Effect of Various Levels of Energy on Performance and Carcass Quality of Cockerels

THESIS

SUBMITTED TO THE

RAJENDRA AGRICULTURAL UNIVERSITY

PUSA (SAMASTIPUR) BIHAR

(FACULTY OF POST - GRADUATE STUDIES)

In partial fulfilment of the requirement

FOR THE DEGREE OF

Master of Veterinary Science

IN

(LIVESTOCK PRODUCTION AND MANAGEMENT)

By

Dr. Uday Prasad Yadav

Registration No. - M/LPM/65/2002-2003

DEPARTMENT OF LIVESTOCK PRODUCTION AND MANAGEMENT

BIHAR VETERINARY COLLEGE

PATNA (BIHAR)

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2005

Dedicated to benevolent adorable Parents

DEPARTMENT OF LIVESTOCK PRODUCTION AND MANAGEMENT
BIHAR VETERINARY COLLEGE, PATNA-14
RAJENDRA AGRICULTURAL UNIVERSITY
PUSA (SAMASTIPUR) , BIHAR.

Dr. S.S. Singh
M.V.Sc., Ph. D.
University Professor & Head
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Bihar Veterinary College, Patna 14

CERTIFICATE-I

This is to certify that thesis entitled ***"Effect of various Levels of energy on performance and Carcass quality of cockerels"*** submitted in partial fulfilment of the requirements for the Degree of **Master of Veterinary Science (Livestock Production and Management)** of the Faculty of post-graduate studies, Rajendra Agricultural University, Pusa, Samastipur, Bihar is the record of bonafide research work carried out by **Dr. Uday Prasad Yadav** Registration No. M/LPM/65/2002-2003, under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

It is further certified that the assistance and help received during the course of this investigation and preparation of the thesis have been fully acknowledged.

SSSingh
5/4/05

(***S.S. Singh***)

Major Advisor

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CERTIFICATE - III

This is to certify that the thesis entitled *" Effect of various Levels of energy on performance and Carcass quality of cockerels"* submitted by **Dr. Uday Prasad Yadav**, Registration No. M/LPM/65/2002-2003, in partial fulfilment of the requirements for the Degree of **Master of Veterinary Science (Livestock Production and Management)** of the Faculty of Post-Graduate studies, Rajendra Agricultural University, Pusa, Samastipur, Bihar, was examined and approved on 9.6.06 2006.

S S Singh 9/6/06

(*S.S. Singh*)

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2. **Dr. K.G. Mandal,** K G Mandal 9/6/06

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CERTIFICATE - II

We, the undersigned members of the Advisory Committee of **Dr. Uday Prasad Yadav**, Registration No. M/LPM/65/2002-2003, a candidate for the Degree of Master of Veterinary Science with Major in **Livestock Production and Management** have gone through the manuscript of the thesis and agree that the thesis entitled ***"Effect of various Levels of energy on performance and Carcass quality of cockerels"*** may be submitted by **Dr. Uday Prasad Yadav** in partial fulfilment of the requirements for the degree.

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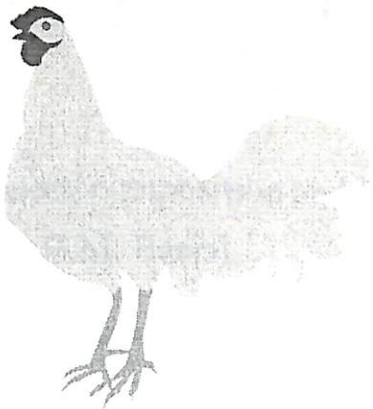
Uday prasad yadav
5/4/05

(Uday Prasad Yadav)



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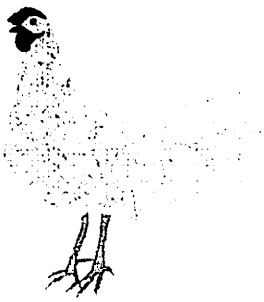
ABBREVIATIONS

