Studies On
The Effect of Lycine Supplementation, Dietary Sources and Levels of Protein on Broiler's Performance

Thesis

Submitted to the Faculty of
Veterinary Science and Animal Husbandry
RAJENDRA AGRICULTURAL UNIVERSITY, BIHAR
in partial fulfilment of the requirements
for the degree of
MASTER OF SCIENCE (ANIMAL HUSBANDRY)
IN
ANIMAL NUTRITION

By
Md. Samiur Rahman
B. V. Sc. & A. H. (R. A. U.)
JUNIOR RESEARCH FELLOW (R. A. U.)
Post-Graduate Department of Animal Nutrition
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Ex-Assistant Professor and Chairman,
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Animal Nutrition,
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PATNA,

Dated, the 14th November, 1975.

This is to certify that the work embodied in this Thesis entitled "STUDIES ON THE EFFECT OF LYSINE SUPPLEMENTATION, DIETARY SOURCES AND LEVELS OF PROTEIN ON BROILER'S PERFORMANCE" is the bonafide work of Dr. Md. Samiur Rahman and was carried out under my guidance and supervision.

Narayan

(P. NARAYAN).

C E R T I F I C A T E

Certified that the research work incorporated in this Thesis have not been published in part or in full in any other journal.

14/XI/75.

(MD. SAMIUR RAHMAN).

A C K N O W L E D G E M E N T

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14/XI/75.

(MD. SAMIUR RAHMAN).

C O N T E N T S

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INTRODUCTION

I N T R O D U C T I O N

Nutrition is of paramount importance, as it plays vital role for the sustenance of life and vigour of a nation. The sayings like "Man is what he eats", "A nation is known by the food it takes", "Army marches on the bellies", are some of the apt expressions which go to emphasize its importance; Prof. Kuhanu, President of the 7th International Nutrition Congress, Hamburg rightly observed that "Civilization,culture and intelligence all depend on rightful nutrition. Of course, there is no food which can introduce intelligence from outside but adequate balanced diet is the pre-requisite for the expression of inherent abilities and psychic qualities". United Nations Secretary General Dr. U. Thant voiced similar concern on the United Nations childrens day, when he said "Calorie-protein mal-nutrition is not only harmful for the present generation, but mars the future of the developing nations, as the damage which takes place during the first five years of life is not reversible". The per capita availability of protein and energy per day to Indians, as compared to the people in other advanced countries are as noted under :

	India	Asia, Latin America and Africa	North and South Amercia and U.S.A.
Total protein available.	51 gms	60 gms	90 gms
Animal protein	11.8 gms	16.7 gms	48.50 gms
Calories	1970	2190	3060

(Quoted from Poultry Guide, January 1971, Vol.XII No.1, p.28).

In this context, the maximum standard of protein and energy as advocated by the Indian Council of Medical Science for a normal man or woman per day is 70 gms total protein with atleast one third i.e. 15 to 20 gms as animal protein along with 2500 calories energy which are much higher than what is actually available to an average Indian.

Poultry have been found to give a sharp and rich turnover due to the short generation gap and is an efficient converter of fairly inferior quality of protein into protein of high biological value. The recent advances in poultry nutrition have gone a long way in revolutionizing the poultry industry within a very short span of time by providing means of livelihood and income to millions of people. The young broiler meat now holds the pride of position in comparison to mutton and pork, and thus provides a cheaper and more satisfying protein ration in the diet of average person.

A rich source of high quality protein, vitamins, important minerals in poultry is at the same time easily digestible and has less fat, compared to other edible meat. Now the technology has developed to such an extent that excellent efforts are afoot in researches towards production of birds with negligible fat. The average composition and energy of eggs and chicken in comparison to other important cereals and milk, as tabulated below, will indicate how rich these poultry products are in some of these essential elements.

TABLE - 1.

Average composition in per cent of rice and a few animal protein sources.

Component	Rice	Cow milk (whole)	Eggs		Chicken meat
			Hen	Duck	
Water	13.0	87.3	74.0	71.0	66.0
Protein	7.1	3.5	12.4	13.0	20.2
Fat	1.1	3.5	11.7	14.5	12.2
Carbohydrate	78.0	5.2	0.9	0.5	0
Fibre	0.7	0	-	-	-
Ash	0.8	0.7	1.0	1.0	1.0
Calories per 100 gm	359.0	65.0	163.0	189.0	200.0

(Quoted from 'Poultry Nutrition' by Bose, S. (1972), p. 72).

The demand for broiler meat for its tenderness, juiciness, soft pliable smooth textured skin and ready to fry cut-up chicken has been increasing day by day and has complied many, who did not take chicken at all. In this back ground of ever increasing demand, the allocation of ingredients of feed which are easily available and can balance the poultry feed with lesser quantity of fish or meat meal. All over the world, specially in the developing countries, the importance of replacing fish or meat meal in poultry ration by substituting with vegetable protein supplements and by addition of several synthetic essential amino acids has

evoked keen interest amongst the poultry breeders. The commercially produced amino acids e.g. lysine and methionine are finding increasing place in poultry rations and thus help in reducing the consumption of expansive animal protein supplements.

The growth rate and feed efficiency are the two important factors in determining the broiler's performance and has a direct influence on carcass composition and meat quality. Several types of supplementation have been introduced in the diet of broilers in order to have desired influence on growth rate and feed efficiency. During these days, there is a trend to supplement synthetic amino acids in the diet to get the desired protein level so as to derive a well-balanced diet particularly in such diet, which has improper balancing of amino acids. Traditional rations lack in some of the limiting amino acids. It has been found by many workers that birds could show much better performance by simple addition of these limiting amino acids. Lysine is one of the important limiting amino acids, which is mostly lacking in practical ration. Quite encouraging results by supplementation of synthetic amino acids in poultry industry have been obtained by some workers (Grau, 1946; Heuser et al, 1946; Doughlas and Harms, 1959; Carter et al, 1962; Leveille et al, 1962; Balloun, 1962; Kobayashi et al, 1966; Patle and Netke, 1966; Cuca and Sunde, 1967; Deaton and Quisenberry, 1967; Nugara and Buvanendran, 1968; Peter et al, 1968; Darwish, 1968; Bayley et al, 1968; Tkachev, 1969; Grigor'ev et al, 1970; Solberg, 1971; Avila and Cuca, 1971; Reddy et al, 1972;

Desai, 1974).

The present study aims at such combinations of feed ingredients with different protein levels and complete replacement of animal protein (fish meal) in broiler rations, supplemented with L-lysine hydrochloride. The effect of these rations on growth rate, feed efficiency, carcass composition as well as the meat quality have been studied, in greater detail in the present investigation.

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REVIEW OF LITERATURE

REVIEW OF LITERATURE

There is considerable literature on the aspect of sources and levels of protein and on the role of supplemental amino acids on the performance of poultry.

The following review includes some of the more recent reports on the subject related to the present investigation.

Part - I : Growth rate and feed efficiency.

Grau (1946) supplemented lysine in graded levels from 0.3 to 1.1 per cent in sesame seed meal ration of leghorn chicks at 20 per cent crude protein and noted optimum growth at 0.3 per cent supplementation.

Heuser *et al* (1946) observed best feed efficiency (2.85 gms) with vegetable protein concentrates along with 3 per cent fish meal than that of all vegetable protein ration (3.83 gms). They further concluded that the best result appeared to be additive rather than supplementary, thus indicating it was not due chiefly to amino acids.

