100/9/6/98

EFFECT OF SODIUM SULPHATE SUPPLEMENTATION IN LAYER DIET

By

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THESIS

Submitted in partial fulfilment of the requirement for the degree of

Master of Veterinary Science

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MANNUTHY, THRISSUR - 680651
KERALA

1998

DECLARATION

I hereby declare that this thesis entitled "**EFFECT OF SODIUM SULPHATE SUPPLEMENTATION IN LAYER DIET**" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Mannuthy
8-6-1998

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CERTIFICATE

Certified that this thesis entitled "**EFFECT OF SODIUM SULPHATE SUPPLEMENTATION IN LAYER DIET**" is a record of research work done independently by **Shri. Vidhyadharan, P.**, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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ACKNOWLEDGEMENT

I wish to express my sincere thanks to Dr. Amritha Viswanath, Associate Professor, All India Co-ordinated Research Project on Poultry, for her scholarly advice, valuable guidance and constant encouragement during the period of study. I am much obliged to her for the help and support offered to me as the Chairperson of Advisory Committee.

I am highly grateful to Dr. A.K.K. Unni, Director, Centre for Advanced Studies in Poultry Science, for his valuable suggestion and advice offered to me.

I express my heartfelt gratitude to the members of Advisory Committee Dr. Maggie D. Menachery, Professor and Head, Department of Animal Nutrition and Dr. P.A. Peethambaran, Associate Professor, Centre for Advanced Studies in Poultry Science for their valuable and constructive criticism and whole-hearted help during the study.

I am indeed thankful to Dr. A. Ramakrishnan, Retired Director, Centre for Advanced Studies in Poultry Science for his kind help, valuable advice and timely assistance given to me.

My sincere thanks to Dr. G. Reghunathan Nair, Professor, Dr. K. Narayanankutty, Associate Professor, Department of Poultry Science, Dr. A. Jalaludeen, Senior Scientist, AICRP, Mannuthy, Dr. Leo Joseph, Associate Professor, University Poultry Farm, Mannuthy for their help and co-operation.

I am very grateful to all other staff members of the Department of Poultry Science, All India Co-ordinated Research Project on Poultry and University Poultry Farm for their friendly co-operation and accommodation shown to me.

I extend my sincere thanks to the help offered by Smt. T.K. Indirabai, Professor i/c, Smt. K.P. Santhabai, Programmer and other staff members of the Department of Statistics in analysing the data.

I am thankful to Dean, College of Veterinary and Animal Sciences for providing me with all facilities needed for study.

I gratefully acknowledge the sincere and immense help rendered to me by Dr. Ponnuvel, Dr. Sangaralingam, Dr. S.P. Muthukumar, Dr. Sulfikar, Dr. C.N. Dinesh, Dr. George, Dr. Kuruvila Varghese, Dr. G. Sunil throughout the period of my research work and Dr. Sini Thomas and Dr. K.C. Jayan for the preparation of my thesis.

I express my profound gratitude to my beloved brothers, sisters, father-in-law, mother-in-law for their love, affection, moral support and encouragement during the study.

I am indeed grateful to my wife Dr. P.S. Sreeja and lovely daughter Sreedhanya, S.V. who always stood as a source of encouragement and affection to me.

I am thankful to Mr. O.K. Ravindran, C/o Peagles, Mannuthy for neat typing of manuscript.

Lastly, to everyone who gave me a helping hand, I express my gratitude.

VIDHYADHARAN, P.

Dedicated to the
sacred memory of my beloved parents

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INTRODUCTION

Poultry production can play a significant role to raise the economic status of rural masses and to improve their level of nutrition. Poultry industry has registered tremendous growth to meet the protein requirement of ever increasing Indian population. During the last two decades, poultry industry achieved an annual growth rate of 10 per cent in egg output and 15 per cent in broiler production. Thus, this sector of agriculture has registered faster growth rate than any other agricultural industry. In India, layer population has increased from 62 million in 1971 to 170 million in 1995. The annual egg production of India has increased from 5340 million eggs in 1971 to 24,800 million in 1993 (Anon, 1994) and is anticipated to produce 28130 million eggs in 1995. Similarly broiler production increased from four million in 1971 to 235 million in 1993 and 330 million in 1995 (Anon, 1994).

Eventhough India ranks sixth position in egg production in the world, per capita annual availability in 1994 was only 29 eggs. This was very low when compared to per capita consumption of 250-300 eggs in developed countries. In Kerala, the estimated annual egg production was 848 million and the per capita consumption was 62 eggs in 1995. To meet the minimum demand of eggs in the state it imports 290 million eggs annually from neighbouring states (Unni, 1995).

The Nutritional Advisory Committee of ICMR has recommended a per capita consumption of half an egg per person per day i.e., 180 eggs/person/year. To reach this target the egg production has to be increased by six times from the present level of production in India.

The requirement of poultry feed was estimated to be seven million tonnes in 1993. By the turn of this century, the requirement of poultry feed would be approximately 11 million tonnes (Chadha, 1991). Major problem faced by the Poultry industry at present is the high cost and non-availability of feed ingredients. Among the various inputs involved in poultry production, the feed alone accounts for 70 per cent of cost of production. Over and above, most of the feed ingredients used for manufacturing poultry feed is being used for human consumption, especially, the grains, fish and tapioca.

Fish occupies an important position among the protein sources. Out of the total protein requirement, 10 per cent is met through fish alone. About 60 per cent of the population in developing countries derive 40 per cent or more of the total animal protein supply from fish. India is one among the

12 leading fish producing countries in the world, producing 3,172 million tonnes annually (Rajammal *et al.*, 1993).

Fish is an excellent protein source, high in lysine and methionine and is one of the important dietary items in Kerala, where majority are non-vegetarian. Fish is a major source of polyunsaturated fatty acids especially omega-3 fatty acids, which help in lowering of blood cholesterol and relieve inflammatory conditions such as arthritis and aid in brain development. In addition, fish is a rich source of vitamins and minerals (Reddy, 1996).

Because of the non availability of good quality fish, and its high cost, poultry nutritionists at present are computing ration using vegetable protein sources sparing the valuable fish protein for human diet. Requirement for sulphur containing amino acid is met either from synthetic methionine supplementation or by inorganic sulphate.

The sparing action of sulphate for methionine and cysteine requirements was first reported by Gordon and Sizer (1955). Studies also have indicated that sulphates are beneficial in sparing sulphur amino acids that are catabolised during aflatoxicosis (Leeson and Summers, 1991). Laying hens synthesize small amount of cystine from the inorganic sulphur absorbed by the intestine as a part of taurine metabolism.

Hence the present study was planned to find out the feasibility of supplementation of sodium sulphate (anhydrous) in ration devoid of unsalted dried fish for layers.

Review of Literature

REVIEW OF LITERATURE

Comprehensive review of research findings available in the literature on the effect of supplementation of sodium sulphate in the layer diet have been gathered and presented in this chapter.

Meteorological profile of Mannuthy

Data pertaining to the meteorological profile of Mannuthy (Latitude 10°32"N; Longitude 76°16"E, Altitude 22.25 m above MSL) for five years were summarised by Somanathan (1980). He reported that when meteorological factors from May to September were compared, the highest mean maximum temperature was recorded during May (32.35°C) and lowest during July (28.15°C). Then again the mean temperature rose to 30.25°C during September. The lowest mean minimum temperature recorded was 23.28°C during July and highest mean minimum temperature was 25.27°C during May. The daily average per cent relative humidity varied between 75.68 during May to 86.52 during July. Climatograph of this locality fell within the hot and moist climate.

Impact of meteorological factors on production parameters

The effect of constant and fluctuating environmental temperature on the biological performance of laying pullets was evaluated by Muller (1961). He found that a constant temperature of 90°F increased mortality and depressed egg production, feed intake, egg weight and shell quality as compared to a constant temperature of 55°F. Pullets kept in an environment where temperature cycled from 55°F to 90°F and back to 55°F every 24 h; produced more eggs than pullets kept at a constant temperature of 55°F. Egg weight and shell quality in the cycling environment were significantly lower than that in the constant 55°F environment, but significantly better than in the constant 90°F environment.

Feed requirements for poultry are directly related to bird weight, ambient temperature and rate of egg production (Esmay, 1969). He also reported that the upper and lower optimum housing temperature of 29.4°C and 12.8°C provided the desirable temperature range for summer to winter housing. If constant and associated with high humidities, the upper optimum temperature of 29.4°C is too high. Day time temperature may be 29.4°C on a diurnal basis if night time temperature drop to 21.1°C or lower.

Mc Dowell (1972) reported that in warm humid areas where air temperature is 21°C or above, livestock production is affected when the relative humidity is 60 per cent or above.

Chand and Razdan (1976) reported that the egg production on hen-day basis differed significantly in different months of the year. Maximum production was recorded in March (59.13 per cent) when the poultry shed temperature ranged from 10.0 to 32.2°C. There was a tendency towards drop in egg production during December-January, when temperature ranged from 3.3° to 23.3°C. They also reported that the feed consumption was low during the months when environmental temperature was high.

North (1984) stated that as the ambient temperature increased, economic parameters like feed intake, bird weight, egg production, egg weight shell thickness and internal egg quality decreased.

Geo (1992) reported mean maximum temperature of 33.96°C during May-June and 28.11°C during July-August. The mean minimum temperature were 26.92°C and 23.74°C respectively during the above periods. The per cent relative humidity were 79.96 and 89.71 in the forenoon, and 58.04 and 78.89 in the afternoon in the above periods respectively.

Body weight

Gordon and Sizer (1955) reported the effect of inorganic sulphate in poultry nutrition for the first time. A basal diet, deficient in cysteine (0.08% cysteine, 0.51% methionine) and sulphate free, was fed to growing chicks, an addition of 0.50 per cent sodium sulphate resulted in a 31.4 per cent growth response over the basal diet alone (371.5 g gain vs

488.1 g) at the end of the fifth week. The addition of 0.22 per cent methionine gave a 39.1 per cent growth response over the basal diet (371.5 g vs 521.0 g). The simultaneous supplementation with 0.22 per cent methionine and 0.50 per cent sodium sulphate resulted in a 66.1 per cent growth response over the basal diet (371.5 g vs. 617.0 g). The author surmised that the chicken can satisfy part of its total sulphur requirement with inorganic sulphate.

Machlin and Pearson (1956) evaluated the effect of a cysteine deficient sulphate-free purified diet on chicks (0.06 per cent cysteine, 0.54 per cent methionine). The average of nine experiments showed a 22 per cent growth response over the basal diet due to 0.50 per cent sodium sulphate supplementation.

Almquist (1964) published the results of his experiments using a sulphate free purified diet with increasing levels of methionine supplementation and a level of 0.50 per cent sodium sulphate addition. The higher the level of methionine supplementation (0.30, 0.50 and 0.70 per cent) the greater the growth response, but for each level of methionine, the addition of 0.50 per cent sodium sulphate gave a growth response.

Ross and Harms (1970) studied the response of broiler chicks to inorganic sulphur in a high energy corn-soyabean basal diet. The diet was formulated to be deficient in methionine (0.40 per cent methionine, 0.39 per cent cysteine) and low in added sulphate. The greatest response was obtained from 0.10 per cent sodium sulphate supplementation for all levels of methionine addition. However, only a 5.2 per cent growth response over the basal diet was obtained.

Hinton and Harms (1972) investigated the effect of sodium sulphate supplementation in corn-soyabean basal diets. Their finding revealed that the supplementation with 0.2 per cent sodium sulphate resulted in a 14.5 per cent growth response over the unsupplemented basal diet.

In a series of experiments, Ross *et al.* (1972) studied the effect of sodium sulphate and methionine on weight gain and feed efficiency of chicks fed a purified diet based on glucose and isolated soy protein. In two experiments, broiler chicks showed consistent increase in weight gain when the methionine deficient diet, low in sulphate was supplemented with 0.08 to 0.32 per cent sulphate in the presence of methionine. The greatest response was obtained at 0.08 per cent sodium sulphate when either 0.08 per cent (28.9 per cent gain over the basal diet plus methionine) or 0.16 per cent methionine (27.1 per cent gain over the basal diet plus methionine) was also added.

To study the effect of the partial replacement of sulphur amino acids in layer diet with sodium sulphate, Damron and Harms (1973) conducted experiments using five diets with crude protein content which ranged from 10.61 to 16 per cent and sulphur amino acid content from 0.355 to 0.592 per cent. A sixth diet containing 0.47 per cent sulphur amino acid and 13.07 per cent crude protein was supplemented with 0.10 per cent sodium sulphate. They noted that the final body weight was significantly influenced by the amino acid and protein level but not by sodium sulphate supplementation. The birds receiving sodium sulphate supplementation had a final body weight gain which did not differ significantly from its counterpart.

