basal level of .256% in the ration.

Plasma cholesterol levels were not affected by dietary protein levels, however, within each protein level, cholesterol levels appeared to be reduced by supplemental methionine. Plasma uric acid levels were significantly increased with increased dietary protein while supplemental methionine appeared to decrease uric acid in the blood of females fed the 16% CP rations. Correlation coefficients were not significant between blood chemistry values and reproductive traits. A positive correlation, however, was observed between body weights and egg weights.

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APPENDICES

APPENDIX 1

THE EFFECT OF FEEDING PROGRAMS ON REPRODUCTIVE TRAITS AND SELECTED BLOOD CHEMISTRIES OF CAGED BROILER BREEDER MALES

1. FEED RESTRICTION LEVELS

The results of the study dealing with the effects of feed restriction on the reproductive capabilities of caged broiler breeder males are listed within the text of Chapter III if statistically significant differences among treatment means were observed when evaluated. The following data listed in Appendix 1 are not significantly different; nevertheless, this information may be of interest by providing more background information about the study. Table A1.3 contains statistically significant data, but due to the nature of the comparisons the conclusions are biased towards the more restricted feeding treatments. The comparisons of semen producing versus non-semen producing males, nevertheless, demonstrates some physiological differences between these two groups.

Table A1.1. Effects of restricted feeding on semen concentration and fertilizing capacity measured in artificially inseminated (AI) White Leghorn hens from 30 to 60 weeks of age[1]

Feed	Age in weeks 30	40	50	60
		Semen concentration		
(g)		(sperm cells /mm^3 x 10^6)		
136	3.67 ±1.96	4.65 ± .89	4.07 ±1.97	4.82 ±1.38
125	3.75 ±1.94	4.32 ±1.03	4.45 ±1.30	4.26 ±1.37
113	3.95 ±1.21	4.57 ±1.47	4.01 ±1.56	4.40 ±1.49
102	3.46 ±1.23	4.12 ± .91	3.29 ±1.62	4.14 ±1.37
91	2.50 ±2.01	3.25 ±1.78	3.78 ± .95	4.04 ±1.38
		Fertility of AI hens[2] (percent)		
136	91.9 ± 8.1	86.6 ±15.5	85.0 ±18.9	73.3 ±23.0
125	95.4 ± 7.0	78.0 ±21,9	79.8 ±16.6	65.1 ±27.4
113	88.5 ±12.6	80.1 ±18.9	78.2 ±21.0	73.6 ±19.1
102	86.8 ±21.2	88.2 ±12.0	76.9 ±21.6	76.3 ±25.4
91	82.1 ±21.1	77.2 ±19.3	76.8 ±26.3	79.4 ± 9.6

[1]Means ±SEM within columns are not significantly different ($P>.05$) and includes only males producing semen.

[2]Means transformed to arcsine for statistical analysis.

Table A1.2. Effects of restricted feeding on plasma total protein and uric acid levels from 30 to 60 weeks of age[1]

Feed (g)	Age in weeks 30	40	50	60
		Total protein (mg/dl)		
136	3.70 ± .55	3.84 ± .67	3.70 ± .47	3.41 ± .56
125	3.85 ± .60	4.04 ± .67	4.02 ± .53	3.89 ±1.02
113	3.57 ± .30	3.77 ± .46	3.99 ± .54	3.37 ± .79
102	3.63 ± .46	3.98 ± .70	4.46 ± .62	3.54 ± .57
91	3.62 ± .36	4.28 ± .71	4.14 ± .81	3.63 ± .58
		Plasma uric acid (mg/dl)		
136	4.61 ±1.22	5.74 ±1.34	6.51 ± .94	4.07 ±1.11
125	4.13 ±1.13	5.48 ±1.22	5.53 ±1.28	3.30 ±1.14
113	4.12 ±1.20	6.11 ±1.26	6.10 ±1.70	3.76 ± .69
102	4.65 ±1.10	6.42 ± .60	6.76 ± .84	4.53 ±1.01
91	4.45 ±1.17	6.11 ±1.35	6.58 ±1.36	4.15 ± .78

[1]Means ± SEM within columns are not significantly different (P>.05).