Wilson (1952) conducted experiment to study the growth rate from crosses of R.I.R. and light sussex birds reared on different plane of nutrition and observed better growth rate with high plane of nutrition than that of low protein one.

The effect of sources and levels of protein on growth rate and feed efficiency in poultry were compared by Johnson and Fisher (1959), who opined that crude protein content of the ration was not the main reason behind better growth but a balance between essential and non-essential amino acids was what mattered.

Doughlas and Harms (1959) using peanut oil meal as the principle source of protein in broilers, observed lysine to be the first limiting amino acid. Significant improvement in growth rate was observed by them with diet supplemented by L-lysine.

Carter et al (1962) experimented with two different levels of protein and further supplemented the lower level with L-lysine or methionine or both to make the contents of the amino acids similar to those of the higher one. This resulted in the same type of growth rate as in higher level. They further observed that though methionine alone was ineffective, lysine had a smaller effect.

Leveille et al (1962) by supplementation (2.5 per cent of protein) of lysine in lysine-deficient diet of chicks, observed significant improvement in weight gains. Further, they concluded that stimulation in growth rate may be due to increased availability of protein by its supplementation.

Balloun (1962) also observed that additional lysine (5 per cent or less) improved weight gains of Male Broad Bronze poults on both high and low protein diets based on maize-Soyabean meal.

Askelson and Balloun (1964) studied the effect of amino acids supplementation to a vegetable protein diet and observed maximum growth and feed utilization with proper balancing of amino acids irrespective of protein sources.

Kobayashi et al (1966) recorded better growth rate at 0.2 per cent lysine supplementation as against that of 0.5 per cent in chicks. In the higher protein level also, they found 0.2 per cent lysine supplementation to be the more efficient.

Patle and Netke (1966) with a graded level of 0.2 to 0.6 per cent lysine and methionine together to a basal all vegetable ration, recorded highly significant growth rate in leghorn chickens. Better feed efficiency was also recorded at all levels of supplementation by them.

Rajaguru et al (1966) reported the superiority of 25 per cent protein over that of 21.3 per cent protein in Arbor Acres male chicks. However, they did not find any beneficial effect on growth with increase of protein level from 25 to 40.6 per cent. Similarly, Payne and Lewis (1966) found improved growth rate in Arbor Acre chicks with increased protein per cent from 21.11 to 23.8 per cent.

Cuca and Sunde (1967) obtained better growth and greater feed efficiency in white leghorn chicks when diets of Sesame and sucrose or Seasame and maize were supplemented with 0.4 to 0.5 per cent lysine.

Combs (1967) also obtained improved feed efficiency at nigher protein level inspite of decrease intake of lysine.

Increased weight gain and feed efficiency were observed by Kara (1967) with increase protein level from 18.25 to 21.25 per cent in New Hamshire chickens.

Non-the-less, beneficial responses in growth rate or efficiency of feed utilization were observed only upto a certain protein level, above which no additional advantage was seen. For instance, the work of Bank (1967) showed beneficial effects in chicks as the protein was increased from 16 - 24 per cent with the optimal level around 22 to 24 per cent and further increase to 31 per cent had no advantage. A similar observation was recorded by Zivkovic and Coworkers (1962) earlier and by Sadagopan et al (1971) and Rao et al (1973).

Muller et al (1968) reported better growth and feed efficiency with fish meal than on the deficient protein diet but not as good as with the amino acid supplementation.

A critical examination of the diets of various experiments supporting beneficial effects of lysine additions would show that such responses became evident only when the diets were deficient in this amino acid. Thus the reports of Nugara and Buvanendran (1968), Peter et al (1968), Grigor'ev et al (1970) and Solberg (1971), become significant in that, their diets had lysine as the limiting amino acid to a varying degree and addition of the amino acid promptly improved responses in chicks.

Darwish (1968) studied the effect of added L-lysine in deficient diet, on growth and efficiency of feed utilization

in growing chicks. The basal diet having 0.637 per cent lysine were supplemented with 0.263 to 0.563 per cent L-lysine. He observed increased weight gains of males and females and maximum feed efficiency with larger supplementation and least with no extra lysine.

Curto and Cicogna (1968) studied the effect of mixtures with or without fish meal on table poultry. The groups given no fish meal got extra lysine or methionine or both to give total contents of these amino acids similar to values with fish meal. They found that the intakes of feed per kg gain were from 2.42 kg with extra lysine to 2.66 kg with all vegetable diet unsupplemented.

Bayley et al (1968) fed low protein basal diet based on wheat-soya alone or supplemented with 0.125 per cent L-lysine hydrochloride to meat type cockrels and observed improved feed efficiency with extra lysine.

Tkachev (1969) observed that in lysine and methionine supplemented optimum protein diets weight gain increased by 15 to 17 per cent and in reduced protein diet by 30 per cent.

Opichal and Coworkers (1970) obtained significantly less weight gain, more feed consumption, when no animal protein was given to leghorn chickens.

Wegner (1970) recorded better efficiency of feed conversion in fish meal group than the vegetable protein groups in Nichols Lohmann chickens.

Kelley et al (1971) conducted experiment to observe the effect of different combinations of vegetable protein with or without meat meal on the performance of white leghorn chicks. They observed that the ration containing 5 per cent meat meal and 0.67 per cent lysine at 23.94 per cent crude protein gave significantly poor growth rate than of all vegetable ration having 0.79 per cent lysine and 22.44 per cent crude protein. However, they recorded best feed efficiency in groups given animal and vegetable proteins. Further, they concluded that the feed consumption was greatly influenced by protein sources.

Srivastava and Talapatra (1971) observed that the feed consumption was not at all affected when animal protein was not included in the mash of white leghorn birds.

Increased body weight and feed efficiency was recorded by Saxena and Pradhan (1971) with increase in protein level from 16 and 20 to 25 per cent in chicks.

Avila and Cuca (1971) recorded increased weight gain and feed efficiency in growing chicks when diet having 0.97 per cent lysine were supplemented with 0.05 to 0.20 per cent lysine.

Ramasubba Reddy et al (1972) did not find any significant difference in weight gains of leghorn chickens when the levels of protein were increased from 18 to 23 per cent. However, feed efficiency was increased as the protein level was raised from 18 to 25 per cent.

Hewitt and Lewis (1972) reported results of

experiments showing improved weight gain in chicks fed a 21 per cent protein ration supplemented with lysine to a 0.9 per cent dietary level of the amino acid.

Reddy et al (1972) observed lysine to be one of the limiting amino acids in maize - groundnut cake rations and obtained satisfactory responses in chicks when such diets were supplemented with lysine to 1 per cent dietary level.

Prasad (1973) reported higher body weights at 7 weeks of age with 23 per cent dietary protein in commercial crossbred broiler chicks in comparison to those at lower protein levels. Similar observation was recorded by Devegowda (1973) in three pure breeds of boriler chicks.

Desai (1974) observed increased growth rate in crossbred broiler chicks when lysine deficient protein diets were supplemented with 0.42 to 0.52 per cent L-lysine hydrochloride. Further, he concluded that a dietary balance of amino acid is more important than their absolute adequacy.

Part - II : Carcass composition and meat quality.