%	:	Percent
Ad-lib	:	Ad Libitum
ANOVA	:	Analysis of variance
AOAC	:	Association of official Analytical chemists
ARC	:	Agricultural Research council
C:P	:	Calorie : Protein
Ca	:	Calcium
CP	:	Crude Protein
D.F.	:	Degree of freedom
DM	:	Dry matter
DORB	:	Deoiled Rice Bran
E	:	Energy
E.E	:	Ether extract
FCR	:	Feed conversion ratio
gm	:	Gram
J	:	Joule
k.cal	:	Kilo calorie
lb	:	Pound
M.S.S.	:	Mean Sum of square
ME	:	Metabolisable energy
MS	:	Mean square
MT	:	Matric ton
P	:	Protein
PI	:	Performance Index
S	:	Significant
S.E.	:	Standard Error
WLH	:	White leghorn chicks
Wt.	:	Weight



CHAPTER - I

INTRODUCTION

INTRODUCTION

Poultry keeping is as old as human civilization. People have been consuming eggs and meat since pre-historic period. In India poultry production has progressed tremendously during last three decades with the development of layers during seventies, broiler during eighties with processing and marketing during nineties. The Indian poultry industry is growing at the rate of 8 to 10% for eggs and 15 to 20% for broilers by application of genetic improvement techniques and adoptation of modern sophisticated managemental practices of poultry husbandary (Paroda 1998).

Inspite of these phenomenal growth of poultry in India, the percapita consumptions of eggs and poultry meat was on an average 40 eggs and 1500 gm meat per year by 2000, where as ICMR has recommended 180 eggs and 11kg meat per capita per year. The availability of meat and eggs is far below than the recommended levels in contrast to developed countries like China (291 eggs and 43 kg meat per capita) thus leaving a big scope for further expansion by many folds.

"Cockerels, usually called the table fowls" which is immature male chicks used for breeding and meat purpose. It is obvious that every one who rears fowls for egg production has surplus male chicks because the percentage of the sexes is usually fifty-fifty that would be pullet and cockerels are equal in number. Out of total male chicks only few chicks are used for breeding purpose and remaining one are discarded or disposed off. Consumers in some part of our country prefer cockerel meat for its light weight and tenderness. This surplus production of male chicks and increasing demand of cockerel meat draw the attention of poultry grower

towards scientific production and management of these male chicks with growing cockerels.

At present the cockerels are reared with pullet and being provided the same ration as for pullet from 0 to 8 weeks and 8 to 18 weeks as per standard recommendation resulting into longer time to achieve market weight because the pullets are reared on the ratio which contained lower amount of protein (16%) and energy (2500-2700 k.cal ME/Kg). It is well known fact that growth rate of male and female is different, male grow faster, so the nutrient requirement for growing cockerels should be different at particular age in order to get maximum growth. Though the feed conversion ratio in cockerels is some what higher than broiler but it can be offset by cost of day old chicks which accounted 25 to 30 % of total cost of broiler production in comparison to only 5 to 10 % of day old chicks of layer strain (Parthsarthy, 1996).

Considering the consumers choice and profitable cockerel husbandry the cockerel should achieve required body weight in a shorter period preferably up to 8 weeks of age. This can be achieved by providing the ration which should contain the appropriate protein and energy level for growing cockerels. At present very little work has been done to establish a appropriate protein energy level for cockerel diet. Thus there is need to asses the specific level of protein and energy for its optimum performance so that the cockerel should achieve the marketable weight in shorter possible time and their rearing may become a profitable enterprise for poultry keepers.

In view of the above fact the present study has been designed to determine the effect of different energy levels with fixed protein percentage on the performance of growing cockerels with following objectives:-

1. To formulate rations of varying energy content to be employed in the experiment based on the nutrient content of different feed ingredients.
2. To determine the effective level of energy in the ration for optimum performance in growing cockerels.
3. To determine effective calorie protein ratio for maximum growth and feed efficiency in cockerels.
4. To study the influence of dietary treatment on carcass characteristics and body compositional traits of growing cockerels.
5. To develop a cost effective economical diet of growing cockerels based on these finding.