When chicks were fed purified crystalline amino acid diet devoid of inorganic sulphate and cysteine deficient (0.30 per cent methionine and 0.10 per cent cysteine) a 40 per cent response in weight gain was obtained from 0.50 per cent potassium sulphate supplementation (Sasse and Baker, 1974). However, when the diet was adequate in sulphur amino acids (0.30 per cent methionine 0.30 per cent cystine) or methionine deficient (0.10 per cent methionine and 0.30 per cent cystine) or equally deficient in both methionine and cystine (0.22 per cent each), a response to potassium sulphate did not occur.

Soares et al. (1974) conducted experiments to test the use of sulphate under practical conditions, and to find the optimal levels of sulphate supplementation to the growing chicks. Five levels of sodium sulphate and three levels of methionine were used in a corn-soyabean meal diet of broiler chicks. The addition of 0.16 per cent sodium sulphate was most effective in stimulating growth in chicks for all levels methionine supplementation. A maximum growth response of 8.6 per cent was obtained over the unsupplemented basal diet. When 1.8 per cent and 0.36 per cent potassium sulphate were added with and without methionine, only 3.8 per cent maximum growth response was obtained.

A practical diet based on soyabean meal and milo, devoid of supplemental sulphate and low in sulphur amino acids was utilized as a basal diet by Bornstein and Plavnik (1977) to evaluate the inter-relationship between inorganic sulphate and sulphur amino acids in broiler diets. In one experiment, the addition of 0.06 per cent sodium sulphate to the basal diet supplemented with 0.08 per cent methionine resulted in a 5 per cent increase in growth over the basal diet containing 0.08 per cent methionine. Additional methionine or sodium sulphate caused only marginal response.

From further studies using the soyabean meal milo diet, Plavnik and Bornstein (1977), observed an age effect on the growth response from sulphate supplementation. Growth response as great as 10 per cent were obtained over the diet supplemented with sulphate. A combination such as 0.10 per cent methionine and 0.12 per cent sulphate supplementation to the basal diet was typical in these experiments.

Plavnik and Bornstein (1978), using practical broiler finisher diets conducted three trials to determine to what extent synthetic methionine can be replaced by sodium sulphate. In the three trials of this study responses to sodium sulphate supplements were obtained during all age periods examined in terms of growth rate and food conversion ratios. They found that sodium sulphate can replace 20 to 50 per cent of synthetic methionine.

Kadirvel and Kothandaraman (1978) reported the results of their experiments in which a basal diet (maize, groundnut meal, fishmeal and wheat bran) alone or with 0.05 per cent copper sulphate or 0.25 per cent sodium sulphate or both were offered to white Leghorn pullets of 12 weeks of age until 20 week. Addition of 0.05 per cent copper sulphate resulted in 27 per cent body weight gain over the basal diet alone (329 g vs 419 g). Addition of 0.25 per cent sodium sulphate resulted in a 28 per cent body weight gain over the basal diet (329 g vs 423 g) and simultaneous addition of 0.05 per cent copper sulphate and 0.25 per cent sodium sulphate resulted in a 41 per cent body weight gain over the basal diet (329 g vs 466 g) at the end of the 8 week experimental period. In another experiment they fed White Leghorn pullets of 22 weeks age with basal diet alone or with 0.2 per cent methionine or 0.25 per cent sodium sulphate or both until 42 weeks of age. They recorded body weight at 42 weeks of age as 1504, 1498, 1442 and 1520 g respectively. These values were not statistically significant.

Hikami *et al.* (1988) fed chicken with commercial diets having three different levels of sulphur amino acids with or without sodium sulphate at 0.8 per cent level. The results showed that supplementary inorganic sulphate decreased gain in body weight with diets high in sulphur amino acids but increased it with those low in sulphur amino acids.

The possibility of replacing some of the methionine by choline in layer diet was studied by Pourreza and Smith (1988). In two experiments they found that the body weight gain was improved when the low protein and total sulphur amino acid diet was supplemented with methionine but not choline.

Yadav *et al.* (1994) in their study on the effect of supplementation of sodium sulphate on the performance of egg type chicks revealed that at 0.3 per cent level ration devoid fish meal gave body weight gains comparable to fish meal fed diets without sodium sulphate.

Sharma *et al.* (1994) reported that sodium sulphate at 0.3 per cent level included in rations devoid of fish meal covered up the deficiency of methionine and improved the performance of egg type pullets.

Age at sexual maturity

Wolf *et al.* (1969) reported that the age at sexual maturity in pullets that consumed 15 g protein per day from 9 to 18 weeks of age ranged from 152.5 to 157.6 days. A protein intake of 10 g/day produced the greatest delay in sexual maturity.

Kadirvel and Kothandaraman (1978) reported that the laying birds showed no difference in age at sexual maturity by looking into the average age at first egg and 50 per cent egg production in layers fed with control diet alone or with 0.2 per cent methionine or 0.25 per cent sodium sulphate or both.

The age at first egg reported in the flock of `F' strain White Leghorn was 130 days and in the particular strain the age at 10 and 50 per cent egg production were 150 and 180 days respectively (Anon, 1979).

Beena (1995) reported the age at first egg and age at 50 per cent egg production in `F' strain were 174 and 196.5 days respectively.

Egg production

Damron and Harms (1973) using six dietary treatments consisting of sulphur amino acid level at 0.355, 0.412, 0.470, 0.528 and 0.592 per cent respectively for one to five and sixth treatment consisted of addition of 0.10 per cent sodium sulphate to the diet with 0.470 per cent sulphur amino acids. They found that the layers receiving 0.412 per cent sulphur amino acid level shown significantly greater cumulative hen-day egg production than those receiving 0.355 per cent sulphur amino acid. The addition of 0.10 per cent sodium sulphate to the diet containing 0.470 per cent sulphur amino acid resulted in a four per cent improvement of egg production, which was equivalent to that provided by any of the unsupplemented diets.

Kadirvel and Kothandaraman (1978) fed the laying pullets at 22 weeks of age with a control diet or with supplemented methionine at 0.2 per cent level or 0.25 per cent sodium sulphate or both and found that at the end of 20 weeks of experimental period (42 weeks) the hen-housed egg production as 58.4, 52.6, 61.6 and 58.2 per cent respectively.

In a study conducted to evaluate the production performance of `F' strain of White Leghorn, the hen-day production reported was 75.6 egg per bird upto the age of 40 weeks (Anon, 1979).

Balachandran *et al.* (1979) compared the production characteristics in the `F' strain single comb White Leghorn hens in cage and deep litter systems of rearing. The mean per cent hen day production was significantly higher in cage system (61.09) in comparison with deep litter system (54.89).

Miles *et al.* (1986) conducted two experiments to find out the response of laying hens to choline. In the first experiment basal diet contained no supplemental choline, inorganic sulphate or sulphur amino acid and was supplemented with 0 or 660 mg choline/kg and 0 and 0.1 per cent potassium sulphate. In this experiment a significant ($P<0.05$) increase in egg production resulted from the addition of 660 mg choline/kg feed in the absence of supplemental inorganic sulphate and sulphur amino acids. The addition of inorganic sulphate alone resulted in an improvement in egg production over that of the control diet (76.2 vs 73.9 per cent). The addition of 0.1 per cent potassium sulphate in the presence of 660 mg of choline/kg resulted in a slight improvement in egg production over that obtained from the supplementation of choline alone. These differences were not statistically significant.

Harms *et al.* (1990) in their experiments on laying hens reported that addition of sulphate to the diets containing supplemental methionine at the levels of 0.033 or 0.067 per cent and 440 mg supplemental choline did not significantly affect egg production. However, the addition of sulphate to the basal diet containing choline alone resulted in a significant ($P<0.05$) increase in egg production. The interaction of methionine by sulphate was not significant. The data from this experiment points that the total sulphur amino acids must be limiting in order to obtain a response from supplemental sulphate.

Feed intake

Damron and Harms (1973) after carrying out experiments using six dietary treatments, found that feed intake was significantly influenced by amino acid levels but not affected by sodium sulphate supplementation. The dietary treatments consist of sulphur amino acid levels of 0.355, 0.412, 0.470, 0.528 and 0.592 per cent respectively for one to five and sixth treatment had an addition of 0.10 per cent sodium sulphate with 0.470 per cent sulphur amino acids. The daily feed intake of birds receiving 0.355 per cent sulphur containing amino acid was lower than any of the other treatment groups. Although the 0.47 per cent sulphur amino acid diets with and without sodium sulphate supplementation had the highest consumption levels, and the 0.528 and 0.592 per cent diets the lowest intake level in comparison to any of the remaining diets, none of these values showed statistically significant difference.

Kadirvel and Kothandaraman (1978) reported a better daily mean feed consumption (59 g) of pullets given basal diet (Maize, GNC, fish meal and wheat bran) than the diet supplemented with 0.05 per cent copper sulphate (59.1 g) or 0.25 per cent sodium sulphate (59.7 g) or both supplemented to the diet (59.2 g) upto 20 weeks of age in White Leghorn pullets. But these differences were not statistically significant.

Balachandran *et al.* (1979) reported the daily feed consumption of 109 g and 102 g in floor and cage system respectively and the feed intake was significantly lower ($P<0.05$) in caged birds than those on floor, in 'F' strain White Leghorn.

Miles *et al.* (1986) reported that supplemental choline alone or in combination with inorganic sulphate, resulted in a significant increase in feed consumption. However, inorganic sulphate alone resulted in only a numerical increase in feed consumption and averaged 94 g/bird/day on a ration based on corn-soyabean meal in layers.

Harms *et al.* (1990) conducted an experiment in commercial laying hens of 24 weeks of age to study the response of adding choline and sulphate in a corn-soyabean meal diet containing different levels of supplemental DL methionine. They found that addition of sulphate significantly reduced feed consumption when the diets contained 0.033 per cent methionine and supplemental choline but addition of sulphate did not affect feed consumption at other levels of methionine (0.067 per cent, 0.10 per cent, 0.133 per cent and 0.20 per cent).

Feed efficiency

Gordon and Sizer (1955) reported that addition of sodium sulphate to the basal diet resulted in improvement in feed efficiency in broiler chicks.

Ross and Harms (1970) studied the response of broiler chicks to inorganic sulphate in a high energy corn-soyabean meal control diet and reported that feed conversion was generally improved in the treatment groups fed sodium sulphate even when the diets also included supplemental methionine.

Ross *et al*. (1972) studied the effect of sodium sulphate (0.08 to 0.32 per cent) and methionine on feed efficiency of broiler chicks fed a purified diet based on glucose and isolated soyaprotein in two experiments. They found that addition of sulphate improved feed deficiency.

Hinton and Harms (1972) reported better feed efficiency in broiler chicks when they supplemented with the control diet with sodium sulphate.

Damron and Harms (1973) in their study to determine the response of laying hens to sodium sulphate supplementation reported that the feed efficiency in layers was not influenced by sodium sulphate supplementation in diet (0.1 per cent), but it was significantly affected by sulphur amino acid and protein level in the diet.

Bornstein and Plavnik (1977) utilized a diet based on soyabean meal and milo, devoid of supplemental sulphate and low in sulphur amino acid to evaluate the interrelationship between inorganic sulphate and sulphur amino acids in broiler chicks and found that feed efficiency in chicks improved from 1.72 to 1.68 by the addition of sodium sulphate.

Kadirvel and Kothandaraman (1978) in their experiment with White Leghorn pullets of 22 weeks of age till 42 weeks reported feed efficiency of 1.57, 1.65, 1.55 and 1.64 respectively for four dietary treatments viz. control diet, control diet with 0.2 per cent methionine, control with 0.25 per cent sodium sulphate and both. These values were not statistically different.

Miles *et al.* (1986) reported that there is no significant difference in feed efficiency of layers when the corn-soy diet was supplemented with or without choline, methionine or both.

Hikami *et al.* (1988) formulated three diets with three levels of sulphur amino acids (0.78, 0,67 and 0.51 per cent) and the diets were fed to chicks with or without the addition of 0.8 per cent sodium sulphate and found that feed efficiency was not affected either with the addition of sodium sulphate nor with the levels of sulphur amino acids.

Harms *et al.* (1990) conducted an experiment in commercial laying hens of 24 weeks of age to study the response of adding choline and sulphate in a corn-soyabean meal diet containing different levels of supplemental DL-methionine. They found that addition of sulphate improved feed efficiency when added to the basal diet alone but not when added to a diet containing supplemental methionine and choline. Significant ($P<0.05$) improvement in feed efficiency was obtained at a level of 0.033 per cent methionine. No response was obtained when sulphate was added to diets containing 0.033 and 0.067 per cent methionine.

Egg weight

Damron and Harms (1973) in their study on partial replacement of sulphur amino acid in layer diets with sodium sulphate noted that the egg weights were significantly ($P<0.05$) improved as sulphur amino acid levels increased to 0.47 per cent. Neither higher sulphur amino acid levels, nor sodium sulphate supplementation resulted in further egg weight improvement.