Harkin et al (1960) observed that sources of proteins and forms of vitamin did not affect the amount of fat.

Essary et al (1965) reported that different levels of protein and fat fed to broilers from one day to 10 weeks of age did not appreciably influence dressing percentages but did significantly influence live weight.

Luhmann (1966) while conducting nutritional study on white leghorn pullets observed that with low protein diet the fat content of the body was greater than when they were reared on one with high protein diet.

Rajaguru et al (1966) reported an increase in protein and decrease in ether extract of the carcass with increased protein of the diet from 21.3 to 24.8 per cent in Arbor Acre male chicks.

Kara (1967) observed little difference in carcass yield by increasing protein level from 18.25 to 21.25 per cent in New Hampshire chickens.

Curto and Cicogna (1968) fed groups of Cobs chickens on diets with and without fish meal. The groups given no fish meal got extra lysine or methionine or both. They observed that the carcass yield of all the groups treated did not differ significantly. However, the ether extract was recorded more in the groups given fish meal and also the meat of this group was preferred than the others.

Takachev (1969) reported higher dressing percentage and higher proportion of edible parts in the groups of chickens given lysine supplemented diets.

Curto and Cicogna (1969) observed that the meat of chickens given fish meal was preferred by the majority of testers. There was also a preference for meat from chickens given amino acids though not significant.

Iovchev and Bachev (1971) found no differences in

carcass yield or quality in turkey poults given basal diet supplemented with 0.1 per cent L-lysine or DL-methionine or 0.1 per cent of each amino acids.

Chhillar et al (1971) reported that the dressing and eviscerated percentages were not affected by variation in protein sources in White Plymouth Rock chicks.

Prasad (1973) found no significant difference on the dressing percentage of birds fed diet containing varying levels of protein.

Desai (1974) observed no significant difference on the dressing percentage when the lysine deficient protein diets were supplemented with L-lysine hydrochloride in cross-bred broiler chicks.

Part - III : Miscellaneous.

According to Almquist (1953) the only part available for growth was the fraction of dietary protein containing amino acids in optimum proportions. He also found that supplementation with deficient amino acid in a deficient protein increase the efficiency of feed utilization.

Weir (1959) found that tenderness and juiciness were closely related; the more tender the meat the more quickly the juices were released by chewing and the more juicy the meat appeared.

Supplementation of amino acids in grain Sorghum low protein diets significantly increased body weight but the

production was not as good as than in high protein diet. This was recorded by Deaton and Quisenberry (1967).

Better weight gain and feed efficiency were reported by Poppe et al (1967) with rations having higher level of L-lysine and DL-methionine and also when proportions of protein was raised.

Singh (1967) observed decreased efficiency of feed conversion with the advancement in the age of Plymouth Rock birds. Similar findings was also recorded by Haleem et al (1971) in broiler chickens.

Vincek et al (1968) obtained that the low lysine content of the feed did not give good results on weight gain in white Rock chickens.

Couch and Trammell (1970) found reduced growth, less feed consumption and high mortality in lysine deficient diet in growing chicks.

Tasaki et al (1972) reported lower body weight gain and feed efficiency in lysine deficient diet of growing chicks. They also observed that the carcass of male chicks fed on lysine deficient diet retained less protein than the others but fat deposition was not affected.

Paul et al (1972) observed faster growth rates in R.I.R. male chicks than in females.

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MATERIALS AND METHODS

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The present investigation was under taken with a view to study (a) the growth rate and feed efficiency, and (b) the carcass composition and meat quality in relation to certain essential amino acids contents of the feed as well as the sources and levels of protein in broiler's ration.

The methods and materials employed for this study are described below :

I. EXPERIMENTAL TECHNIQUES.

Selection and grouping of chicks :

Two hundred days old broiler chicks from the same hatch were obtained from the Central Poultry Farm, Patna. They were vaccinated against usual viral infections, as a routine procedure of management at the farm.

The chicks were individually weighed and wing banded. They were divided into two lots according to their body weights, in one case they ranged from 27 to 38 gms and in the other from 39 to 48 gms. The chicks were then randomly distributed into four experimental groups in such a manner that the group average weights were approximately the same. Again, within the groups, the chicks were subdivided sexwise, for the sake of studying the growth rates in different weeks.

Housing of the experimental chicks :

The chicks were reared in four different tires of electrically heated battery brooders for four weeks. Thereafter, the chicks of each group were transferred to separate pens on deep litter system. Identical managemental and environmental conditions in all the four groups were simulated during the entire period of experimentation.

Feeding and watering :

The feed was offered twice daily to each of the groups in the morning at about 7 A.M. and in the evening at about 4 P.M. The chicks were fed ad libitum. Every possible care was taken to minimize the wastage of feeds by spreading the plastic cloth under each feeder properly. Feed left was collected periodically and was accounted for in calculating the total feed consumption.

The feeding troughs were cleaned once daily just before offering the fresh feed in the morning.

The chicks were provided with fresh and clean water in an earthen pot, which was changed twice in the morning and afternoon daily. Uniformity in all respects was maintained in all the four pens.

Feeds and their preparation :

The ingredients of the ration were obtained from the local market and were analysed for their chemical composition for computing the different experimental rations.

Four experimental rations (Table 2) with varying levels of protein were constituted from different feed sources.

TABLE - 2.

Composition of experimental rations (parts per 100).

Ingredients	RATIONS			
	I	II	III	IV
Ground yellow maize	46	42	42	38
Groundnut oil-cake (decorticated)	19	20	20	29
Til cake	13	14	14	9
Fish meal	5	-	-	-
Rice polishings	15	11	11	11
Kulthi	-	11	11	11
Minerals and Vitamin supplements*	2	2	2	2
Bifuran (Smith Kline and French).	50 gms	50 gms	50 gms	50 gms
Total	100	100	100	100
Protein %	22.34	22.29	22.29	24.12

*Mineral and Vitamin supplements consisted of -

(a) Avlomin (I.C.I.) - added 2% of the ration

Composition:

Calcium	-	28 per cent
Phosphorus	-	5 per cent
Sodium chloride	-	18 per cent
Iron	-	3500 P.P.M.
Iodine	-	33 P.P.M.
Copper	-	130 P.P.M.

Manganese	-	2500 P.P.M.
Zinc	-	1100 P.P.M.
Magnesium	-	800 P.P.M.
Cobalt	-	50 P.P.M.

(b) Vitablend AB_2D_3 (Glaxo) - added 20 gms to 1 quintal of ration.

Each gram of Vitablend AB_2D_3 contains :

Vitamin A	-	40,000 I.U.
Vitamin B_2	-	25 mg.
Vitamin D_3	-	6,000 I.U.

Out of the four experimental rations, Ration I, was prepared both with animal and vegetable proteins. The remaining three Rations (II, III and IV) were computed entirely from vegetable sources. The protein content of the first three Rations (I, II and III) were almost equal being 22 per cent, whereas the protein content of Ration IV was 24 per cent being higher than the other three rations. The experimental rations were analysed for their chemical composition and their resultant values are tabulated below : -

TABLE - 3.

Chemical composition of rations.