Table A1.3. Comparisons of semen producing (P) and nonproducing (NP) males for selected characteristics in the feed restriction study from 30 to 60 weeks of age[1]

Males	30 wks	40 wks	50 wks	60 wks
		Body weights (kg)		
P	4.0 ± .5[a]	4.8 ± .6[a]	4.9 ± .6[a]	4.9 ± .7[a]
NP	3.3 ± .3[b]	3.8 ± .8[b]	3.8 ± .7[b]	3.9 ±1.1[b]
		Hematocrits (percent)		
P	43.4 ±5.0[a]	44.8 ±3.4[a]	44.5 ±2.6[a]	42.3 ±4.0[a]
NP	38.5 ±5.3[b]	40.8 ±4.1[b]	39.3 ±5.3[b]	40.0 ±6.2[a]
		Plasma cholesterol (mg/dl)		
P	107.0 ±25.5[b]	106.7 ±23.5[b]	111.9 ±27.4[b]	97.0 ±21.7[b]
NP	135.1 ±24.8[a]	136.5 ±27.2[a]	142.6 ±44.5[a]	149.2 ±21.7[a]
		Plasma total protein (mg/dl)		
P	3.58 ±.42[a]	3.88 ±.61[a]	3.96 ±.54[b]	3.53 ±.74[a]
NP	3.71 ±.41[a]	4.18 ±.63[a]	4.35 ±.83[a]	4.08 ±.55[a]
		Plasma uric acid (mg/dl)		
P	4.29 ±1.05[a]	5.95 ±1.25[a]	6.23 ±1.40[a]	3.87 ± .98[a]
NP	4.64 ±1.15[a]	6.16 ±1.07[a]	6.35 ± .95[a]	4.75 ±1.53[a]

[a,b]Means ± SEM within columns by subject with different lettered superscripts are significantly different ($P<.05$).

APPENDIX 2

THE EFFECT OF FEEDING PROGRAMS ON REPRODUCTIVE TRAITS AND SELECTED BLOOD CHEMISTRIES OF CAGED BROILER BREEDER MALES: 2. FREE CHOICE, LOW ENERGY RATIONS OF 9, 7, AND 5 PERCENT CRUDE PROTEIN

The data listed in this appendix contain information which may be of interest to the reader but which have no significant contribution to the conclusions stated in Chapter IV on the subject of dietary protein level on reproductive traits of caged broiler breeder males.

Table A2.1. The effects 9, 7, and 5% crude protein on mean semen concentrations from 24 to 65 weeks of age

Protein Level	Age in Weeks 24	28	32	36	40	44	50	65
	Semen Concentration (sperm cells/mm^3 x 10^6)							
9%	2.54±1.42^{ab}	5.60±2.73^{a}	5.20±1.32^{a}	4.58±1.12^{a}	5.20±1.42^{a}	4.31±1.48^{a}	3.06±1.65^{a}	3.69±2.07^{a}
7%	2.80±1.22^{a}	5.40±2.07^{ab}	2.38±1.45^{a}	4.45±1.25^{a}	4.97±1.45^{a}	4.02±1.35^{a}	2.01±1.25^{b}	3.59±1.94^{a}
5%	1.68±1.28^{b}	3.82±2.27^{b}	4.41±1.25^{a}	4.02±1.58^{a}	4.05±1.15^{a}	3.89±1.22^{a}	2.24±1.51^{ab}	4.41±2.24^{a}

^{a,b}Means ±S.E. within columns (semen-producing males only) with different superscripts are significantly different ($P<.05$).

TABLE A2.2. The effects of 9,7, and 5% crude protein diets on plasma triglyceride levels from 24 to 65 weeks of age

Protein Level	Age in weeks 24	28	32	40	50	65
	Plasma triglyceride (mg/dl)					
9%	61.3± 9.6[b]	82.9±16.6[a]	71.1±11.9[a]	58.4±11.9[a]	71.7±24.3[a]	82.0±28.1[a]
7%	60.1± 6.6[b]	90.0±29.0[a]	73.5±29.2[a]	56.7±19.8[a]	62.5±18.8[a]	79.3±12.9[a]
5%	70.1±13.8[a]	84.6±17.0[a]	80.0±23.6[a]	56.1±15.8[a]	69.3±20.3[a]	77.3±20.8[a]

[a,b]Means ±S.E. within columns with different superscripts are significantly different (P<.05).

APPENDIX 3

INFLUENCES OF 16 AND 17.5 PERCENT DIETARY PROTEIN AND SUPPLEMENTAL METHIONINE ON THE REPRODUCTIVE TRAITS AND SELECTED PLASMA CHEMISTRIES OF CAGED DWARF (dw) BROILER BREEDER FEMALES

Experimental data within the text of Chapter V in which no significant differences were observed were listed only as mean values, and only data from selected ages were presented. The following data is a more precise description of the mean values obtained and is provided for the reader who may have further interests in the area of fertility and hatchability of fertile eggs, body weights and egg weights, and plasma total protein and albumin values.