Kadirvel and Kothandaraman (1978) reported that there was no significant difference in egg weight among treatment groups in which the birds were fed with either control diet or control diet supplemented with 0.2 per cent methionine, or 0.25 per cent sodium sulphate or both.

Anon (1979) reported that the average egg weight in the 'F' strain of White Leghorn birds was 53.7 g in the Seventh Random Sample Laying Test conducted at Bangalore.

Keshavarz and Austic (1983) found that adding methionine supplements to diets having crude protein levels of 16.4 and 14.4 per cent resulted in a significant ($P<0.05$) increase in egg size. Combinations of methionine and choline tended to increase egg size with 14.4 per cent protein diet. Adding choline alone to the basal diet did not affect egg size.

Miles *et al.* (1986) in their experiment on the response of layers to choline reported that supplemental choline with sulphate in the diet resulted in a significant ($P<0.05$) improvement in egg weight; however, they were ineffective when fed alone.

Harms *et al.* (1990) reported that addition of 0.067 per cent or higher level of methionine resulted in a significant ($P<0.05$) increase in egg weight over that of basal diet. The addition of sulphate to the basal diet containing added choline resulted in significantly ($P<0.05$) increased egg mass. However, the addition of sulphate to the diets containing supplemental methionine and choline did not affect egg mass.

Beena (1995) reported that mean egg weight in 'F' strain of White Leghorn pullets was 40.35 g at 24 weeks of age which gradually increased to 50.13 g at 40 weeks of age.

Ponnuvel (1996) recorded an egg weight of 45 g to 52.9 g in 'F' strain of White Leghorn birds under cage system of rearing.

Livability

Anon (1979) reported that mortality was 3 per cent during the period from 20 to 40 weeks of age in 'F' strain of White Leghorn.

Balachandran *et al.* (1979) studied the production characteristics in `F' strain White Leghorn birds under cage and deep litter systems of housing. During the experimental period of six, 28 day periods, the livability was 82.2 and 86.6 per cent on floor and cage systems respectively.

Materials and Methods

MATERIALS AND METHODS

An experiment was carried out at the Department of Poultry Science, College of Veterinary and Animal Sciences, Mannuthy to evaluate the effect of supplementation of sodium sulphate in White Leghorn layer diets devoid of animal protein source.

One hundred and sixty White Leghorn `F' strain pullets at 18 weeks of age were used for the study. All the pullets were dewormed, debeaked and vaccinated against Ranikhet Disease before housing. The birds were housed in two-tier California type four-bird cages at 18 weeks of age for acclimatization. Body weights were recorded individually at 20 weeks of age and the birds were wing badged and distributed at random to five different dietary treatments as detailed below.

Treatment groups	Number of replication	Type of ration	Level of added methionine (g/100 kg diet)	Level of added sodium sulphate (g/100 kg diet)
T_1	8	Control diet containing unsalted dried fish	0	0
T_2	8	All vegetable protein diet	300	0
T_3	8	All vegetable protein diet	0	200
T_4	8	All vegetable protein diet	0	300
T_5	8	All vegetable protein diet	0	400

Each treatment group consisted of eight replicates containing four birds each. Allotment of birds to each treatment and replicates was made at random. Mean body weight of birds within each treatment and replicate at 20 weeks of age was kept fairly uniform at the commencement of the experiment.

Feed and water were provided *ad libitum*. Standard layer ration (T_1) was prepared using unsalted dried fish as animal protein source and is used as control diet. All vegetable protein diet (T_2) was prepared using soyabean cake, groundnut cake and gingelly oil cake as protein source with the addition of 300 g DL methionine in every 100 kg diet. Other experimental diets were prepared using soyabean cake, groundnut cake and gingelly oil cake as vegetable protein source with the addition of anhydrous sodium sulphate at the levels of 200 g (T_3) 300 g (T_4) and 400 g (T_5) in every 100 kg diet. All the rations were formulated as per BIS (1992) specification of nutrients for layer chicken.

The ingredient compositions of diets are presented in Table 1. The proximate analysis of the ration was carried out according to the procedure described in AOAC (1990) and the chemical composition of diets are presented in Table 2.

Standard management practices were followed throughout the experimental period. The production performance of the

Table 1. Per cent ingredient composition of experimental diets

Ingredient	Control diet	Treatment diets			
	T_1	T_2	T_3	T_4	T_5
Maize	44.00	42.00	42.00	42.00	42.00
Groundnut cake	10.00	16.00	16.00	16.00	16.00
Gingilly oil cake	5.00	5.00	5.00	5.00	5.00
Rice polish	19.00	19.00	19.00	19.00	19.00
Soyabean meal	5.00	11.00	11.00	11.00	11.00
Unsalted dried fish	10.00	-	-	-	-
Shell grit	4.50	4.50	4.50	4.50	4.50
Mineral mixture[1]	2.25	2.25	2.25	2.25	2.25
Salt	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Added per 100 kg feed					
Vitamin mixture (g)[2]	20	20	20	20	20
DL-methionine (g)[3]	-	300	-	-	-
Sodium sulphate (g)[4]	-	-	200	300	400

1 Poultry min: Calcium 32%, Phosphorus 6%, Iron 0.1%, Megnesium 1000 ppm, Manganese 2700 ppm, Copper 100 ppm, Cobalt 60 ppm, Zinc 2600 ppm, Iodine 100 ppm

2 Indomix (AB_2D_3). Vitamin A 40,000 IU; B_2 20 mg, D_3 5000 IU per gram

3 Rhodimet (DL-methionine 99%) Rhone - Poulenc.

4 Anhydrous Sodium Sulphate. M/S NICE chemicals

Table 2. Per cent chemical composition of experimental diets (on dry matter basis)

Ingredient	Control diet T_1	All vegetable protein diet			
		T_2	T_3	T_4	T_5
Dry matter	89.06	89.38	89.38	89.38	89.38
Crude protein	18.07	17.95	17.95	17.95	17.95
Crude fibre	4.75	5.50	5.50	5.50	5.50
Ether extract	5.82	4.50	4.50	4.50	4.50
Total ash	13.90	13.92	13.92	13.92	13.92
NFE	46.52	47.51	47.51	47.51	47.51
Acid insoluble ash	6.60	4.10	4.10	4.10	4.10
Calcium	3.16	3.03	3.03	3.03	3.03
Phosphorus	0.83	0.77	0.77	0.77	0.77
Sodium	0.13	0.13	0.13	0.13	0.14
Calculated values					
Metabolisable energy (kcal/kg)	2730	2720	2720	2720	2720
Lysine (%)	0.83	0.75	0.75	0.75	0.75
Methionine (%)	0.31	0.24	0.24	0.24	0.24

birds were recorded for seven, 28-day periods. The following observations were recorded during the experimental period.

1. **Meteorological parameters**

The dry bulb and wet bulb thermometer readings were taken at 8 AM and 2 PM daily. The maximum and minimum temperatures were recorded on all days. From this data, period wise maximum and minimum temperature and per cent relative humidity were arrived at.

2. **Body weight**

Body weight of individual birds were recorded at 20 weeks of age and at the end of the experimental period (48 weeks) to study the pattern of body weight maintenance under different feeding regimes.

3. **Age at sexual maturity**

Age at sexual maturity is arrived at by noting the average age at first egg and age at 50 per cent egg production in each replicate.

4. **Egg production**

Egg production in each replicate was recorded daily throughout the experimental period. From this data, per cent hen-housed and hen-day egg production were calculated.

5. **Feed intake**

Feed issued to each replicate and balance feed on last day of each 28 day period was recorded. From this mean daily feed intake per bird per day was calculated for each treatment group.

6. **Feed efficiency**

Feed conversion efficiency was calculated based on the data on kilograms of feed consumed per dozen of eggs produced for each 28 day period.

7. **Egg weight**

Eggs were weighed in from each replicate during the three consecutive days towards the end of each 28-day period and mean egg weight was calculated period-wise and treatment-wise.

8. **Livability**

Mortality of birds from different treatment groups was recorded during the experimental period and livability was worked out. Post mortem examination was carried out to determine the causes of death.

9. Cost benefit analysis

Cost of feed ingredients used for feed formulation and the total feed cost for production of different experimental diets were calculated. Total number of eggs produced in different treatment groups were also calculated. From this data cost of production of one egg was calculated for different dietary regimes.

10. Statistical analysis

The data collected on various parameters were statistically analysed as per methods of Snedecor and Cochran (1967).

Results

RESULT

A feeding trial to evaluate the effect of supplementation of sodium sulphate in layer diets devoid of any animal protein source was carried out for a period of 28 weeks from the point of lay. The results obtained in the study are presented in this chapter.

Meteorological parameters

The data pertaining to microclimate inside the experimental house in respect of mean maximum and minimum temperature (°C) and per cent relative humidity during the experimental period from June to December 96 are presented in Table 3. During the course of the experiment the maximum temperature ranged from 28.85 to 32.07°C and minimum temperature from 23.17 to 25.57°C. The highest mean maximum temperature recorded was during the sixth period of study (32.07°C). The per cent relative humidity in the morning varied from 77 to 86 and in the afternoon from 65 to 78.

Body weight

Individual body weight of birds in the different dietary treatment groups at 20 and 48 weeks of age are presented in Table 4 and represented graphically in Fig.1. The weight of birds at 20 weeks of age averaged 1.218, 1.161, 1.214, 1.176

Table 3. Mean values of meteorological parameters recorded in the experimental house

Experimental period (weeks)	Age in weeks	Temperature (°C)		Relative humidity (%)	
		Maximum	Minimum	8 AM	2 PM
I	21-24	31.38	25.57	81	72
II	25-28	28.85	24.87	86	78
III	29-32	30.53	25.53	85	74
IV	33-36	30.35	25.26	85	73
V	37-40	31.03	24.42	82	73
VI	41-44	32.07	25.28	77	68
VII	45-48	30.46	23.17	77	65

Table 4. Mean body weight (kg) of experimental birds as influenced by different dietary treatments

Treatment groups	20 week	48 week
T_1	1.218 ± 0.02	1.688 ± 0.03^{bc}
T_2	1.161 ± 0.02	1.595 ± 0.04^{ab}
T_3	1.214 ± 0.02	1.605 ± 0.04^{ac}
T_4	1.176 ± 0.02	1.534 ± 0.04^{a}
T_5	1.199 ± 0.02	1.696 ± 0.04^{bc}

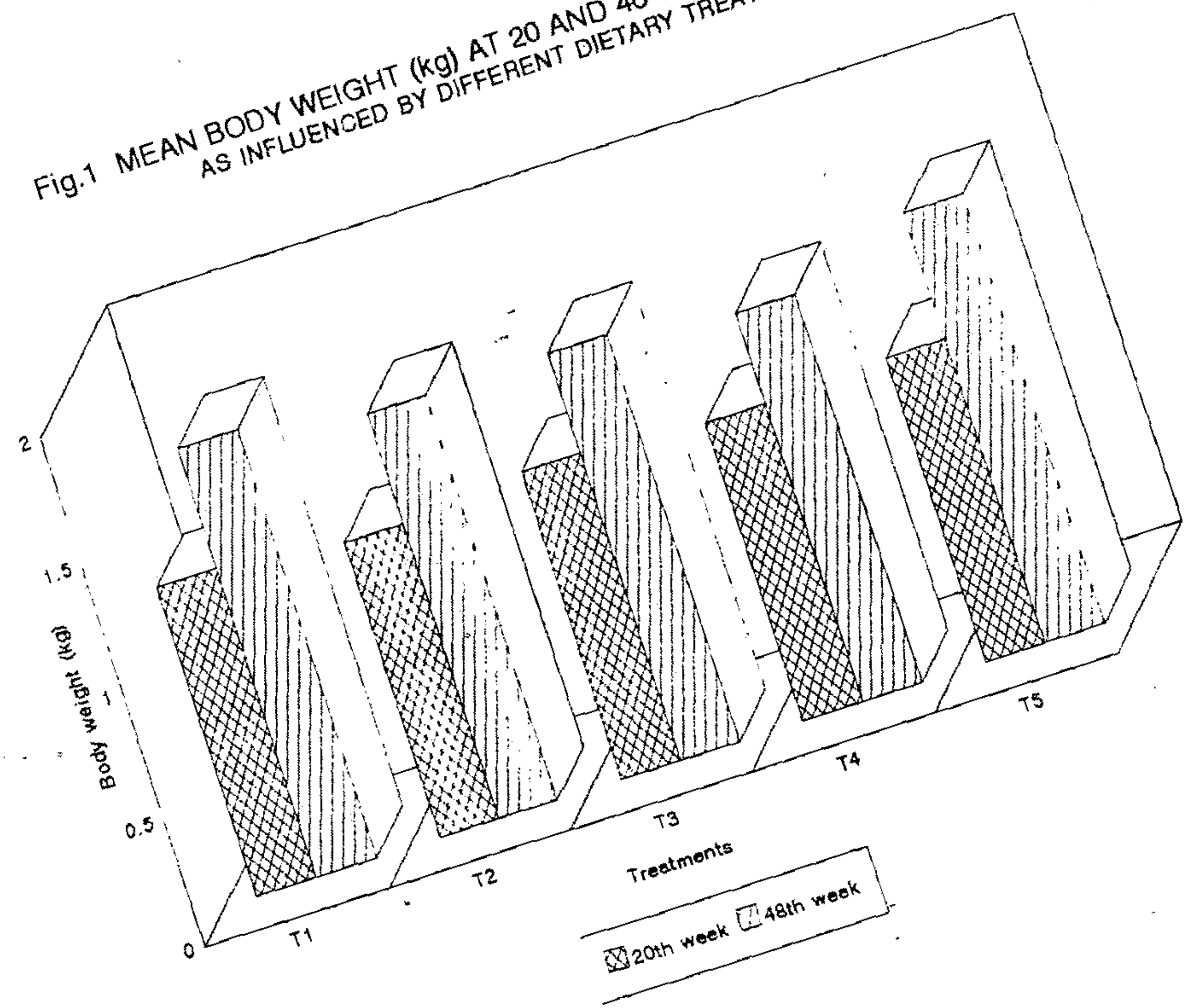
* Means bearing same superscript did not differ significantly ($P<0.05$)

Table 5. Analysis of variance for 20th week body weight

Source	Df	SS	MSS	F
Treatment	4	0.019	0.005	1.248 NS
Error	35	0.132	0.004	
Total	39	0.151		

NS - Non significant

Fig.1 MEAN BODY WEIGHT (kg) AT 20 AND 48 WEEKS OF AGE AS INFLUENCED BY DIFFERENT DIETARY TREATMENTS



and 1.199 kg in treatment groups 1, 2, 3, 4 and 5 respectively. The mean body weights of birds at 48 weeks of age were 1.688, 1.595, 1.605, 1.534 and 1.696 kg respectively in treatment groups 1, 2, 3, 4 and 5, the highest being in group 5 and the lowest in group 4.