Rations	Percentage on raw matter basis					
	Moisture.	Crude protein	Crude fibre	Ether extract	Total ash	Acid insoluble ash
I	6.78	22.12	3.96	4.15	7.69	2.56
II	6.35	22.25	4.38	5.05	6.15	2.26
III	6.35	22.25	4.38	5.05	6.15	2.26
IV	5.92	24.00	4.56	4.61	5.97	2.22

The contents of lysine, methionine + cystine, tryptophan and metabolisable energy were calculated in all the rations separately and their values are presented below:

TABLE - 4.

Calculated values* of amino acids and Metabolisable Energy.

Rations	Per cent of the ration			Metabolisable Energy KCal/kg.
	Lysine	Methionine + cystine	Tryptophan	
I	0.75	0.83	0.34	2986
II	0.87	1.02	0.34	2970
III	0.87(0.23)**	1.02	0.34	2970
IV	0.90	1.03	0.35	2938

*Calculated from the values of different feed ingredients (incorporated in the experimental rations) quoted in the tables of 'Poultry Nutrition' by Bose, S., 1972.

**Value denoted here was supplemented.

Rations I, II, III and IV were offered to the birds of Groups I, II, III and IV in the same order. The metabolisable energy of all the rations were just about adequate (Table 4).

It is evident from the Table 4, that all rations were having optimum level of these amino acids, except lysine. Ration III was supplemented with L-lysine hydrochloride (0.23%) to compensate the deficiency, and for attaining the optimum level as well.

II. METHODS OF ANALYSIS.

(i) Estimation of mosture, dry matter, crude protein, crude fibre, ether extract, total ash and acid insoluble ash - were done by A.O.A.C. method (1970).

(ii) Palatability test for tenderness and juiciness scoring by panel of judges :

Meat samples from respective groups of chicks were placed separately in a container and steam cooked in a pressure cooker at 250°F for 15 minutes. Sufficient care was taken to maintain similar conditions and treatments for all the Groups (I to IV) tested e.g. method of cooking, temperature, scalding, portions of the meat, etc. After cooking, the judges were requested to evaluate the tenderness and juiciness of the similar portions of meat by organoleptic method. The criteria laid down for measuring the tenderness was the easiness of mastication or the number of chews required to swallow the given piece of cooked meat.

The score for tenderness and juiciness for different groups from the judges were recorded separately and the marks so obtained were compiled. A maximum of 3 points was allotted to the most tender and juicy meat, 1 point to the least tender and juicy meat and 2 points for that class of meat, which ranked in between. The average of scores was worked out by dividing the total points by the number of judges in the panel. The samples recording highest score was adjudged to be the most tender and juicy meat.

III. MAINTENANCE OF RECORDS TO STUDY THE GROWTH RATE AND FEED EFFICIENCY.

Weekly records of the feed offered and the feed left behind (unconsumed) were properly maintained. Feed wasted was collected periodically and was accounted for in calculating the feed consumption.

The chicks were weighed individually at weekly intervals groupwise. Weekly average weight gains and feed consumed were carefully recorded. Gain in weight and feed efficiency were determined on the basis of their data.

IV. QUANTITATIVE ANALYSIS OF DIFFERENT PORTION OF CARCASS.

At the end of the experiment, two male birds from each of the four groups were picked up atrandom and subjected to further tests as noted under.

Killing of the birds :

The full fed birds were first weighed alive and then killed by dislocation of neck.

Dressed weight :

When the struggle after killing was over, all the feathers were removed from the carcass by dry picking. It was then weighed and the percentage of dressed weight was also obtained.

Feather percentage :

The percentage of feathers to live weight was calculated from the live weight and dressed weight (live weight - dressed weight = weight of the feathers).

Drawn weight (or Eviscerated weight) :

After dressing the bird properly, the head was removed by cutting between the first cervical vertebra and the occipital bone and kept on a plate. The neck along with the skin was then cut at the base where it joins the body. The blood adhering to it was removed and the neck along with the skin was kept separately in another plate. The legs (Shanks) including the tendons were cut off from the hock-joint and kept along with the head portion. The viscera was exposed by giving a horizontal cut in the region of the abdomen. Thereafter, all the internal organs were taken out by inserting the hand inside. When the body was completely devoid of all the internal organs, the eviscerated carcass was weighed and its percentage with respect to dressed weight was calculated.

Giblet and neck :

The neck along with its skin, the liver without gall bladder, the outer muscular layers of gizzard and the heart constituted the giblet and neck. All these portions were taken out properly and carefully and afterwards weighed together inorder to obtain their percentage in relation to dressed weight.

Different cut-up portions of the eviscerated birds :

The eviscerated birds were properly cut into different portions e.g. back, breast, drumsticks, thighs and wings. Later on it was weighed separately and the percentages of each part to the dressed weight were calculated.

Total inedible portion or total waste :

Total inedible portion consists of the lungs, trachea, kidney, intestine, proventriculus, crop with oesophagus, head and legs (Shanks) etc. These internal organs and the external parts were weighed together so as to obtain the total inedible loss. The percentage of this loss was calculated and expressed in terms of dressed weight.

Statistical methods were employed for evaluating the significance of difference in body weights in different weeks of growth in different sexes under different treatment groups (Snedecor and Cochran, 1967).

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RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

A. EFFECT ON GROWTH.

Weekly average body weights and cumulative gain in different weeks are presented in Table 5 to 8. Figure 1 & 2 shows the graphical representation of growth rates of different Groups (I, II, III and IV) upto 10 weeks.

Table 5 incorporates the mean body weights of chicks, from day old to 10 weeks of age sexwise, under different feed treatments. From the perusal of the table it is evident that in general the mean body weights in all the groups from first week to ten weeks were more in the male chicks than in the case of the females.

Initially, the average body weight of female chicks in Groups I, II, III and IV were 33.12, 32.80, 34.83 and 34.49 gms respectively. In the first week, the maximum weight was shown by Group III (59.38 gms) followed by Group IV (59.27 gms), II (57.24 gms) and I (55.82 gms) in order. Again, in the second week chicks of Group III recorded the highest weight (100.68 gms) followed by Group II (89.73 gms), then Group I (84.23 gms) and Group IV (83.28 gms) comes in the last. In the third week also, the growth in Group III exceeded the weights of all the other groups with a value of 198.66 gms as compared with weight of 188.32 gms of Group IV and 162.22 gms

TABLE - 5.

Mean body weights of chicks from 1 day to 10 weeks of age.