Table A3.1 Effects of dietary protein and supplemental methionine on mean body and egg weights from 28 to 50 weeks of age[1]

Treatments	Ages in weeks 28	32	36	40	50
	Mean body weights (kg)				
(%CP+ MET)					
16	2.34 ±.22	2.42 ±.22	2.61 ±.25	2.66 ±.27	2.92 ±.33
16+.08	2.35 ±.20	2.45 ±.21	2.63 ±.24	2.73 ±.25	2.99 ±.29
16+.15	2.34 ±.20	2.41 ±.20	2.57 ±.21	2.64 ±.23	2.88 ±.28
17.5	2.34 ±.21	2.42 ±.22	2.56 ±.26	2.63 ±.26	2.89 ±.31
17.5+.08	2.34 ±.24	2.42 ±.25	2.58 ±.29	2.64 ±.30	2.88 ±.33
17.5+.15	2.39 ±.21	2.44 ±.21	2.60 ±.23	2.86 ±.24	2.92 ±.27
	Mean egg weights (g)				
16	54.4 ±3.4	58.1 ±2.7	61.2 ±3.4	62.1 ±3.4	64.1 ±3.4
16+.08	55.2 ±3.3	58.7 ±4.3	61.4 ±4.2	62.7 ±3.5	64.4 ±4.2
16+.15	55.1 ±3.5	58.6 ±3.3	61.0 ±3.4	63.0 ±4.0	64.9 ±4.3
17.5	54.9 ±3.8	58.6 ±4.6	61.2 ±3.9	62.5 ±3.6	64.0 ±4.1
17.5+.08	54.5 ±3.5	58.7 ±3.7	61.7 ±3.4	62.6 ±4.3	64.7 ±3.9
17.5+.15	55.1 ±3.8	58.2 ±3.9	60.8 ±3.8	62.2 ±4.1	64.4 ±3.8

[1]Means ±S.E. within columns are not significantly different (P>.05).

Table A3.2. The effects dietary protein and supplemental methionine on mean plasma total protein and albumin at 32, 40, and 50 weeks of age[1]

Treatments	Age in weeks 32	40	50
	Mean plasma total protein (mg/dl)		
16	4.75 ± .64	5.19 ±1.13	5.41 ± .58
16+.08	4.58 ± .51	5.01 ± .99	6.00 ±1.01
16+.15	4.48 ± .92	4.96 ±1.11	5.74 ± .61
16 Ave	4.61 ± .70	5.05 ±1.06	5.72 ± .78
17.5	4.43 ± .64	5.13 ± .90	5.94 ±1.06
17.5+.08	4.59 ± .61	5.12 ± .72	5.22 ± .38
17.5+.15	4.46 ± .67	4.74 ± .58	5.65 ± .94
17.5 Ave	4.49 ± .63	5.00 ± .75	5.60 ± .88
	Mean plasma albumin (mg/dl)		
16	1.98 ± .42	2.11 ± .27	2.30 ± .24
16+.08	2.01 ± .35	2.05 ± .34	2.50 ± .53
16+.15	1.89 ± .62	2.06 ± .42	2.31 ± .18
16 Ave	1.96 ± .46	2.07 ± .34	2.37 ± .36
17.5	1.81 ± .49	2.10 ± .30	2.28 ± .44
17.5+.08	1.67 ± .27	2.02 ± .29	2.23 ± .30
17.5+.15	2.05 ± .61	1.86 ± .25	2.20 ± .31
17.5 Ave	1.84 ± .45	1.99 ± .29	2.24 ± .35

[1]Means ±S.E. within columns are not significantly different ($P<.05$).

Table A3.3 Effects of dietary protein and supplemental methionine on mean[1] fertility and hatchability from 32 to 40 weeks of age

treatments	Age in weeks 32	36	40	32-40 ave
(%CP+ MET)	Mean fertility (%)			
16	93.9 ±12.6	92.7 ±17.7	89.1 ±21.4	91.9 ±17.2
16+.08	92.3 ±12.2	89.8 ±17.5	89.9 ±19.2	90.6 ±16.3
16+.15	91.0 ±21.7	94.7 ±15.2	84.2 ±22.5	90.8 ±17.8
17.5	96.1 ± 8.6	92.9 ±19.5	93.4 ±14.9	94.1 ±14.3
17.5+.08	93.1 ±14.9	96.1 ± 8.9	89.5 ±19.2	92.9 ±14.3
17.5+.15	95.4 ±12.0	96.2 ±12.2	91.2 ±19.8	93.7 ±14.4
	Mean hatchability of fertile eggs (%)			
16	96.3 ± 7.9	91.6 ±15.5	90.2 ±18.1	92.7 ±13.8
16+.08	90.2 ±12.3	85.2 ±22.4	95.8 ±13.3	90.4 ±16.0
16+.15	86.8 ±20.0	89.8 ±18.5	90.9 ±21.9	89.2 ±20.1
17.5	84.9 ±22.9	87.6 ±18.0	94.6 ±13.7	89.0 ±18.2
17.5+.08	91.5 ±18.7	91.5 ±13.8	96.1 ±11.9	93.1 ±14.8
17.5+.15	91.9 ±13.2	91.6 ±14.6	94.8 ±11.4	92.8 ±13.1

[1]Means ±S.E. within columns are not significantly different ($P>.05$).