The statistical analysis of the data on 20 week body weight presented in Table 5 showed no significant difference in body weight among the treatment groups. However, data on 48 week body weight presented in Table 6 showed that there is significant ($P<0.05$) difference among the treatment groups. The gain in body weight in birds fed with standard layer ration (T_1) and those fed with vegetable protein diet with 0.4 per cent sodium sulphate (T_5) were significantly higher than those birds fed with vegetable protein diet with 0.3 per cent sodium sulphate (T_4). However there was no significant difference in 48 week body weight of birds fed with vegetable protein diet containing 0.3 per cent methionine (T_2) and birds fed with vegetable protein diet supplemented with 0.2 (T_3) and 0.3 per cent sodium sulphate (T_4).

The body weight of birds fed with vegetable protein diet containing 0.3 per cent methionine (T_2) were statistically comparable with those birds fed with standard layer ration (T_1) and vegetable protein ration supplemented with 0.4 per cent sodium sulphate (T_5). There was no significant difference in 48 week body weight of birds fed with standard layer ration (T_1) and birds fed with vegetable protein diet with 0.4 per cent (T_5) and 0.2 per cent sodium sulphate (T_3).

Age at sexual maturity

The average age at first egg and age at 50 per cent production of the experimental birds for the different treatment groups are presented in Table 7 and the analysis of variance in Table 8a and 8b. The magnitude of variation among the mean values were not statistically significant. The average age at first egg was 156, 155, 155, 153 and 154 days respectively for treatment groups viz., T_1, T_2, T_3, T_4 and T_5. The average age at 50 per cent production for the treatment group T_1, T_2, T_3, T_4 and T_5 were 166, 164, 169, 162 and 164 days respectively.

Egg production

Hen-housed egg production

The mean per cent hen-housed egg production calculated period wise for different dietary treatment groups are set out in Table 9. The mean per cent hen-housed egg production was 59.38, 58.86, 55.46, 61.30 and 59.91 for the treatment groups T_1, T_2, T_3, T_4 and T_5 respectively. The highest per cent hen-housed egg production (61.30) was recorded in birds fed with vegetable protein diet supplemented with 0.3 per cent sodium

Table 6. Analysis of variance for 48th week body weight

Source	Df	SS	MSS	F
Treatment	4	0.149	0.037	3.633*
Error	35	0.058	0.010	
Total	39	0.507		

* Significant at 5 per cent level
CD for comparing treatment efficiency 0.1015

Table 7. Mean age (days) at first egg and 50 per cent egg production of experimental birds as influenced by different dietary treatments

Treatment	Age at first egg	Age at 50 per cent egg production
T_1	156 ± 2.20	166 ± 2.58
T_2	155 ± 2.18	164 ± 2.56
T_3	155 ± 2.18	169 ± 2.61
T_4	153 ± 2.10	162 ± 2.53
T_5	154 ± 2.15	164 ± 2.56

Table 8a. Analysis of variance for age at first egg

Source	Df	SS	MSS	F
Treatment	4	39.150	9.787	0.218 NS
Error	35	1568.75	44.821	
Total	39	1607.90		

NS - Non significant

Table 8b. Analysis of variance for age at 50 per cent egg production

Source	Df	SS	MSS	F
Treatment	4	205.750	51.438	1.803 NS
Error	35	998.250	28.521	
Total	39	1204.00		

NS - Non significant

Table 9. Mean per cent hen-housed egg production as influenced by different dietary treatments

Treatment groups	Period							Overall mean±SE (NS)
	I	II	III	IV	V	VI	VII	
T_1	11.91	65.62	84.14	79.79	67.18	53.45	53.45	59.38±3.34
T_2	10.26	57.81	80.79	75.66	68.41	63.94	55.13	58.86±3.99
T_3	8.47	62.05	80.79	69.41	61.26	54.82	51.44	55.46±3.60
T_4	10.59	58.81	83.03	80.24	70.97	65.28	60.15	61.30±3.54
T_5	8.14	63.84	82.80	73.76	73.76	61.15	55.91	59.91±3.59
Overall mean	9.88^{a}	61.62^{c}	82.31^{f}	75.77^{e}	68.32^{d}	59.73^{bc}	55.24^{b}	

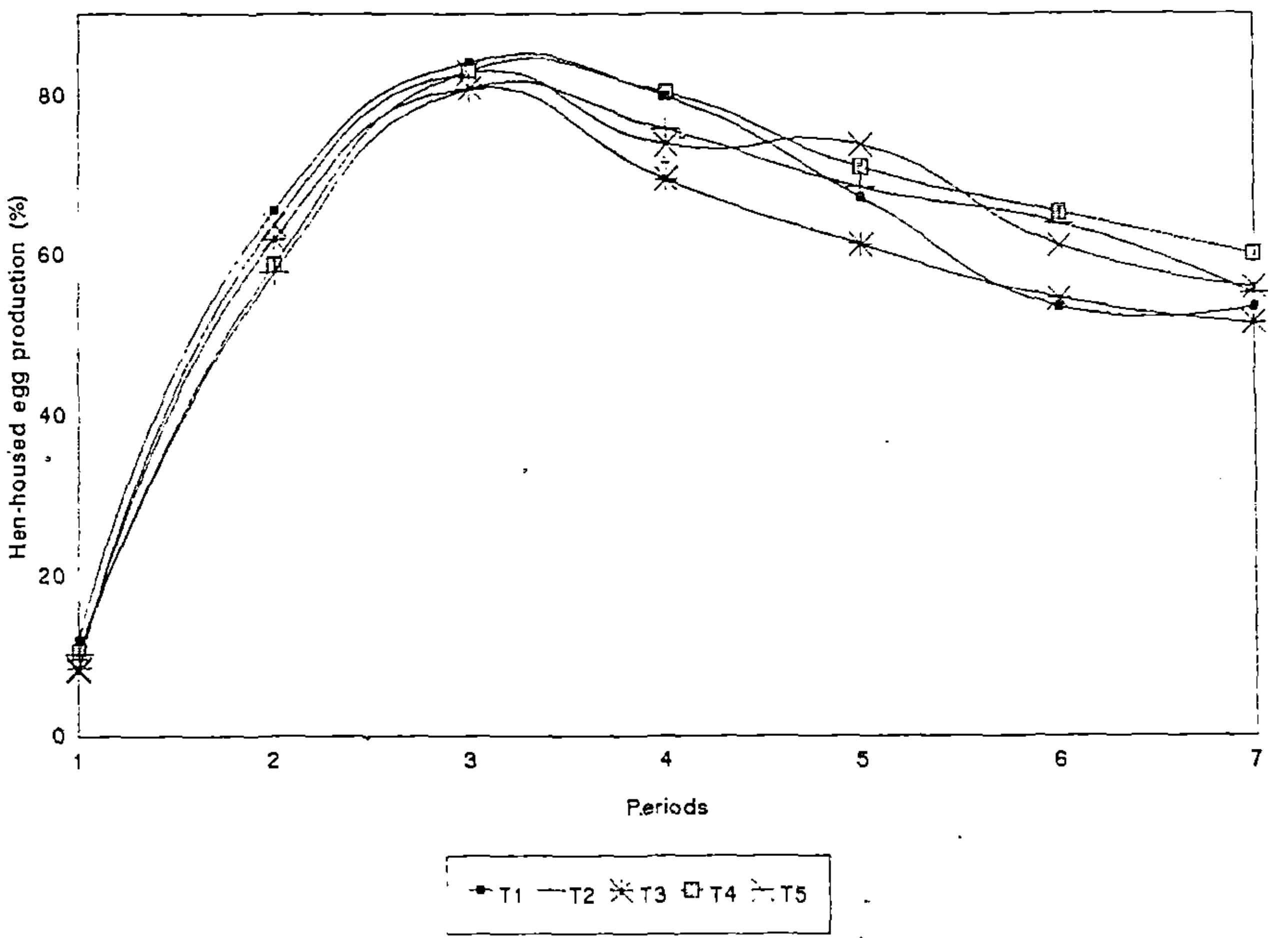
* Means bearing same superscript did not differ significantly (P<0.01)
NS Non-significant

Table 10. Analysis of variance for per cent hen-housed egg production

Source	Df	SS	MSS	F
Treatment	4	445.26	111.31	1.3494 NS
Period	6	58785.39	9797.56	118.7587 **
Interaction	24	778.71	32.44	0.3933 NS
Error	245	20212.44	82.50	
Total	245	80221.81		

CD for comparison = 5.24
** Significant at 1% level
NS Non significant

Fig.2 PERCENT HEN-HOUSED EGG PRODUCTION
AS INFLUENCED BY DIFFERENT DIETARY TREATMENTS



sulphate (T_4) and the lowest mean value (55.46 per cent) in group supplemented with 0.2 per cent sodium sulphate (T_3).

Statistical analysis of the data (Table 10) showed that the variations in per cent hen-housed egg production due to different dietary treatments were not statistically significant. However, the differences among the experimental periods were highly significant ($P<0.01$).

The mean per cent hen-housed egg production for the periods I to VII were 9.88, 61.62, 82.31, 75.77, 68.32, 59.73 and 55.24 respectively. The highest production was recorded in the third period (82.31) and the lowest in the first period (9.88). No significant difference in egg production was noted during the periods VI and VII. Similarly, during the periods II and VI egg production did not differ statistically. Egg production during the first period was significantly lower ($P<0.01$) than second period. Egg production recorded during third period was significantly ($P<0.01$) higher than all other periods. The per cent hen-housed production was represented graphically in Fig.2. The fluctuations in production due to treatment groups are more evident from fourth period onwards.