Weeks	Group I				Group II				Group III				Group IV			
	Female		Male		Female		Male		Female		Male		Female		Male	
	n	Mean ± S.E.*	n	Mean ± S.E.	n	Mean ± S.E.	n	Mean ± S.E.	n	Mean ± S.E.	n	Mean ± S.E.	n	Mean ± S.E.	n	Mean ± S.E.
Day old	25	33.12± 0.83	25	36.21± 0.99	25	32.80± 0.83	25	34.83± 0.78	26	34.83± 0.76	24	36.32± 0.85	22	34.49± 0.68	26	37.29± 0.99
1st week	25	55.82± 0.89	23	57.34± 0.72	24	57.24± 0.69	22	60.19± 0.83	26	59.38± 1.21	24	63.52± 1.88	22	59.27± 0.96	25	63.18± 1.10
2nd week	25	84.23± 0.62	23	90.47± 0.53	24	89.73± 1.10	22	96.24± 1.30	26	100.68± 1.92	24	120.39± 2.01	22	83.28± 2.18	25	101.10± 3.17
3rd week	25	148.92± 1.83	23	153.38± 2.40	24	162.22± 1.53	22	176.78± 1.38	26	198.66± 2.81	24	229.60± 3.28	22	188.32± 4.89	25	223.55± 8.32
4th week	25	238.79± 3.42	23	240.83± 5.82	24	273.81± 2.83	22	283.65± 2.17	26	303.41± 5.83	24	354.60± 6.12	22	297.93± 10.58	25	340.83± 13.89
5th week	24	307.93± 8.92	23	317.87± 9.87	22	372.94± 2.71	22	384.22± 2.79	25	403.88± 10.19	24	458.35± 11.28	22	382.78± 20.80	24	432.93± 28.17
6th week	24	383.17± 13.82	23	400.62± 15.12	18	493.53± 3.82	18	511.71± 4.77	20	495.97± 13.81	18	556.93± 15.89	22	478.93± 20.58	20	559.74± 36.69
7th week	24	530.17± 23.19	23	540.38± 28.72	18	623.09± 8.12	18	659.81± 9.04	20	683.29± 16.80	18	729.50± 18.12	22	599.17± 35.81	20	693.81± 40.29
8th week	24	632.04± 35.83	23	644.93± 43.38	18	883.27± 10.82	18	801.18± 0.36	20	798.05± 20.18	18	882.36± 20.62	22	749.39± 48.18	20	863.96± 43.18
9th week	23	789.58± 53.21	21	810.83± 62.93	18	923.34± 10.89	17	984.49± 13.63	18	987.94± 20.83	17	1088.71± 25.74	22	923.05± 58.23	19	1034.69± 60.93
10th week	17	938.88± 79.87	20	989.63± 98.17	16	1053.65± 98.73	14	1124.08± 112.82	18	1088.06± 32.82	14	1179.91± 38.71	20	1011.89± 69.34	16	1198.48± 73.29

* Standard error.

TABLE - 5(a).

Analysis of variance of groups, weeks and sexes on the body weights of chicks.

Sources of variation	df	M. S.
Between groups	3	9568.76**
Within groups	1928	2345.12
Total.	1931	
Between weeks	10	13970.79**
Within weeks	1921	2301.08
Total.	1931	
Between sexes	1	229730.25**
Within sexes	1930	2238.53
Total.	1931	

** indicates significance at 1% level.

TABLE - 5(b).

Mean weekly body weights of chicks (both sexes) under different feed treatments.

Weeks	G R O U P S			
	I	II	III	IV
Day old	34.66	33.81	35.57	35.89
1	56.58	58.71	61.45	61.22
2	87.35	92.98	110.53	92.19
3	151.15	169.50	214.13	205.93
4	239.81	278.73	329.00	319.38
5	312.90	378.58	431.11	407.85
6	391.89	502.62	526.45	519.33
7	535.27	641.45	706.39	646.49
8	638.48	792.22	840.20	806.67
9	800.20	953.91	1038.32	978.87
10	964.25	1088.86	1133.98	1105.18

TABLE - 6.

Average cumulative gain in weights per chick in Groups I, II, III and IV at different weeks (in grams).

Weeks	GROUPS							
	I		II		III		IV	
	Male	Female	Male	Female	Male	Female	Male	Female
1	21.13	22.70	25.36	24.44	27.20	24.55	25.89	24.78
2	54.26	55.11	61.41	56.93	84.07	65.85	63.81	48.79
3	117.17	115.80	141.83	129.42	193.28	163.83	186.26	153.83
4	204.62	205.67	248.82	241.01	318.28	268.58	303.54	263.44
5	281.66	274.81	349.39	340.14	422.03	369.05	395.64	348.29
6	362.41	350.05	476.88	460.73	520.61	461.14	522.45	444.44
7	504.21	497.05	624.98	590.29	693.18	648.46	656.52	564.68
8	608.72	598.92	766.35	750.47	846.04	763.22	826.29	714.90
9	774.21	756.46	949.66	890.54	1052.39	953.11	997.40	888.56
10	953.42	905.76	1089.25	1020.85	1143.59	1053.23	1161.19	977.40

TABLE - 7.

Average cumulative gain in weights per chick in Groups I, II, III and IV at different weeks (in gms) (Chicks of both sexes).

Weeks	G R O U P S			
	I	II	III	IV
1	21.91	24.90	25.87	25.33
2	54.68	59.17	74.96	56.30
3	116.48	135.62	178.55	170.04
4	205.14	244.91	293.43	283.49
5	278.23	344.76	395.54	371.96
6	356.23	468.80	490.87	483.49
7	500.63	607.63	670.82	610.60
8	603.82	758.41	804.63	770.59
9	765.33	920.10	1002.75	942.98
10	929.59	1055.05	1098.41	1069.29

TABLE - 8.

Average gain in body weight per chick in Groups I, II, III and IV at different intervals of time (in grams) (chicks of both sexes).

Groups	1-4 weeks	1-6 weeks	1-8 weeks	1-10 weeks
I	205.14	356.23	603.82	929.59
II	244.91	468.80	758.41	1055.05
III	293.43	490.87	804.63	1098.41
IV	283.49	483.49	770.59	1069.29

of Group II. Group I with a value of 148.92 gms ranked last in the series. Similarly, the chicks of Group III always remained at the top in respect of its body weight till the end of experimentation i.e. upto 10th week. However, a definite deviation from the previous trend was marked from 6th week onwards with respect to the body weights of Group IV and II. Here, the values of Group II (493.53 gms) exceeded over Group IV (478.93 gms) unlike previous results and this trend was maintained till the end of the experiment. As regards Group I, it always scored the least values.

In male chicks, the average initial body weights of Groups I, II, III and IV were 36.21, 34.83, 36.32 and 37.29 gms respectively.

Again, the male chicks of Group III showed the maximum weight all along the period of experimentation, excepting in the sixth and tenth week, ranging from 63.52 to 458.35 gms upto 5th week and 729.50 to 1088.71 gms from seven to nine weeks. Next in order, comes Group IV, with a figure of 63.18 to 432.93 gms and 693.81 to 1034.69 gms and then Group II with 60.19 to 984.49 gms and in the last Group I, with a figure of 57.34 to 810.83 gms — (Table 5).However, in the sixth and at the end of the experiment i.e. in tenth week, a change in this trend was observed. Here, the value of Group IV exceeded the all, followed by Groups III,II and I in order — (Table 5).

It may be concluded by the perusal of the afore-said data that optimum level of certain essential amino acids are more important than the sources or total crude protein content of the ration. As it evident, the ration of Group III, although consists of vegetable proteins only, has lysine (after supplementation), methionine + cystine and tryptophan in optimum quantity with 22.25 per cent crude protein - gives best growth results among the lot. On the contrary, Group II and I, both showed diminished body weights at the same level of crude protein. It is also important to note here, that sources are not important as compared to the levels of essential amino acids. Ration of Group I, with 0.75 per cent lysine, which is much less than the optimum level, resulted in lowest body weights, although it contains both animal and vegetable proteins. Group IV stands next in order most of the times, even with highest crude protein content (24%), may be

due to the fact that it contains slightly less lysine (0.90%) than Group III (1.1%), which is at the same time less than the optimum level. However, Group IV, with 0.90 per cent lysine and 24 per cent crude protein, showed superior results from Group I and II all along, as it contained higher lysine and crude protein than these two groups having 0.75 and 0.87 per cent lysine and 22.12 and 22.25 per cent crude protein respectively. Group I, with lowest lysine content among the lot showed minimum body weight. Of course, some variation from the usual trend was observed in the 6th and 10th week when Group IV superseeded Group III even. As it evident Group IV ration is only marginally short in lysine but at the same time is quite rich in crude protein content, can be attributed for the cause.