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CHAPTER - II

REVIEW OF LITERATURE

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REVIEW OF LITERATURE

Managemental practices and economic feeding have an important role in sustainability and profitability of the cockerel production. Since feed alone constitutes about 60 to 70% of the total expenditure hence the efforts should be made to reduce the feed cost as much as possible without affecting the quality of feed and proper growth of the birds. Therefore various feeding strategies have been adopted to reduce the cost of production.

In recent years different approaches to feeding replacement pullet has been tried in order to prevent the pullet too heavy and to delay the sexual maturity. (Hussain *et al.*, 1996 and Cantor and Jhonson, 1985). While these approaches were found to be beneficial to pullets but the performance of growing cockerel were suffered. Since, no definite and seprate requirement for growing cockerel has been given in any of the standard recommendation, only a limited work has been reported in the literature which are available on the basis of individual experiment. From available limited informations indicated that the growing rate and feeding efficiency could be improved by providing higher nutrient levels to the existing rations usually fed to cockerels.

The subject will be reviewed under the following heading :

A. Requirement of energy and protein and their ratio for optimum performance.
B. Nutritional effect on carcass and meat quality.
C. Miscellaneous.

A. Requirement of energy and protein and their ratio for optimum performance.

Requirements of energy and protein could be expressed as independent absolute units of the diet or as the requirement of dietary available energy carrying protein as its function (ME : CP ratio). The latter views holds good.

Concepts of feeding high-energy diet to broiler originate with the reports of Scott *et al.* (1947). He demonstrated that both growth rate and feed efficiency were improved by feeding diets high in digestibility and energy concentration. A great deal of work on the utilizations of high-energy rations for the productions of broilers.

Hill and Dansky (1950) indicated a relationship between the levels of protein and productive energy in the diet of chicks. These authors observed a reduced growth rate in chicks fed a diet containing less than 20% protein but high in productive energy normal growth was obtained, when the level of productive energy was reduced.

Hill and Dansky (1954) reported that over a wide range of dietary energy concentration chicken tended to eat in order to satisfy their energy requirement and on high energy concentration consumed more feed than required for maximum growth and the excess may be deposited as fat.

Scott *et al.* (1955) increasing energy level while keeping protein constant at 20% resulted in a striking adverse effect on growth and plumage development.

Donaldson *et al.* (1956) an excess of production energy in ration to the amount of protein in the diet depressed the growth and decreases the efficiency of feed utilization.

Donaldson *et al.* (1956). The calorie protein ratio for chicks was influenced by the energy level of the ration being narrow for low energy diets and wide for high energy one.

Sunde (1956) observed depressed growth rate and feed efficiency on low energy and high protein ratio, which could be improved through increased level of energy in the diet. The optimum C:P ratio has been reported to vary with the protein level in the diet. He further showed ration, high in protein low in energy reduced ration resulted in reduced growth and feed utilization increased calorie level in isocalorie ration resulted in reduced feed consumption.

Harms *et al.* (1957) found that as the energy level of the diet increased from 793 k.cal to 978 k.cal pE/lb feed a significant increase was obtained in percentage of eviscerated yield. Further they observed that birds receiving high-energy diets had a greater percentage of drippings and significantly lowered cooking losses due to evaporation.

Sibbald *et al.* (1961) reported that as the ME consumption increased, the weight gain of birds will increase with an increase in protein consumption.

Oniel *et al.* (1962) observed that the excess of protein in relation to energy did not adversely affect either growth rate or feed efficiency but resulted in wastage of protein.

Sibbald *et al.* (1962) reported an increase in weight gain of birds with the increase in protein consumption, which may be due to different in calorie protein pattern.