Hen-day egg production

The data on per cent hen-day egg production was presented in Table 11 and its graphical presentation in Fig.3. The mean

Table 11. Mean per cent hen-day egg production as influenced by different dietary treatments

Treatment groups	Period							Overall mean±SE (NS)
	I	II	III	IV	V	VI	VII	
T_1	11.91	65.62	84.14	79.79	70.02	58.14	57.81	61.06±3.28
T_2	10.26	57.81	81.06	75.66	73.39	68.41	59.70	60.90±3.37
T_3	8.47	62.44	83.71	77.74	72.91	64.53	61.71	61.65±3.45
T_4	10.59	58.81	83.03	80.24	72.15	70.22	63.83	62.69±3.30
T_5	8.14	63.95	84.78	75.51	75.36	63.59	59.09	61.49±3.50
Overall mean	9.88^{a}	61.72^{bc}	83.34^{f}	77.79^{e}	72.77^{d}	64.98^{c}	60.43^{b}	

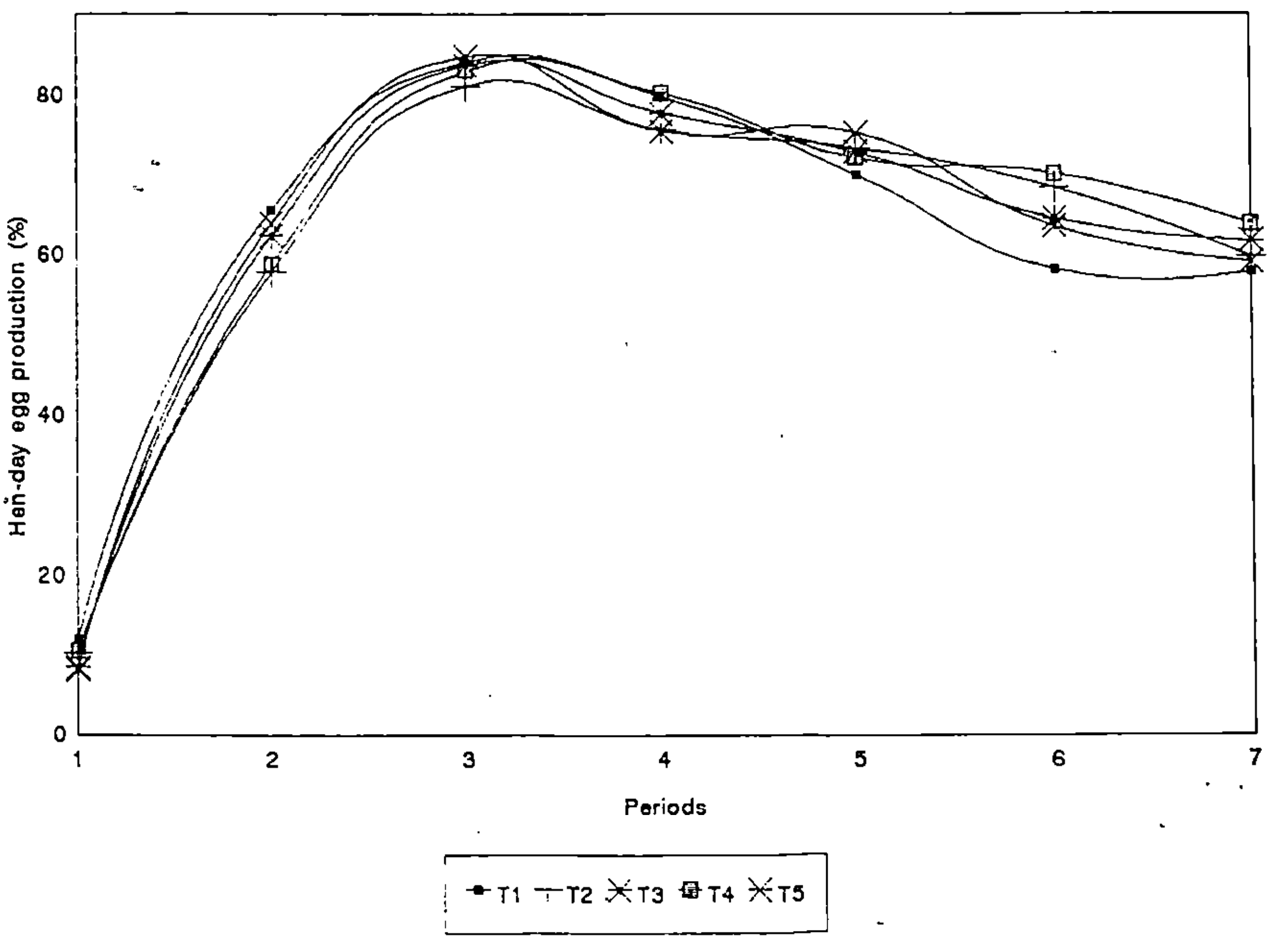
* Means bearing same superscript did not differ significantly (P<0.01)
NS Non-significant

Table 12. Analysis of variance for per cent hen-day egg production

Source	Df	SS	MSS	F
Treatment	4	57.21	14.30	0.2755 NS
Period	6	62114.31	10352.38	199.3620 **
Interaction	24	639.89	26.66	0.5135 NS
Error	245	12722.25	51.92	
Total	279	75533.68		

CD for comparison = 4.15
** Significant at 1% level
NS Non significant

Fig.3 PERCENT HEN-DAY EGG PRODUCTION
AS INFLUENCED BY DIFFERENT DIETARY TREATMENTS



per cent hen-day egg production for the treatment groups T_1, T_2, T_3, T_4 and T_5 were 61.06, 60.90, 61.65, 62.69 and 61.49 respectively. The highest per cent hen-day egg production (62.69) was noticed in group fed with vegetable protein diet supplemented with 0.3 per cent sodium sulphate (T_4) and the lowest in group fed with vegetable protein diet supplemented with 0.3 per cent methionine (T_2).

When data were subjected to statistical analysis (Table 12) magnitude of difference in per cent hen-day egg production among different treatment groups were not significant. The statistical analysis of period wise per cent hen-day egg production revealed significant ($P<0.01$) difference in egg production. The period wise mean per cent hen-day egg production for the periods I to VII were 9.88, 61.72, 83.34, 77.79, 72.77, 64.98 and 60.43 respectively. Highest per cent hen-day egg production was noted during third period (83.34). Hen-day egg production values obtained during the periods II and VII and also during the periods II and VI were not significantly different. Per cent hen-day egg production for the periods I, II, III, IV and V were significantly different.

Feed intake

The mean daily feed intake for birds in different dietary treatment groups are presented in Table 13. Results indicated

Table 13. Mean daily feed consumption (g/bird) as influenced by different dietary treatments

Treatment groups	Period							Overall mean±SE
	I	II	III	IV	V	VI	VII	
T_1	90.40	102.13	111.85	119.21	131.09	123.19	132.11	115.71±2.96^{ac}
T_2	88.05	93.58	103.89	113.02	127.90	119.87	124.06	110.05±3.04^{a}
T_3	89.23	99.06	110.54	139.91	144.82	124.46	137.55	120.79±4.02^{bc}
T_4	86.87	95.64	111.88	119.13	136.60	131.85	124.57	115.22±3.68^{ac}
T_5	89.56	105.57	118.03	138.67	147.05	138.28	132.34	124.21±3.92^{b}
Overall mean	88.82^{a}	99.20^{b}	111.24^{c}	125.99^{d}	137.49^{d}	127.55^{de}	130.13^{e}	

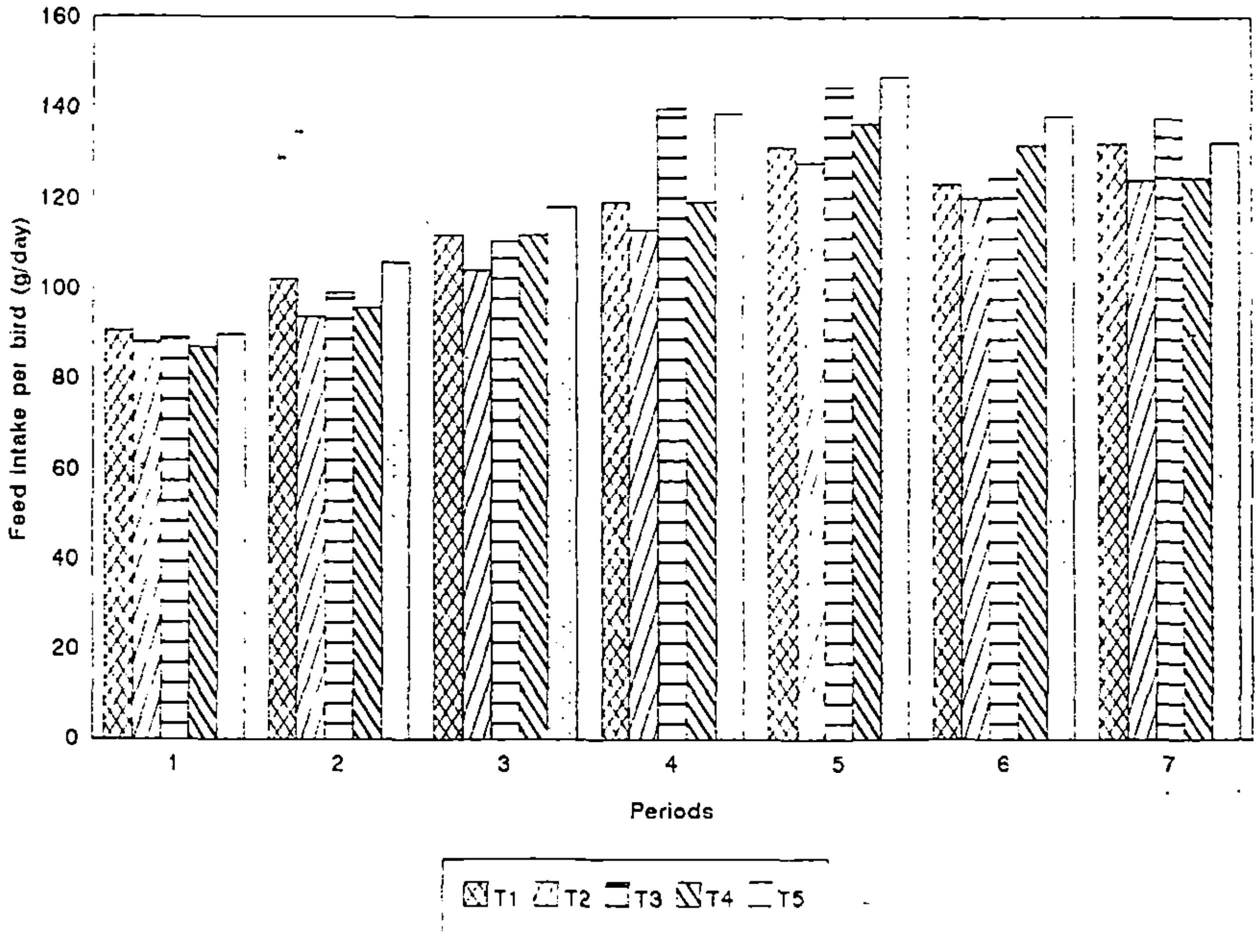
* Means bearing same superscript did not differ significantly (P<0.01)

Table 14. Analysis of variance for feed consumption

Source	Df	SS	MSS	F
Treatment	4	3340.96	835.24	12.9682 **
Period	6	38555.15	6425.85	99.7698 **
Interaction	24	2457.82	102.409	1.5900 NS
Error	105	6762.71	64.407	
Total	139	51116.66		

CD for comparing treatment = 5.913
CD for comparing periods = 6.996
CD for comparing interaction = 1.65
** Significant at 1% level
NS Non significant

Fig.4 MEAN FEED INTAKE PER BIRD (g/day)
AS INFLUENCED BY DIFFERENT DIETARY TREATMENTS



that overall mean daily feed consumption of birds fed with different dietary treatments were 115.71, 110.05, 120.79, 115.22, 124.21 g respectively for treatments I, II, III, IV and V. The highest feed intake was in group V followed by III, IV, I and II in the descending order.

The statistical analysis of the data pertaining to mean daily feed consumption per bird (Table 14) revealed that there is significant difference among the treatment groups ($P<0.01$). The mean daily feed intake of birds fed with vegetable protein diet containing 0.3 per cent supplemented methionine (T_2) were significantly lower than those treatment groups supplemented with 0.2 and 0.4 per cent sodium sulphate in vegetable protein diet (T_3 and T_5). The mean daily feed intake of birds fed 0.3 per cent methionine added diet (T_2) was statistically comparable with those fed vegetable protein diet containing 0.3 per cent sodium sulphate (T_4) and standard layer ration (T_1). Similarly the mean daily feed intake per bird in groups fed with vegetable protein diet supplemented with 0.2 and 0.3 per cent sodium sulphate (T_3 and T_4) were statistically comparable with standard layer ration (T_1). Thus, the feed intake in T_1 was statistically comparable with all treatment groups except T_5.

Statistical analysis of period-wise mean daily feed consumption revealed that the difference among periods were significant ($P<0.01$). The initial three periods showed a progressive and significant increase in feed intake (88.82, 99.20 and 111.24 g). The fourth, fifth and sixth periods showed no significant difference in feed intake (125.99, 137.49 and 127. 55 g). These values were significantly higher than those in other periods. Period five recorded the highest value for (137.49) feed intake in comparison with other periods. The feed consumption in the seventh period (130.13 g) was significantly lower than the mean values in period five and was statistically comparable to the fourth and sixth period.

Figure 4 revealed the variations in the mean feed intake during periods I to VII by the different dietary treatment groups.

Feed efficiency

The feed efficiency calculated as kilogram feed consumed per dozen eggs in the five dietary treatments at various periods were presented in Table 15. Since the mean per cent hen-housed egg production in the first period was only 9.88 the data pertaining to feed efficiency for the first period was not taken for statistical analysis.