The statistical analysis, tabulated in Table 5(a), revealed highly significant variation between weeks, groups as well as between sexes in respect of the body weights. It was definitely found that the chicks of Group III was out standing in increase of body weight in all the weeks except the 6th and 10th week. This was closely followed by the chicks of Group IV. The chicks of Group IV also exhibited the maximum body weight at 6th and 10th week of age. In other cases chicks of Group III tilted the balance over other groups.

As is to be expected the increased age showed increased body weight but the body weight increase in Group III also seems to outweigh those of other groups. As regards the effect of sexes, the present study revealed that males were having significantly higher body weight in all the groups as

well as in all the weeks, but it was observed that the growth rate was more prominent in different groups as the age is increased.

Similar views have been expressed by several other workers. Leveille et al (1962) observed significant increase in weight gains by supplementing lysine in lysine deficient protein diets in growing chickens. Askelson and Balloun (1964) also recorded maximum growth in lysine supplemented all vegetable ration in growing chickens.

In 1966, Darwish reported most weight gains with 0.263 to 0.563 per cent lysine and least with no extra lysine in leghorn chickens. Couch and Trammell (1970) also recorded reduced growth with low lysine contents than optimum in pullets.

Similarly Nugara and Buvanendran (1968) observed improved growth rate more in males than in females in lysine supplemented group in broiler chickens. Hewitt and Lewis (1972) also recorded increased weight gains by supplementation of 0.1 per cent lysine in lysine deficient protein diet in broiler chickens. Desai (1974) also observed the same results by supplementation of synthetic lysine from 0.42 to 0.52 per cent in low protein diets in cross-bred broiler chickens.

Kobayashi et al (1966) recorded increased growth rate by supplementing 0.2 per cent L-lysine hydrochloride in chickens. Avila and Cuca in 1971, also observed the same results by adding the diet with 0.05 to 0.20 per cent lysine in fattening chickens.

Solberg (1970) observed increased weight gain by

supplementation of 0.2 per cent lysine in ration based on soyabean meal, sesame meal and maize meal in chickens. Doughlas and Harms (1959) also recorded an improvement in growth rate by supplementation of lysine in the amino acids deficient diet in broilers.

In pullets, Deaton and Quisenberry (1967) reported increased body weight by supplementing amino acids to the all vegetable grain sorghum low protein diet. Grau (1946) also recorded optimum growths by supplementation of 0.3 per cent lysine in Sesame seed meal ration in leghorn chickens.

Kelley et al (1971) observed significantly poor growth rates in leghorn chickens with animal (5% meat meal) and vegetable proteins than all vegetable protein rations.

In 1972, Paul and Coworkers reported faster growth rates in R.I.R. male chicks than in females.

Johnson and Fisher (1959) opined that crude protein content of the ration was not the main reasons behind better growth but a balance between essential and non-essential amino acids was what mattered.

The findings of the above workers are in close confirmity with that of the present study. The results obtained here clearly indicate that it is the optimum level of limiting lysine which matters when others are in balanced quantity and that lysine supplementation in lysine dificient diet always result towards increased body weights.

From the results it will be evident that when the

level of crude protein was increased to 24 per cent in Group IV, the body weight of chicks showed better trend accordingly.

In respect to the level of crude protein Rajaguru et al (1966) observed improved growth at 25 per cent protein than that of 21.2 per cent. Similar observation was recorded by Payne and Lewis (1966) by increasing protein per cent from 21.11 to 23.8 per cent in the ration.

Similarly Kara (1967) recorded increased weight gains when the level of protein was increased from 18.25 to 21.25 per cent in Hampshire chickens. Bank (1967) and Desai (1974) also obtained the same results at 24 per cent protein than lower levels.

In 1971, Sadagopan and Coworkers observed improved growth rate when the protein level was increased from 17 to 27 per cent in leghorn chickens. Similar results was obtained by Saxena and Pradhan (1971) by increasing the levels of protein from 16 to 25 per cent in poultry.

Prasad (1973) also recorded higher body weights with 23 per cent protein in commercial cross-bred broiler chicks than those at lower protein levels. Similar findings were observed by Devegowda (1973) and Rao et al (1973) in three pure breeds of broiler chicks.

The observations of the above authors are in agreement with those of the present findings.

B. EFFECT ON FEED EFFICIENCY.

The amount of feed consumed per gram of gain in body weight represent the feed efficiency.

The average feed consumption for chicks of both sexes on air dry basis, as well as on D.M. basis from 0-4 weeks, 0-6 weeks, 0-8 weeks and 0-10 weeks are presented in Table 9 and 10. The feed efficiency data is shown in Table 11.

(i) Effect of sources of protein :

From the perusal of Table 11, it will be evident that the chicks of Group II, in which the sole source of protein was of vegetable origin did not show better feed efficiency than Group I whose ration incorporates both animal and vegetable proteins. Group I also showed better feed efficiency over Group IV in 8 and 10 weeks of growth. The feed efficiency of Group II and IV was 2.74, 2.87, 2.99 and 3.14; 2.39, 2.61, 2.77 and 2.88 and that of Group I 2.42, 2.69, 2.76 and 2.83 at 4, 6, 8 and 10 weeks of the trial respectively. The results indicate that some amount of animal protein is needed for better efficiency. This effect appeared to be additive rather than supplementary, thus indicating it was not due chiefly to amino acids.

The above results are in agreement with those of Heuser et al (1946), Opichal and Coworkers (1970), Wegner (1970) and Kelley et al (1971).

TABLE - 9.

Average weekly feed consumption (air dry) per chick in Groups I, II, III and IV (in grams) (chicks of both sexes).

Weeks	GROUPS			
	I	II	III	IV
1	92.81	97.00	51.46	95.65
2	88.85	120.00	95.87	112.59
3	153.31	219.70	194.35	220.64
4	195.33	280.10	238.69	307.87
5	220.64	370.89	271.00	292.93
6	273.49	383.42	386.80	327.50
7	344.68	519.16	448.75	484.52
8	415.11	538.43	423.05	448.93
9	493.79	578.13	465.92	493.00
10	536.25	615.50	516.00	515.24

TABLE - 10.

Average feed consumption (on D.M. basis) per chick in Groups I, II, III and IV (in gms) (chicks of both sexes).

Groups	1-4 weeks	1-6 weeks	1-8 weeks	1-10 weeks
I	497.32	957.93	1666.16	2634.42
II	672.00	1343.63	2266.62	3318.49
III	544.31	1161.00	1978.31	2898.86
IV	678.64	1262.31	2140.45	3088.95

TABLE - 11.

Showing efficiency of feed conversion of different Groups (I to IV) at different intervals of times.