Summer *et al.* (1963) employed 5 levels of protein and 4 levels of energy in order to study the effect of energy and protein levels on protein utilizations. The quality of protein was kept constant in all diets by using soybean oil meal supplemented with methionine as the sole source of protein. Each dietary treatment comprised 4 replicate groups of 10 white leghorn male chicks. Metabolizable energy and net protein value (N.P.V) were determined for all treatment groups. There was a decrease in N.P.V. at all levels of energy from the lowest to the highest protein level. This decrease was more pronounced at the lower energy levels. Energy was not effective in altering N.P.V. at the lower levels of protein even at higher protein levels. The results demonstrated the importance of considering the energy as well as the protein level of the diet in studies on protein utilization.

In an earlier report Robberts *et al.* (1965) fed two type of rations to one day old male layer chicks one with very low protein (8%) and another a higher protein (18%). He obtained about 1.1 Kg of body weight and better food utilizations at 12 weeks of age on high protein diet in comparison to very low body weight gain (500 gm) and in-efficient utilization of feed in chicks fed low protein diet.

Malik *et al.* (1966) conducted investigation under tropical condition to study the different levels of energy with two levels of protein (20.5 and 24.5%) in white leghorn chicken. ME and P ratio of 130 at 24.5% protein level was found to be optimum when both the growth rate and feed efficiency were taken into consideration.

Wisman and Beane (1966) increased protein level improved the feed efficiency but caused a decrease protein utilization based on body weight.

Han (1970) observed a better weight gain when 21% protein was fed in starting diets than 19% protein diet.

Moran (1971) observed that 1400 k.cal ME/lb gave better result in terms of growth, feed utilization than the rations having 1200 and 1000 k.cal/lb.

Sadagopan *et al.* (1971) observed that growth response of laying type starter chicks was improved as the level of protein increased from 19 to 21% while 21% dietary protein level at 2717 k.cal ME/kg with a ratio 1 : 123 gave the maximum weight. Widening the ratio beyond this protein level showed slight depressing effect on growth at 8 weeks.

Panda (1972), have recommended 20% protein in chick ration.

Reddy *et al.* (1973) employed various dietary protein levels ranging from 19 to 22% with a constant C:P ratio 132 k.cal ME/kg and concluded that 20% protein level was adequate for layer type starter chicks.

Fisher and Wilson (1974) have shown that when the ME content of the diet increased within the range 2400-3600 k.cal ME/kg, broiler showed linear response in weight gain, feed intake, feed conversion efficiency and energy intake.

Farrel *et al.* (1975) fed high diets to broilers having ME concentration ranging from 2.93 to 3.36 M.cal/kg diet. Birds on a diet with medium energy concentration (3.1 M.cal/kg) require slightly less ME than those on other diet and reached the required live weight earlier. They concluded that feed intake was found to be inversely related to the energy concentration but the ME required to reach given live weight was quite similar.

Haque and Agarwal (1975) employed different energy protein ratio (178.1, 137.5:1, 128.2:1 and 114.4:1) at 4 level of protein (16,20,22, 24%)

for 8 weeks in egg type male chicks to determine the optimum energy and protein ratio. They obtained greater body weight gain with ration containing 23% protein having energy and protein ratio 128.2 : 1. They noticed no significant difference in feed consumption but improvement in feed efficiency with increased protein level and decreased energy and protein ratio, of ration.

Scott *et al.* (1976) chicken has the ability to consume required amount of feed to obtain sufficient amount of energy for maximum growth over a dietary range of 2800 to 3400 k.cal ME/kg diet.

Virk *et al.* (1976) evaluated energy requirement at constant protein level (22%) with ME ranging from 2300 to 3800 k.cal ME/kg. Their result indicated a requirement of 2900 k.cal ME/kg diet in summer and 3200 k.cal ME/Kg in winter and increasing ME beyond this level gave lower body weight gain. Explanation of this view was being given that chickens perform better on lower dietary energy level in tropic because of high environmental temperature, which probably calls for lower energy need to maintain basal metabolism.

Bolton and Blair (1977) have pointed that the adjustment ability to consume required amount of feed to obtain sufficient amount of energy is even lower i.e., 2284 k.cal ME/kg diet.