Statistical analysis of the data (Table 16) showed that there was no significant difference among treatment groups in feed conversion efficiency. The mean values of feed

Table 15. Mean feed efficiency (kg feed/dozen egg) as influenced by different dietary treatments

Treatment groups	Period						Overall mean±SE (NS)
	II	III	IV	V	VI	VII	
T_1	1.903	1.58	1.73	2.15	2.53	2.78	2.11±0.108
T_2	1.94	1.53	1.73	2.11	2.12	2.49	1.99±0.072
T_3	1.90	1.58	2.14	2.48	2.62	3.17	2.31±0.183
T_4	1.97	1.56	1.77	2.20	2.36	2.42	2.05±0.113
T_5	1.99	1.66	2.23	2.39	2.98	2.83	2.35±0.171
Overall mean	1.94^{ab}	1.58^{a}	1.92^{ab}	2.26^{bc}	2.52^{c}	2.74^{c}	

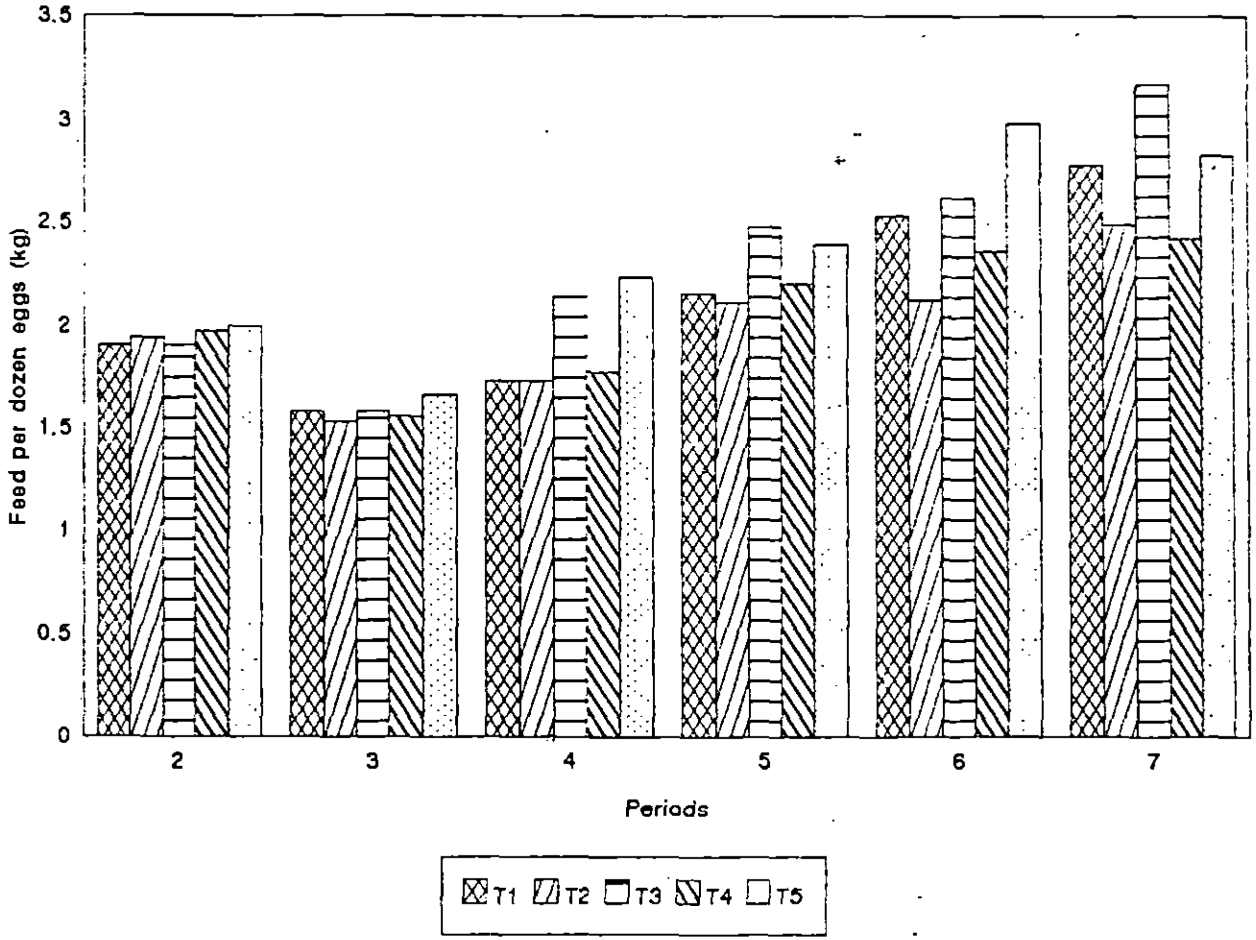
* Means bearing same superscript did not differ significantly (P<0.01)
NS Non-significant

Table 16. Analysis of variance for feed efficiency

Source	Df	SS	MSS	F
Treatment	4	2.49	0.621	1.8307 NS
Period	5	18.31	3.66	10.7637 **
Interaction	20	2.02	0.10	0.2968 NS
Error	90	30.62	0.34	
Total	119	53.44		

CD for comparing periods = 0.475
** Significant at 1% level
NS Non significant

Fig.5 MEAN FEED EFFICIENCY (kg feed/dozen eggs)
AS INFLUENCED BY DIFFERENT DIETARY TREATMENTS



efficiency for the five treatments were 2.11, 1.99, 2.31, 2.05 and 2.35 respectively for treatments T_1 to T_5. The best feed conversion efficiency of 1.99 was recorded in birds fed with vegetable protein diet supplemented with 0.3 per cent methionine. The lower feed efficiency of 2.35 was noted in group fed with vegetable protein diet containing 0.4 per cent sodium sulphate.

However, the period wise mean feed efficiency revealed significant (P<0.01) difference. The feed efficiency was better in the third period and was statistically comparable to periods II and IV. At the same time the feed efficiency noted in the second and fourth period showed no significant difference with that obtained in the fifth period. Statistically comparable values of feed efficiency were obtained during periods V, VI and VII and these values were significantly higher than the feed efficiency obtained in period III.

Figure 5 indicated that the mean values of feed efficiency are higher in period II and thereafter showing lower feed efficiency in other periods.

Egg weight

The data on mean egg weight for the different dietary treatment groups are set out in Table 17. The mean egg weight

Table 17. Mean egg weight (g) as influenced by different dietary treatments

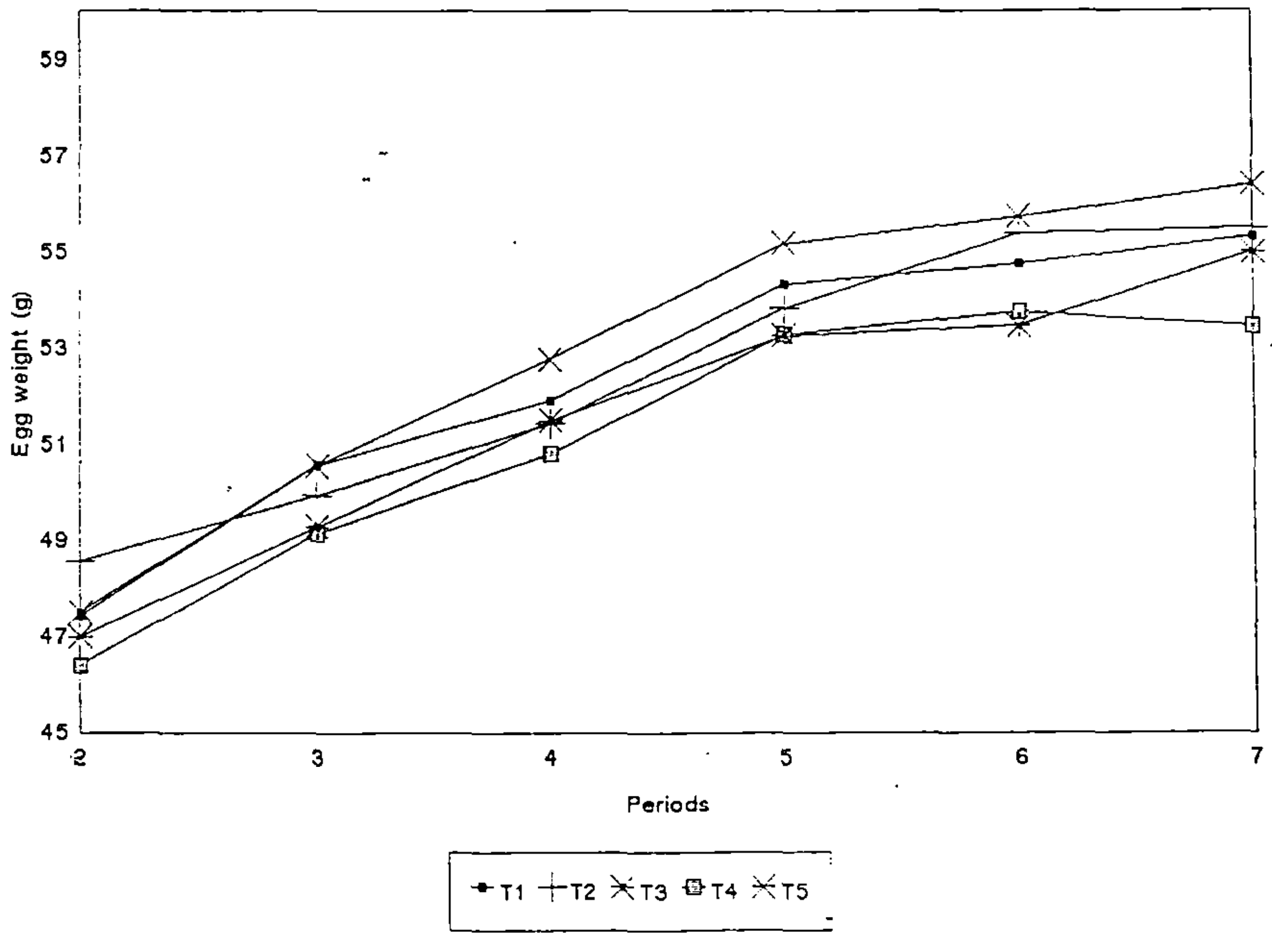
Treatment groups	Period						Overall mean±SE
	II	III	IV	V	VI	VII	
T_1	47.43	50.56	51.90	54.32	54.76	55.31	52.38±0.473 ^{bc}
T_2	48.56	49.93	51.43	53.83	55.39	55.47	52.44±0.467 ^{bc}
T_3	47.00	49.29	51.50	53.26	53.46	54.98	51.58±0.528 ^{ab}
T_4	46.40	49.16	50.80	53.28	53.75	53.43	51.14±0.592 ^{a}
T_5	47.51	50.56	52.77	55.18	55.73	56.39	53.02±0.491 ^{c}
Overall mean	47.38 ^{a}	49.90 ^{b}	51.68 ^{c}	53.97 ^{d}	54.62 ^{d}	55.12 ^{d}	

Table 18. Analysis of variance for egg weight

Source	Df	SS	MSS	F
Treatment	4	107.51	26.87	5.2457 **
Period	5	1851.85	370.37	72.2852 **
Interaction	20	33.41	1.67	0.3261 NS
Error	210	1075.98	5.12	
Total	239	3068.77		

CD for comparing treatment effect = 1.15
CD for comparing periods = 1.26
** Significant at 1% level
NS Non significant

Fig.6 MEAN EGG WEIGHT (g)
AS INFLUENCED BY DIFFERENT DIETARY TREATMENTS



was 52.38, 52.44, 51.58, 51.14 and 53.02 g for the treatment groups T_1, T_2, T_3, T_4 and T_5 respectively.

The highest mean egg weight of 53.02 g was recorded in birds fed with vegetable protein diet supplemented with 0.4 per cent sodium sulphate (T_5) and lowest (51.14 g) in the group received vegetable protein diet supplemented with 0.3 per cent sodium sulphate (T_4). The difference between these two mean values was statistically significant ($P<0.01$).

Statistical analysis of the data (Table 18) showed significant ($P<0.01$) differences in egg weights among different treatment groups. The mean egg weight of birds fed with vegetable protein diet with 0.4 per cent sodium sulphate (T_5) was significantly higher than treatment group T_3 and T_4. But T_5 was statistically comparable with treatments T_1 and T_2. The mean egg weights in T_1, T_2 and T_3 were under a homogenous group having statistically comparable values. Similarly egg weight of group fed with vegetable protein diet with 0.2 per cent sodium sulphate (T_3) and 0.3 per cent sodium sulphate (T_4) were also statistically comparable.

Because of small size and fewer number of eggs obtained in first period, egg weight in this period were not taken for statistical analysis. The overall mean egg weight for periods II to VII were 47.38, 49.90, 51.68, 53.97, 54.62 and 55.12 g respectively. The mean egg weight was significantly low at second period (47.38 g) and increased progressively to 53.97 g at period V showing significant difference between periods. However, the overall mean egg weight registered during fifth period (53.97 g) was comparable to that of sixth and seventh period.

The mean egg weights presented in Fig.6 indicated that the egg weight was higher in T_5 at all periods from III to VII in comparison to other treatment groups.