Groups	Total feed consumed* (gm) (D.M. basis)	Total weight gains* (gm)	Feed consumed* (gms)/gm of weight gain.
I			
1-4 weeks	497.32	205.14	2.42
1-6 weeks	957.93	356.23	2.69
1-8 weeks	1666.16	603.82	2.76
1-10 weeks	2634.42	929.59	2.83
II			
1-4 weeks	672.00	244.91	2.74
1-6 weeks	1343.63	468.80	2.87
1-8 weeks	2266.62	758.41	2.99
1-10 weeks	3318.49	1055.05	3.14
III			
1-4 weeks	544.31	293.43	1.85
1-6 weeks	1161.00	490.87	2.36
1-8 weeks	1978.31	804.63	2.45
1-10 weeks	2898.86	1098.41	2.63
IV			
1-4 weeks	678.64	283.49	2.39
1-6 weeks	1262.31	483.49	2.61
1-8 weeks	2140.45	770.59	2.77
1-10 weeks	3088.95	1069.29	2.88

* Chicks of both sexes.

In 1946, Heuser and Coworkers obtained best feed efficiency with vegetable protein concentrates along with 3 per cent fish meal than that of all vegetable ration in leghorn chickens. In the same breed of chickens Opichal and Coworkers (1970) observed more feed consumption for gain when no animal protein was given. Wegner (1970) also found better efficiency of feed conversion in fish meal group than the vegetable protein groups in Nichols - Lohmann chickens of both sexes. Similar observation was recorded by Kelley et al (1971) in leghorn chickens with meat meal and G.N. cake or Til cake than all vegetable rations.

(ii) Effect of lysine supplementation :

Data in Table 11, reveals a better feed conversion rate in Group III than the unsupplemented Group II and Group I. The feed efficiency was 1.85, 2.36, 2.45 and 2.63 for Group III; 2.74, 2.87, 2.99 and 3.14 for Group II and 2.42, 2.69, 2.76 and 2.83 for Group I at 4, 6, 8 and 10 weeks of age respectively.

Again, these findings are in general agreement with Darwish (1968), who supplemented lysine ranging from 0.2 to 0.6 per cent and observed improved feed efficiency in leghorn chickens. Bayley et al (1968), Avila and Cuca (1971) and Hewitt and Lewis (1972) also reached similar conclusions with a lower level of lysine supplementation ranging from 0.05 to 0.2 per cent. Similarly Tasaki et al (1972) recorded less feed efficiency in lysine deficient diet in leghorn chickens.

(iii) Effect of levels of protein :

The level of protein was raised to 24 per cent without fish meal and lysine supplementation in Group IV. The feed efficiency was 2.39, 2.61, 2.77 and 2.88 at 4, 6, 8 and 10 weeks of the experimentation respectively. The re-result indicates that by increasing the level of crude protein from 22.25 (Group II) to 24 per cent (Group IV), the feed efficiency also improved simultaneously. On the contrary, Group III showed better feed efficiency results than Group IV, even with lower crude protein content, which may be due to its better amino acid balance.

Bank (1967) obtained best feed efficiency with 24 per cent protein in fattening chickens. Kara (1967) also observed that as the level of protein was increased from 18.25 to 21.25 per cent, the feed efficiency was also considerably increased. A further extension of this hypothesis has been put forth by Combs (1967) in which it was found that additions of more protein than necessary to meet the requirements improved feed efficiency. Similar observations were also recorded by Sadagopan et al (1971), Ramasubba Reddy et al (1972) and Desai (1974).

In the present investigation the feed efficiency was also influenced by the age of chicks, as evident from Table 11. It gradually increased from 2.42 to 2.83 in Group I; 2.74 to 3.14 in Group II; 1.85 to 2.63 in Group III and 2.39 to 2.88 in Group IV from 1st week to 10 weeks irrespective of the diets. The efficiency of feed conversion decreased

with the advancement of the age of chicks. Similar views were expressed by Singh (1967) and Haleem et al (1971). They recorded decreased efficiency of feed conversion with increase in the age of birds.

Thus from the foregoing observations it can be concluded that -

(i) the lysine supplemented Group III showed improved feed efficiency among all the groups. It excels in feed efficiency even from Group IV in which the level of protein was increased. Here the balance of essential amino acids plays a considerable role in improving the feed efficiency.

(ii) the sources of protein has also got positive effect in improving the feed efficiency of Group I over Group II and IV.

(iii) with an increase in the level of crude protein from 22.25 (Group II) to 24 per cent (Group IV), the feed efficiency was also increased simulataneously.

(iv) with the advancement in the age of chickens, the efficiency of feed conversion was decreased in all the Groups (I to IV).

C. EFFECT ON CARCASS COMPOSITION.

The weights and percentages with respect to dressed weight of different cut portions in different Groups (I to IV)

along with their feather weights and its percentages to live weight are presented in Table 12.

(i) Effect on Dressed and Drawn weight :

By studying the Table 12, it is evident that the percentage of dressed weights in all the four groups are more or less similar. Their percentages in Groups I, II, III and IV were 86.25, 86.09, 88.12 and 87.42 respectively. The treatments did not influence the dressing percentage among the groups.appreciably. However, Groups III and IV showed only a slight difference of 2 and 1 per cent respectively which is negligible. Almost similar trend was recorded in these Groups (I to IV) also with respect to their drawn weights percentage. The percentages of drawn weights in Groups I, II, III and IV were 66.06, 67.57, 68.37 and 67.62 respectively. Thus, the levels of protein or the supplementation of lysine in lysine deficient ration which were otherwise adequate, did not influence the percentages of dressed and drawn weights of the birds. The present observations are quite in accordance with those quoted below.

Essary et al (1965) reported that the dressing percentage is not affected by differences in protein levels in the diet. Kara (1967) also obtained very little effect of varying protein levels on carcass yield. Curto and Cicogna (1968) observed that the carcass yield of Cobs chickens, fed on rations with fish meal, without fish meal or ration without fish meal but supplemented with lysine, did not differ significantly. Chillar et al (1971) also found that the variation

TABLE - 12.

Carcass composition and different cut-up portions of male chicks at 10th week of age (in grams).

	G R O U P S			
	I	II	III	IV
Live weight.	1162.50±4.5*	1269.00±13.34	1354.32±8.10	1235.20±7.16
Dressed weight.	1002.70±4.40 86.25% ±1.08	1092.51±14.49 86.09% ± 0.44	1193.40±17.44 88.12% ± 1.01	1080.30±14.84 87.42% ± 0.46
Drawn weight.	662.41±3.91 66.06%±0.46	738.25±5.96 67.57%±0.53	816.00±5.85 68.37%±0.62	730.50±9.86 67.62%±0.42
Breast weight.	162.15±5.89 16.17%±0.62	173.58±5.38 15.88%±0.43	195.50±5.40 16.38%±0.43	175.50±6.64 16.24%±0.49
Back weight.	119.50±8.96 11.91%±0.48	128.00±9.64 11.71%±0.46	144.50±9.14 12.11%±0.49	128.50±5.94 11.89%±0.50
Drumstic weight.	126.00±3.97 12.56%±0.38	134.25±8.09 12.27%±0.42	155.00±3.56 12.98%±0.46	132.50±5.62 12.26%±0.63
Thigh weight.	140.50±7.47 14.01%±0.27	164.24±6.53 15.04%±0.36	185.00±6.38 15.50%±0.68	163.00±6.13 15.08%±0.83
Wing weight.	107.51±6.49 10.72%±0.33	110.05±7.63 10.07%±0.52	128.20±8.10 10.74%±0.56	113.00±9.55 10.46%±0.51
Giblet and neck weight.	121.25±8.10 12.09%±0.58	126.12±5.01 11.54%±0.48	135.31±7.91 11.34%±0.46	122.50±10.05 11.33%±0.49
Offal weight.	209.00±9.65 20.84%±0.36	249.00±5.09 22.79%±0.42	232.15±9.05 19.45%±0.43	232.00±7.55 21.47%±0.46
Feather weight.	159.80±9.69 13.74%±0.36	176.49±8.04 13.90%±0.32	154.90±5.84 11.91%±0.31	160.92±6.61 12.54%±0.49

*Standard error - Each value is the average of two birds.

in protein sources did not affect the dressing and eviscerated percentages in broiler chicks. In 1973, Prasad recorded no significant difference on the dressing percentage of birds fed diet containing varying levels of protein. A similar finding was also observed by Desai (1974) in cross-bred broiler chicks when the rations were supplemented with L-lysine hydrochloride. Iovchev and Bachev (1971) found no difference in carcass yield of Turkey poults fed diet supplemented with lysine.