Ahuja *et al.* (1978), conducted studied five experiments using 5 metabolizable energy (ME) levels (2300, 2600, 2900, 3200 and 3500 k.cal ME/Kg) to assess the energy requirement of egg-type chicks up to 10 weeks of age in summer and rainy seasons. All the rations were isoproteinous and contained equal amounts of mineral and vitamins. Body – weight gain and feed-conversion data showed that the dietary level of 2900-3000 k.cal

ME/Kg ration was optimum for starter chicks in summer and rainy seasons. The ME intake was not influenced by different dietary levels of energy. On the other hand, seasons directly affected not only the feed consumption but also the voluntary caloric intake irrespective of ME concentration in the ration.

Hoffmann *et al.* (1982) reported the maintenance energy requirement in 6 broiler cockerels per Kg $W^{0.75}$ was greater. At body weights 200 to 300 gm than at 200-250 gm the mean values for maintenance energy requirements obtained in 3 experiments were 536, 521 and 471 KJ metabolizable energy/Kg $W^{0.75}$. The amount of protein in the diet had no effect on maintenance energy requirement.

Okosum (1987) recommended 21% CP and 2700 k.cal ME/kg for the growing cockerels in tropics.

Baghel and Pradhan (1988) estimated the effect of various levels of energy (2800, 3000 and 3200 k.cal ME/Kg diet), and protein (starter 20, 22, 23 and 25%, grower 18, 20, 22 and 24% and finisher 16,18, 19 and 21 % and limiting amino acids on body weight gain in broilers for 0-8 weeks. The 2800 k.cal ME/Kg diet and 25, 24 and 21% protein with 1.2, 1.0 and 0.85 lysine and 0.93, 0.72 and 0.6% sulphur amino acids in starting, growing and finishing phases of growth respectively resulted in significantly higher weight gains. Increased energy levels in the diet increased the retention of amino acids, while the increased levels of protein decreased the retention in different phases of growth. At the lower levels of protein, in all the phases of growth (starter 20%, grower 18%, and finisher 16%) retention of different amino acid was highest. Maximum retention was observed in starting phase followed by growing and finishing phase of growth. The interaction of

energy, protein and limiting amino acids influenced the retention of different amino acids significantly ($P<0.01$).

Sudhakar *et al.* (1988) studied the comparative economics of sexed broilers and white leghorn cockerel at two protein and two energy level up to 8 week of broiler and up to 12 weeks in cockerel. While the variable cost expressed as percent of total cost was highest in cockerel (86.77%) followed by broiler (70.78%), the reverse trend was in the fixed cost which was lowest in cockerel. Since the cockerel chicks cost was much lower as compared to broiler, the fixed cost of cockerel decreased while proportionally the variable cost increase. Age did not influence the variable and fixed cost in cockerel. The total cost of production per bird basis was least for cockerel and highest in broiler. Low energy and other protein levels resulted in the lowest cost/kg live weight in both broiler and cockerel. The average cost of production per kg live weight of cockerels and broiler were found to be 16.6 and 14.0 respectively.

Madrazo, G. (1989) reviewed the results of recent research for the nutrient requirements and feed intake of breeding cocks aimed at increasing reproductive capacity and preventing fattening. It is concluded that the ideal D.M. intake is 128 gm/bird of a diet with 12% protein and energy 2800 k.cal ME/Kg feed.

Morris and Njuru (1990) compared the responses on male broiler chicks and male chicks of an egg laying stock on different diets containing different levels of protein ranging from 16 to 25% and ME content 13 MJ/Kg. They concluded from the experiment that male layer chicks needed at least 18.8% crude protein (CP) to maximize their live weight gain. Maximum efficiency of conversion of feed to live weight was achieved with

a diet containing 23% crude protein (CP). The efficiency of protein utilization was found to be same in both male broiler chicks and male chicks of layer strain.