Livability

The influence of sodium sulphate supplementation on survivability of hens was studied based on the mortality pattern observed during the course of the experiment. Mortality of birds occurred in the different dietary treatment groups are presented in Table 19. A total of 15 birds were died during the course of the study. Among the treatment groups the highest mortality number of five was recorded in the group fed vegetable protein diet supplemented with 0.2 per cent sodium sulphate. Autopsy of all dead birds was conducted to detect the causes of the death in each case. The lesions did not show any signs attributable to treatment effect. The overall mortality of 15 among the experimental birds accounted to livability of 90.7 per cent.

Table 19. Mortality number as influenced by different dietary treatments

Treatment	Period							Total
	I	II	III	IV	V	VI	VII	
T_1	-	-	1	-	2	-	-	3
T_2	-	-	1	-	1	-	-	2
T_3	-	1	1	3	-	-	-	5
T_4	-	-	-	3	-	-	-	3
T_5	1	-	-	-	1	-	-	2
Total	1	1	3	6	4	-	-	15

Cost benefit analysis

The cost of different diets used in the study was calculated based on the actual price of feed ingredients which prevailed at the time of experiment and are presented in Table 20. Cost of different diets computed for the different treatments viz., T_1, T_2, T_3, T_4 and T_5 were Rs.6.55, 7.62, 6.87, 6.94 and 7.01 per kilogram respectively. Among the rations the cost of vegetable protein diet with 0.3 per cent methionine was highest (Rs.7.62) and the standard layer ration was the cheapest (6.55). All the vegetable protein diets indicated higher cost even before the addition of methionine and sodium sulphate because of the inclusion of soyabean meal, which was not available in Trichur market. The cost of fish meal during the experimental period was Rs.8.70 per kilogram from there it went upto 12.87 per kg which is the present market rate.

The economics of production set out in Table 21 indicated that the feed cost for producing an egg varied from 119.44 to 140.36 paise for the different treatment groups. Further, it was revealed that cost of production of eggs was lower in standard layer ration compared to vegetable protein diet incorporated with methionine and sodium sulphate. The highest cost of production per egg was recorded in groups fed with vegetable protein diet supplemented with 0.4 per cent sodium sulphate.

Table 20. The cost of experimental diets (Rs.) as influenced by the price of ingredients

Ingredients	Cost/kg (Rs.)	Dietary treatments				
		T_1	T_2	T_3	T_4	T_5
1. Yellow maize	5.66	249.04	237.72	237.72	237.92	237.72
2. Soyabean meal	10.12	50.60	111.32	111.32	111.32	111.32
3. Groundnut cake (deoiled)	9.24	92.40	147.84	147.84	147.84	147.84
4. Rice polish	4.79	91.01	91.01	91.01	91.01	91.01
5. Gingilly oil cake	9.04	45.20	45.20	45.20	45.20	45.20
6. Unsalted dried fish	8.70	87.00	-	-	-	-
7. Shell grit	3.35	15.07	15.07	15.07	15.07	15.07
8. Common salt	1.51	0.37	0.37	0.37	0.37	0.37
9. Mineral mixture	6.99	15.72	15.72	15.72	15.72	15.72
10. Vitamin mixture	479	9.58	9.58	9.58	9.58	9.58
11. Methionine	295	-	88.50	-	-	-
12. Sodium sulphate	70	-	-	14.00	21.00	28.00
Cost/100 kg diet		655.99	762.33	687.83	694.83	701.83
Cost/kg diet		6.55	7.62	6.87	6.94	7.01

Table 21. Economics of production as influenced of experimental diets

Particulars	Dietary treatments				
	T_1	T_2	T_3	T_4	T_5
1. Total feed intake (Kg)	690.25	663.17	680.20	687.03	752.53
2. Total number of eggs produced	3785	3692	3509	3845	3758
3. Feed consumed per egg (g) (20-48 weeks)	182.36	179.62	193.84	178.68	200.24
4. Cost of feed/kg (Rs.)	6.55	7.62	6.87	6.94	7.01
5. Cost of feed/egg (Paise)	119.44	136.87	133.16	124.00	140.36

Discussion

DISCUSSION

The results obtained in the study of sodium sulphate supplementation in the diet devoid of animal protein sources on the production performance and other related parameters of layer chicken are discussed in this chapter.

Meteorological observations

The data pertaining to microclimate inside the experimental house are presented in Table 3. During the course of the experiment the mean maximum temperature ranged from 28.85 to 32.07°C with the highest mean maximum temperature of 32.07°C recorded during the sixth period of study. The mean minimum temperature ranged from 23.17 to 25.57°C with the lowest temperature recorded during VIIth period of study. The mean maximum relative humidity of 86 per cent and mean minimum relative humidity of 65 per cent were recorded during the experimental period from June to December. The mean maximum and mean minimum temperature as well as the mean relative humidity in the morning and evening, recorded during the course of the experiment is similar in trend to that reported by Somanathan (1980) and Geo (1992). The data obtained in this study therefore indicated that the maximum as well as minimum temperature were within the stress level as adjudged by Esmay (1969), McDowel (1972) and North (1984).

Body weight

The difference in mean body weight of experimental birds in different dietary treatment groups at 20th week of age were not statistically significant, indicating homogenity among the experimental birds (Table 4). However, at 48 weeks of age there was significant ($P<0.05$) difference in body weights among dietary treatments (Table 4).

The gain in body weight of birds fed with standard layer ration (T_1) and those fed with vegetable protein diet with 0.4 per cent sodium sulphate (T_5) were significantly higher than those fed with vegetable protein diet with 0.3 per cent sodium sulphate. The body weight of birds fed with vegetable protein diet containing 0.3 per cent methionine (T_2) were statistically comparable with the treatment groups T_1 and T_5 and body weight gains of these three treatment groups were also comparable with those birds fed with vegetable protein diet with 0.2 per cent sodium sulphate (T_3).

These findings agree with the findings of Kadirvel and Kothandaraman (1978) who reported there is no significant difference in body weight at 42 week of age in White Leghorn birds fed with experimental diet containing 0.2 per cent methionine, 0.25 per cent sodium sulphate or both when compared to control diet. Damron and Harms (1973) also reported similar findings as non-significant difference in body weight gain in layer with sodium sulphate supplementation.

But positive growth response in chicks were reported by Ross and Harms (1970), Hinton and Harms (1972), Soares *et al.* (1974), Bornstein and Plavnik (1977), Plavnik and Bornstein (1977), Yadav *et al.* (1994). Positive growth response in White Leghorn pullets has also been reported by Sharma *et al.* (1994). Contrary to the above findings Hikami *et al.* (1988) reported a decreased gain in body weight in a ration high in sulphur amino acid supplemented with inorganic sulphate. Thus it is evident that supplementation of sodium sulphate did not have any deleterious effect on gain in body weight.

Age at sexual maturity

The data presented in Table 7 on age at first egg and at 50 per cent egg production indicated that the variation in dietary treatments did not influence the age at first egg and 50 per cent egg production. These findings agree with the findings of Kadirvel and Kothandaraman (1978).

Egg production

Data on the mean per cent hen-housed and hen-day egg production are presented in Table 9 and 11 respectively. The mean per cent hen-housed egg production was 59.38, 58.86, 55.46, 61.30 and 59.91 for the treatment groups T_1, T_2, T_3, T_4 and T_5 respectively. Similarly, the mean per cent hen-day egg production for the treatment groups T_1, T_2, T_3, T_4 and T_5 were 61.06, 60.90, 61.65, 62.69 and 61.49 respectively.

Statistical analysis of the data (Table 10 and 12) indicated that the magnitude of differences in hen-housed and hen-day egg production among the various treatments were not significant. Though there were no significant difference in egg production due to different dietary treatments, those birds fed with vegetable protein diet with 0.3 per cent sodium sulphate (T_4) have shown numerically higher hen-housed and hen-day egg production than all other experimental diets. This possibly suggests that supplementation of sodium sulphate did not have deleterious effects on egg production.

The results of this experiment agrees with the findings of Damron and Harms (1973), Kadirvel and Kothandaraman (1978), and Miles *et al.* (1986) who reported non-significant improvement in egg production when compared with the egg production obtained with control diet.

Period-wise egg production data revealed significant ($P<0.01$) difference among the different periods of experimental study. The results indicated that the overall mean egg production during the first period was significantly low and the egg production recorded during the third period was significantly higher than all other periods. Same trend was noticed in all the treatment groups. The hen housed and hen-day egg production obtained during sixth and seventh period were statistically comparable and followed the natural egg production trend in pullet year production. These findings agree with those reported by Romanoff and Romanoff (1949).

Feed intake

The mean daily feed intake of birds in different dietary treatment groups are presented in Table 13. Results indicated that overall mean daily feed consumption of birds fed with different dietary treatments were 115.71, 110.05,, 120.79, 115.22 and 124.21 g respectively for treatments I, II, III, IV and V. The highest feed intake was in group V followed by III, IV, I and II in the decreasing order.

The statistical analysis of the data (Table 14) pertaining to mean daily feed intake per bird revealed that there is significant ($P<0.01$) difference among the treatment groups. The mean daily feed intake of birds fed with vegetable protein diet containing 0.3 per cent methionine were significantly lower than those treatment groups supplemented with 0.2 and 0.4 per cent sodium sulphate in vegetable protein diet (T_3 and T_5). This finding agrees with the finding of Damron and Harms (1973) who reported a significantly lower feed consumption in layers supplemented with 0.355 per cent sulphur amino acid. In the same work they reported higher feed consumption in treatment groups fed with 0.47 per cent sulphur amino acid with or without 0.1 per cent sodium sulphate. The numerically higher feed intake of 124.21 g in birds fed with 0.4 per cent sodium sulphate agree with this findings.

An overall view of the feed consumption pattern revealed that the feed consumption in different dietary treatments consisting of vegetable protein diet supplemented with methionine and different levels of sodium sulphate were statistically comparable with the control diet. Damron and Harms (1973) and Kadirvel and Kothandaraman (1978) reported such finding in their experiment with laying birds.

Period-wise daily feed intake revealed that the differences among periods were highly significant ($P<0.01$). The initial three periods showed a progressive and significant increase in feed intake. These values were significantly lower than those in other periods. Lowered body weight of pullets during the initial period have resulted in a lowered feed intake at that time. Apparently lowered egg production during the first periods could also have contributed to the lesser feed intake. Eventhough period five showed the highest numerical (137.49) feed intake it was not significantly different from period four and period six. The reason for the higher feed intake may be due to increased body weight of birds as age advance.

Feed efficiency

The feed efficiency calculated as kilogram feed consumed per dozen eggs in the five dietary treatments at various periods II to VII are presented in Table 15. Since the mean per cent hen-housed egg production in the first period was only 9.88, the data pertaining to feed efficiency for the first period was not considered for statistical analysis.

The mean values of feed efficiency for the five treatments were 2.11, 1.99, 2.31, 2.05 and 2.35 respectively for treatments T_1 to T_5. The superior feed efficiency among the five treatments was recorded in birds fed with vegetable protein diet supplemented with 0.3 per cent methionine (T_2) followed by T_4, T_1, T_3 and T_5.

The statistical analysis of the data on mean feed conversion efficiency (Table 16) revealed that all treatments were statistically comparable in respect of this trait, indicating that birds were equally efficient in utilizing different experimental diets.

These findings agree with the findings of Damron and Harms (1973), Kadirvel and Kothandaraman (1978), Miles *et al.* (1986) and Hikami *et al.* (1988). The results of work done by these authors confirmed that addition of sodium sulphate did not result in significant improvement in feed efficiency in layers.

On the other hand Harms *et al.* (1990) reported a improvement in feed efficiency when sodium sulphate was added to the basal diet devoid of methionine and choline. They also found that no response was obtained when sulphate was added to the diets containing 0.033 and 0.067 per cent methionine.

However, numerical superior feed efficiency observed in birds fed with vegetable protein diet supplemented with sodium sulphate indicated that supplementation of sodium sulphate did not have any harmful effect on utilization of diet.

Period-wise mean feed efficiency revealed significant ($P<0.01$) difference among different periods of study. Due to higher production of eggs in period three, the feed efficiency was also better in this period and it was statistically comparable to those obtained in period II and IV. Similarly, statistically comparable values of feed efficiency were obtained during V, VI and VII.

Egg weight

The data on egg weight for the different dietary treatment groups are set out in Table 17. The mean egg weight was 52.38, 52.44, 51.58, 51.14 and 53.02 g for the treatment groups T_1, T_2, T_3, T_4 and T_5 respectively. The highest mean egg weight of 53.02 g was recorded in birds fed with vegetable protein diets supplemented with 0.4 per cent sodium sulphate (T_5) and lowest (51.14 g) in the group which received vegetable protein diet supplemented with 0.3 per cent sodium sulphate (T_4).