(ii) Percentage of different cuts :

The breast weight percentage of lysine supplemented Group III was slightly heavier than the unsupplemented Group II. Its percentage was 16.38 in comparison to 15.88, 16.17 and 16.24 of Groups II, I and IV respectively. There was no variable difference in the percentages of back, thigh, drumstick, wing, giblet and neck in Groups I to IV. Thus the percentage of these cut portions appeared to be independent of the factors studied here. In general, breast was heavier than the back and the high was heavier than the drumstick in all the Groups (I to IV).

(iii) Percentage of feathers :

The percentage of feathers were more or less the same in Groups I and II. But it was slightly lower in Groups III and IV. They were 13.74, 13.90, 11.91 and 12.54 per cent in Groups I, II, III and IV respectively. Here also, the

treatments did not seem to produce any appreciable effect.

(iv) Percentage of offals :

Percentage of offals in Groups I, II, III and IV were 20.84, 22.79, 19.45 and 21.47 respectively. There was a slight decrease of 1-3 per cent in Group III. Here, addition of lysine seem to influence on decreasing the offal percentage slightly.

As the number of observations were only two, valid statistical interpretation of results could not be done.

D. EFFECT ON MEAT QUALITY.

(i) Chemical composition of meat :

The chemical composition of the composite meat samples (muscles of drumstick, thigh and back) of different Groups (I to IV) are shown in Table 13.

It can be seen from Table 13, that the meat samples of Groups I, II, III and IV are similar in dry matter content. Their percentages were 29.58, 29.32, 28.52 and 28.83 respectively. The protein content in Group IV was more in comparison to other groups, whereas it was lowest in fat content. The effect may be due to an increase in the level of crude protein in the diet of Group IV. The protein and fat percentages in Groups I, II, III and IV were 22.77, 23.11, 23.49 and 24.57; 4.98, 4.53, 4.78 and 3.87 respectively. Rajaguru et al (1966)

TABLE - 13.

Chemical composition of meat.

Groups	Dry matter %	% on D.M. basis	
		Protein	Fat
I	29.58 ± 2.10*	22.77 ± 2.32	4.98 ± 0.70
II	29.32 ± 1.90	23.11 ± 3.06	4.53 ± 0.26
III	28.52 ± 1.87	23.49 ± 2.81	4.78 ± 0.38
IV	28.83 ± 2.21	24.57 ± 2.18	3.87 ± 0.29

* Standard error — Each value is the average of two birds.

also recorded an increase in protein and decrease in ether extract of the carcass with increased protein of the diet in Arbor Acre male chicks. Tasaki et al (1972) also observed that the carcass of leghorn male chicks fed on lysine deficient diet, fat deposition was not affected. Valid statistical analysis could not undertaken due to very small number of observations.

(ii) Tenderness and juiciness scores on the basis of palatability test :

The scores for tenderness and juiciness is given in Table 14.

TABLE - 14.

Tenderness and juiciness scores on the basis of palatability test.

Groups	Scores
I	1.83*
II	2.00**
III	2.66****
IV	2.50***

Note : - Number of stars indicate order of preference by the panel.

It will be evident from the above table, that Group III with lysine supplementation, has been preferred most for its tenderness and juiciness. The socres of Group IV with higher level of protein and better combination of essential amino acids in comparison to Group II and I, comes next with a point of 2.50. Group II with a point of 2.00 comes third. Group I having fish meal and lowest amino acid content in their diet ranked last with a score of 1.83 in the trial.

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*

S U M M A R Y

S U M M A R Y

A nutritional experiment was conducted at the Bihar Veterinary College, Patna to study the effect of different sources and levels of proteins and supplementation of synthetic lysine in broiler ration on -

(i) growth rate

(ii) feed efficiency

(iii) carcass composition and meat quality, from 0 to 10 weeks of age.

The chicks were randomly distributed into 4 experimental groups of 50 birds each.

Accordingly 4 experimental rations were computed. Ration I consisted of animal and vegetable proteins both while other Rations (II to IV) were computed entirely from vegetable proteins only. The crude protein percentage of first three Rations (I, II and III) were 22.12, 22.25 and 22.25 per cent respectively. While Ration IV was having 24 per cent crude protein. In order to compare the effect of amino acid balance, Ration III was supplemented with L-lysine hydrochloride (0.23%). The lysine content of the said ration was 1.1 per cent after supplementation. Number of Groups were designated according to the number of rations offered.

The chicks were reared in battery brooders for four weeks and thereafter transferred to deep litter system and kept there upto 10 weeks. Feed and water were provided ad libitum.

Records of weekly feed consumption and increase in body weight of individual chick of different groups were maintained. Two male birds from each group were taken randomly for the analysis of chemical and carcass composition. The composite meat samples (muscles of drumstic, thigh and back) from each group was analysed for dry matter, crude protein and fat percentages. The adjacent part of the muscle was subjected to panel evaluation for tenderness and juiciness.

At 10th week of growth of birds irrespective of sex the maximum mean body weight was recorded in Group III (1133.98 gms) followed by that of Group IV (1105.18 gms) and Group II (1088.86 gms), whereas the minimum value was obtained in Group I (964.25 gms). Likewise, the best feed efficiency was recorded in Group III (2.63) and this was followed by Group I (2.83) and IV (2.88). The efficiency was the lowest in Group II (3.14).

Statistically significant increase in body weights in different groups was recorded — the male chicks having significantly higher body weights than females in all the groups.

Sources and levels of protein or amino acid supplementation did not seem to influence the carcass and chemical composition of broiler meat significantly.

In organoleptic test Group III, supplemented with lysine received highest score (2.66) for tenderness and juiciness whereas Group I received lowest (1.83) from a panel of

six judges.

The present study revealed that as far as growth rate and feed efficiency in broiler are concerned, the balance of essential amino acids was more important than either the sources or the levels of protein.

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*

ABBREVIATION AND SYMBOLS FREQUENTLY USED.

gm	-	Gramme.
mg	-	Miligramme.
e.g.	-	For example.
df	-	Degree of freedom.
M.S.	-	Mean sum of square.
n	-	Total number of observations.
S.E.	-	Standard error.
I.U.	-	International unit.
P.P.M.	-	Parts per million.
KCal	-	Kilo calorie.
Kg	-	Kilogramme.
%	-	Per cent.

***
*

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