Multani *et al.* (1991) estimated the effect of 3 dietary protein levels (20, 20 and 24%) and 3 energy levels (2500, 2700 and 2900 k.cal ME/Kg) on broilers under deep litter system of housing. The performance of chicks was evaluated from week 1-8 of age with respect to body – weight gain, dry matter (DM) intake and feed conversion efficiency in autumn, winter, summer and rainy seasons. 24% protein diet had significantly better effect on body weight gain in summer and rainy seasons. At 2900 k.cal ME/Kg the performance in terms of body-weight gain and feed conversion efficiency was significantly better in all seasons. The effect of season was significantly better in autumn on body-weight gain and in summer on dry matter (DM) intake as well as on feed conversion efficiency. Protein and energy interaction was better reflected with 20, 22, or 24% protein at 2900 k.cal ME/Kg in autumn and in winter, while 24% protein at 2700 k.cal ME/Kg in summer and 24% protein at 2900 k.cal ME/Kg in rainy season.

Madrazo *et al.* (1992) given cockerels a mixed feeds based on maize and soybean meal with crude protein 20, 20, 18 and 18% during the starting period and 15, 12, 15 and 12% during the growing period respectively. Results indicate that diets with 18 and 12% protein during the starting and growing period can be given the cockerel without affecting reproductive performance.

Nagra and Chawla (1995), estimated energy and protein requirements of commercial (IBL-80) broilers were determined under the cold climatic conditions in a 3 X 3 factorial design using 20, 22 and 24% protein levels,

each with 2500, 2700 and 2900 k.cal ME/kg diet. A single diet feeding programmed was followed from day - old to 56 days of age. Protein content of the diet had significant ($P<0.05$) effect on growth rate, but it influenced the efficiency of feed utilization during first 42 days of age only. Energy content of the diet had significant ($P<0.05$) effect on growth rate and efficiency of feed utilization both at 42 and 56 days of age. The evisceration percentage increased with the increase in energy content of diet. The highest interaction effect of protein X energy combination was reflected in 22-24% protein on growth rate and 20-22% protein on efficiency of feed utilization with 2900 k.cal ME/kg diet. The least amount of protein per unit gain in live weight was required in 20/2900 combination but the energy cost was minimum in 22/2900 combination. The cost of feed per unit weight gain was minimum 20/2900 k.cal ME/kg diet and was recommended in a single diet feeding programme, for optimum performance. Rearing of birds beyond 42 days of age involved higher feeding cost per unit weight gain due to lower efficiency of feed utilization.

Agnihotri and Baghel (1996) fed and formulated five sorghum based isocaloric diets (2900 k.cal ME/Kg) to contain 26, 24, 22, 20 or 18% CP. Each diet was allotted to 2 groups of 8 chicks for 5 weeks. While from the remaining groups each of the 2 groups were fed 26-24, 24-22, 26-22, 22-20 or 20-18% CP diet during 0-2 and 3-5 weeks respectively. Best performance (weight gain, feed utilization and performance index) and profit per broiler was observed in groups fed diet containing 26% CP and 2900 k.cal ME/kg, constantly for 5 weeks. Feeding constant level of protein was beneficial over feeding 2 different levels of protein during 0-2 and 3-5 weeks. It was

concluded that 26% CP along with 2900 k.cal ME/kg diet would be most economical with sorghum based diet.

Eruvbetine *et al.* (1996) while including Cassava as an energy source in cockerel diet, found that cockerel fed diet having 19% CP obtained a body weight about 575 gm at 6 weeks and 1170gm at 12 weeks with a feed efficiency 2.77 and 4.43, respectively.

Gheisari and Gollian (1996) used varied energy and protein requirement diet during rearing period in layer strain of chicks containing three levels of energy 2900, 2700 and 2500 k.cal ME/Kg and three levels of protein (80%, 100% and 120% of NRC recommendations). An improvement in feed consumptions energy and protein intake, daily gain and feed conversions, was observed as consequence of protein increases in the rations.

Parthasarthy (1996) stated that the next major item of cost in broiler productions was chick, which accounted about 25 to 30% while it was only 5-10% in male chicks of layer strain. At present the day old male chicks are considered to be unproductive in commercial hatcheries and are available at very cheaper rate then broiler. These day old egg type male chicks constituting about 50% at hatching are usually destroyed due to their uneconomic raising and if reared along with pullet become uneconomic to the poultry keeper.