Statistical analysis of the data on mean egg weight (Table 18) showed significant ($P<0.01$) difference in egg weights among different treatment groups. The mean egg weight of birds fed with vegetable protein diet with 0.4 per cent sodium sulphate (T_5) was significantly higher than treatment groups T_3 and T_4. But T_5 was statistically comparable with treatment group of T_1 and T_3 having intermediary and almost similar egg weight. An overview of the data on egg weight showed that the egg weight obtained with different dietary treatments are comparable with each other. The egg weight obtained in this strain of birds was comparable with those reported by Anon (1979), Beena (1995) and Ponnuvel (1996).

Statistically superior higher mean egg weight of birds fed with 0.4 per cent sodium sulphate revealed that addition of sodium sulphate at this level does not have any deleterious effect on egg weight. The beneficial effect of adding 0.4 per cent sodium sulphate on egg weight is difficult to explain. Hence further studies are warranted to confirm this beneficial effect.

On the contrary to the finding of this experiment with the findings of Damron and Harms, (1975) Kadirvel and Kothandaraman (1978) and Miles *et al.* (1986) reported non-significant improvement in egg weight with that of control diet.

The period-wise overall mean egg weight for periods II to VII are 47.38, 49.90, 51.68, 53.97, 54.62 and 55.12 g respectively. Due to comparatively very small number and small sized eggs in first period of study (21-24 weeks age) the egg weight obtained in this study were not considered for statistical analysis. Period-wise data revealed significant difference in mean egg weight from period to period and followed the normal pattern of increase in egg weight during the first year of production. This is in agreement with the reports of Romanoff and Romanoff (1949). The mean egg weight was significantly low at initial periods and increased progressively upto period five. The overall mean egg weight registered during fifth period was comparable to that of sixth and seventh period of study.

Livability

The data on the mortality pattern of birds under the different dietary treatment groups are presented in Table 19. During the entire course of the experiment covering 28 weeks, altogether fifteen birds died. Among the treatment groups the group fed with vegetable protein diet supplemented with 0.2 per cent sodium sulphate had highest mortality (5 numbers). The maximum number of mortality was observed during the fourth period. Necropsy findings revealed that birds died due to oophoritis (7 numbers), non-specific enteritis (3 numbers), pecking injuries (2 numbers) and other conditions like hepatosis and nephritis (3 numbers). The lesions did not show any signs attributable to treatment effect. Thus it is evident that sodium sulphate did not have any detrimental effect on the physiological well being of laying hens.

The overall mortality of 15 birds among the experimental birds accounted to livability of 90.7 per cent. This agrees with the findings of Balachandran *et al.* (1979) who reported a livability of 86.6 per cent in `F' strain White Leghorn birds reared in cages.

Cost benefit analysis

The cost of different diets used in the study was calculated based on the actual price of feed ingredients which prevailed at the time of experiment and are presented in Table 20 cost of different diets computed for the different treatments viz., T_1, T_2, T_3, T_4 and T_5 were Rs.6.55, 7.62, 6.87, 6.94 and 7.01 per kilogram respectively. Among the rations the standard layer ration was the cheapest (6.55/kg) and vegetable protein diet with 0.3 per cent methionine was the costliest (7.62/kg). All the vegetable protein diets showed higher cost even before the addition of methionine and sodium sulphate because of the inclusion of soyabean meal, which was not available at Trichur market.

When the cost of egg production based on feed alone was calculated (Table 21) it revealed that cost of production of egg was lower in standard layer ration compared to vegetable protein diet incorporated with methionine or sodium sulphate. The highest cost of production of an egg was noted in group fed with vegetable protein diet supplemented with 0.4 per cent sodium sulphate. But compared to methionine added diet the 0.3 per cent sodium sulphate added vegetable protein diet was cheaper and it occupied the second position among comparatively cheaper diets.

Based on the above findings it was concluded that supplementation of sodium sulphate at the level of 0.2, 0.3 and 0.4 per cent have definite advantage over non-supplemented group. Further studies are warranted with exclusion of soyabean cake and utilizing locally available vegetable protein sources to reduce the feed cost.

Summary

SUMMARY

An investigation was carried out at the Department of Poultry Science, College of Veterinary and Animal Sciences, Mannuthy to evaluate the effect of supplementation of sodium sulphate in White Leghorn layer diets devoid of animal protein sources.

White Leghorn `F' strain pullets of 18 weeks of age were housed in four-bird cages. Body weights were recorded individually at 20 weeks of age and birds were wing badged and distributed at random to five different dietary treatment groups. Each treatment group consisted of eight replicates of four birds. Standard routine managemental practices were followed throughout the experimental period. Feed and water were provided ad libitum. The dietary treatments consisted of standard layer ration (T_1) which was prepared using unsalted dried fish as animal protein source and is used as control diet. All vegetable protein diet (T_2) was prepared using soyabean cake, groundnut cake and gingelly oil cake as protein sources with the addition of 300 g DL-methionine in every 100 kg diet. Other experimental diets were prepared using soyabean cake, groundnut cake and gingelly oil cake as vegetable protein sources with the addition of anhydrous sodium sulphate at the levels of 200 g (T_3), 300 g (T_4) and 400 g (T_5) in every 100 kg diet. All the rations were

formulated as per BIS (1992) specification of nutrients for layer chicken.

Body weight at 20 and 48 weeks of age, age at sexual maturity, egg production, feed intake, feed efficiency, egg weight, livability and cost benefit analysis were the major criteria considered for the evaluation. The data were collected for seven, 28 day periods and were subjected to appropriate statistical analysis.

The results obtained during the course of the study are summarised in Table 22. Based on the results of this study following observations were made.

1. The mean body weight of birds at 20 weeks of age were statistically similar. Whereas 48 weeks of age showed significant difference ($P<0.05$). The gain in body weight of birds fed with standard layer ration (T_1) and those fed with vegetable protein diet with 0.4 per cent sodium sulphate (T_5) were significantly ($P<0.05$) higher than those birds fed with vegetable protein diet with 0.3 per cent sodium sulphate (T_4).

2. The age at sexual maturity as measured by age at first egg and age at 50 per cent production among the five treatment groups were statistically comparable.

Table 22. Summary of performance of layers as influenced by different dietary treatments

	Particulars	Dietary treatments				
		T_1	T_2	T_3	T_4	T_5
1.	Mean body weight at 20 weeks (kg)	1.018± 0.02	1.161± 0.02	1.214± 0.02	1.176± 0.02	1.199± 0.02
2.	Mean age at first egg (days)	156± 2.20	155± 2.18	155± 2.18	153± 2.10	154± 2.50
3.	Mean age at 50 per cent egg production	166± 2.58	164± 2.56	169± 2.61	162± 2.53	164± 2.56
4.	Per cent hen-housed egg production	59.38± 3.34	58.86± 3.99	55.46± 3.60	61.30± 3.54	59.91± 3.59
5.	Per cent hen-day egg production	61.06± 3.28	60.90± 3.37	61.65± 3.45	62.69± 3.30	61.49± 3.50
6.	Mean daily feed intake (g)	115.71± 2.96	110.05± 3.04	120.79± 4.02	115.22± 3.68	124.21± 3.92
7.	Mean feed efficiency (kg feed/dozen eggs)	2.11± 0.108	1.99± 0.072	2.31± 0.183	2.05± 0.113	2.35± 0.171
8.	Mean egg weight (g)	52.38± 0.473	52.44± 0.467	51.58± 0.528	51.14± 0.592	53.02± 0.491
9.	Livability (%)	1.88	1.25	3.12	1.88	1.25
10.	Cost of feed (Rs./kg)	6.55	7.62	6.87	6.94	7.01
11.	Feed cost per egg (paise)	119.44	136.87	133.16	124.00	140.36
12.	Mean body weight at 48 weeks of age (kg)	1.688± 0.03	1.595± 0.04	1.605± 0.04	1.534± 0.04	1.696± 0.04

3. There was no significant difference among different dietary treatment groups in both hen-day and hen-housed egg production. Statistical analysis of the data on hen-housed and hen-day egg production showed significant ($P<0.01$) difference among periods.

4. Data on mean daily feed intake per bird revealed that there is significant ($P<0.01$) difference among treatment groups. The mean daily feed intake of birds fed with vegetable protein diet with 0.3 per cent methionine were significantly lower than those treatment groups supplemented with 0.2 and 0.4 per cent sodium sulphate in vegetable protein diet. However, the feed intake of birds fed with standard layer ration (T_1) was statistically comparable with all treatment groups except birds fed with vegetable protein diet with 0.4 per cent sodium sulphate (T_5). Daily feed intake of birds showed significant ($P<0.01$) difference among different periods.

5. The feed efficiencies calculated based on feed per dozen eggs were statistically homogenous in five dietary treatments. It differed significantly ($P<0.01$) between periods.

6. The mean egg weight among different dietary treatment groups ranged from 51.14 to 53.02 g and showed significant ($P<0.01$) difference. The mean egg weight of

birds fed with vegetable protein diet with 0.4 per cent sodium sulphate (T_5) was significantly higher than treatment groups T_3 and T_4. However T_5 was statistically comparable with those fed with standard layer ration (T_1). The mean egg weight in T_2 and T_3 were statistically comparable with egg weight of control group (T_1). Statistical analysis of the data on mean egg weight showed significant difference among different periods.

7. Mortality was not different among the five different dietary treatment groups tested.

8. Cost benefit analysis revealed that cost of production of eggs was lower in standard layer ration compared with vegetable protein diet supplemented with either methionine or sodium sulphate. The highest cost of production per egg was recorded in group fed with vegetable protein diet supplemented with 0.4 per cent sodium sulphate.

Based on the above findings it can be inferred that the supplementation of sodium sulphate at the level of 0.2, 0.3 and 0.4 per cent have no deleterious effect in all vegetable protein layer ration. It was also found that incorporation of sodium sulphate do not negatively influence production parameters. Incorporation of sodium sulphate in all vegetable protein ration appears to provide sulphur containing aminoacid from sulphate, which otherwise would have been provided by fish. Thus based on the present study, it can be concluded that sodium sulphate can be effectively utilized as sulphur donor in circumstances when good quality fish/fishmeal is not available.

In addition to the above findings the study also revealed that addition of methionine at 0.3 per cent level to vegetable protein diet can also be effectively utilized in formulation of layer ration when scarcity of fish occurs.

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EFFECT OF SODIUM SULPHATE SUPPLEMENTATION IN LAYER DIET

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ABSTRACT OF A THESIS

Submitted in partial fulfilment of the requirement for the degree of

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1998

ABSTRACT

An investigation was carried out to evaluate the effect of supplementation of sodium sulphate in White Leghorn layer diets devoid of animal protein sources. White Leghorn `F' strain pullets of 20 weeks of age were wing banded and randomly distributed to five different dietary treatment groups, each with eight replicates of four birds each. The dietary treatment consisted of control ration (T_1) prepared using unsalted dried fish as animal protein source, all vegetable protein diet with the addition of 300 g DL-methionine (T_2), all vegetable protein diet with the addition of anhydrous sodium sulphate at the levels of 200 g (T_3), 300 g (T_4) and 400 g (T_5) in every 100 kg of diet. All the rations were formulated as per BIS (1992) specification of nutrients for layer chicken. Soyabean cake, groundnut cake and gingelly oil cake were used as protein sources in vegetable protein diet. Body weight at 20 and 48 weeks of age, age at sexual maturity, egg production, feed intake, feed efficiency, egg weight, livability and cost-benefit analysis were the major criteria considered for the evaluation. The data were recorded for seven, 28 day periods.

There was significant difference in body weight at 48 weeks of age ($P<0.05$). Body weight of birds fed with standard layer ration (T_1) and birds fed with 0.4 per cent sodium sulphate were significantly ($P<0.05$) higher than those birds

fed with 0.3 per cent sodium sulphate (T_4) supplemented diet. But body weight of birds fed with standard layer ration (T_1) was comparable with body weight of birds fed with vegetable protein diet having 0.4 per cent sodium sulphate (T_5). Similar trend was followed in egg weight also, with significantly higher egg weight in treatment group fed with 0.4 per cent sodium sulphate (T_5). Egg weight of birds fed with standard layer ration (T_1) was comparable with T_5 ($P<0.01$). But parameters like age at sexual maturity, hen-day and hen-housed egg production and feed efficiency were not affected by the supplementation of Sodium Sulphate. Feed intake showed significant ($P<0.01$) difference between dietary treatments. The group fed with 0.3 per cent methionine (T_2) had significantly lower feed intake in comparison with 0.2 per cent (T_3) and 0.3 per cent sodium sulphate (T_4) supplemented group. Feed intake of birds fed with control diet (T_1) was statistically comparable with all treatment groups except those birds fed with vegetable protein diet with 0.4 per cent sodium sulphate (T_5). Mortality pattern showed no difference among the five dietary treatments tested. All vegetable protein ration prepared with the addition of either methionine or sodium sulphate had higher price when compared with standard layer ration. Based on this study it was surmised that sodium sulphate supplementation did not have any deleterious effect on production performance of White Leghorn layers. So methionine or sodium sulphate can be effectively utilized in formulation of all vegetable layer ration when scarcity of fish occurs.