Patle *et al.* (1996) estimated energy and protein requirement in white Leghorn female chicks of 0-8 weeks age using comparative slaughter technique. Nine diets containing three (3) levels of protein i.e., 18, 20 and 22% and three (3) levels of energy i.e. 2500, 2700 and 2900 k.cal ME/kg were fed to 27 groups of chicks for a period of 56 days. Body weight gains were not affected significantly due to diets. Feed consumption was

significantly (P<0.01) higher in low energy (2500 k.cal ME/kg) and low protein (18%) diet and decreased proportionately as the energy and protein levels increased. The basal metabolic rate and the ME requirement for maintenance value were respectively 91.7 and 133.1 k.cal/$W^{0.75}$ Kg/d. The ME required per k.cal gain was 1.19 k.cal. The efficiency of utilization of ME for maintenance was 78% and for energy gain 7.4%. The optimum energy requirement for starter chick diet was 2850 k.cal ME/kg.

Pathak and Netke (1996) studied the effect of maize verses sorghum on utilization of ME in WLH male and broiler chicks at a period of 7 - 21 and 21-42 days of age. The ME used for maintenance was found to be much higher in WLH chicks as compared to broilers. The type of diet did not influence the performance of WLH chicks and these chicks tended to divert lesser quantity of surplus energy towards fat deposition than that of broiler. This is an advantage to those health conscious consumers who prefer lesser fat in meat of poultry.

Raju *et al.* (1996) studied with naked neck (Na) and normal (No) broilers tested for their response to three energy levels, 2600, 2700, 2750 and 2900 k.cal ME/Kg diet with 20% protein in winter and summer seasons. In winter, 90 day old chicks from each genotype were equally distributed to 3 energy levels and in summer, 135 chicks from each genotype were similarly distributed. Minimum and maximum temperature in winter (19.5 and 26°C) and summer (28.1 and 37.4^{0}C) were recorded. Feeding trails were conducted for 6 and 7 wks. In winter and summer seasons, respectively. In winter, significant improvement in body weight (1214-1383 g), feed conversion efficiency (2.44-2.05), percent digestibility of dry matter (59.5-37.7) protein (61.1-66.8) and fat (67.1-80.2) was observed with 2900 k.cal ME/kg

compared to 2750 and 2600 k.cal ME/kg. Carcass yields (7.5%) and weights of abdominal fat (2.3%) and skin (6.5%) were also significantly higher with 2900 k.cal ME/kg. However, no statistical differences were noticed between the two genotype for all the parameters irrespective of energy levels, except for lower skin weight in Na. In summer, both 2750 and 2900 k.cal ME/kg yielded similar body weight (1279, 1302g), but higher feed intake, poor feed efficiency and low carcass yields were recorded with 2750 k.cal ME/kg compared to 2900 k.cal ME/kg. The percent digestibility of dry matter (74.0) and protein (64.4) was significantly better with 2900 k.cal ME/kg than other energy levels. Both the genotype did not differ for all the traits studied, except for low percent feather and skin contents in naked neck.

Sharma and Singh (1996) fed broilers on various energy levels in a feeding trial. Rations containing 23% crude protein with varying energy levels were fed to broilers chicks to determine their growth performance. Diets containing 3600 (T_1), 3400 (T_2), 3200 (T_3), 3000 (T_4), and 2800 (T_5) ME/kg were fed to broilers. The weight gain and feed intake were 1250, 1260, 1251, 1209, 1178 gm and feed intake 2924, 3111, 3212, 3231, 3214 gms respectively, in five treatments. High energy level group consumed less ($P<0.05$) feed than the birds fed lower energy level diet. Feed consumption of birds in T_3, T_4 and T_5 did not differ significantly. The performance indexes of T_1, T_2, T_3 and T_3, T_4, T_5 were comparable. It was concluded that 2800 k.cal ME/kg diet showed growth performance comparable to that of 3000 and 3200 k.cal ME/kg feed on isonitrogenous diet containing 23% protein.

Ulmek *et al.* (1996) studied the growth performance of male chicks of WLH strain with broiler starter ration and broiler finisher ration. They

observed an average body weight of cockerel at 10 week of age as 1026 gm with on overall feed conversion ratio of 1 : 3.69.

Vala *et al.* (1996) fed rations containing 20% crude protein (CP) and 2700 k.cal ME/Kg to day old male chicks of laying strain for a period of 7 weeks. During that period the cockerels achieve a body weight gain of 680 gm with a feed efficiently of 1 : 3.0 and an average gain per week was found to be 97.09 gm. They advocated that cockerels, which are considered as unproductive, could be productive and viable by poultry keeper.

Waldroup *et al.* (1996) stated that broiler grown to 63 days for further processing responded to increased nutrient density (supplemental poultry oil 0-9%) with increased growth rates and improved feed utilizations but responses finished at higher levels of oil supplementation. Abdominal fat has not increased by increasing energy, however energy : protein ration remained constant proportion of breast meat remained fairly constant except at higher nutrient density levels.

Fan and Zhen, (1997) obtained the body weight of growing cockerel around 750 gm at 9 weeks of age by a diet which provided 11.0 MJ ME/Kg and 18.5% cruded protein (CP) from day old to 6 weeks of age and from 6 weeks onwards on a diet containing 11.55 MJ ME/Kg of ME and 16.0 crude protein (CP). They also indicated that a large number of surplus growing cockerel chicks could be made profitable by equating growth curve, feeding cost and market price of layer type cockerel chicks.

Kumar, S. (2000). In an experiment on growing cockerels fed with ration of different crude protein levels (16%, 19%, 22%) and different energy levels (2500, 2700, 2900 k.cal ME/kg). He observed that ration containing 19 and 22% crude protein with 2700 and 2900 k.cal ME/kg

supported highest weight gain in growing cockerels. He also found that the efficiency of feed utilization was found to be more in chicks fed diet either with 22% crude protein and 2900 and 2700 k.cal ME/kg of energy or 19% crude protein with 2900 k.cal ME/kg.

Manjhi, P.K. (2002). Conducted an experiment on growing cockerels fed with starter and finisher ration of different crude protein levels (16 –20 %, 18 – 22%, 20-24%) and different energy levels (2500, 2700, 2900 k.cal ME/kg). He observed that ration containing 18 –22% CP and 20 –24% CP with 2700 and 2900 k.cal ME/kg supported comparable but highest weight gain in growing cockerels. He also found that feed utilization was mare in chicks fed with the diet containing 18 –22% CP with either 2700 or 2900 k.cal ME/kg.

B. Nutritional effects on carcass yield.

The progressively increasing demand for chicken of uniform size and composition has stimulated the formulation of rations to give specific weights and body composition at marketing. Trends are in a way to produce chicken with less body fat and more lean meat as excessive body fat can pore waste management problem. Thus it has now become increasingly important to consider not only weight gain and feed efficiency of meat type chickens but also their carcass composition.

Dansky and Hill (1952) indicated that birds fed a high energy ration deposited more fat on the carcass than did birds on a moderate energy ration, as the content of both protein and energy was reduced the carcasses be came progressively poorer in fleshing and finish.

Leong *et al.* (1955) found an increase in weight on visceral depot fat in broilers as the energy content of the diet was increased.

Donaldson *et al.* (1956) marked change in body composition can be achieved by altering protein and energy levels in the ration.

Donaldson *et al.* (1956) observed that ration of varying PE and crude protein in ration influenced percentage of water and ether extract in carcass. When rations ranging from 35.7 to 48.6 calories PE/lb for each percentage crude protein were fed to chick up to 4 weeks the moisture content of carcass ranged from 67.2-70.6% and ether extract from 5.6-9.4% despite no increase in growth rate. In other words the carcass quality could be influenced in the absence of alteration of gain.

Hill *et al.* (1956) reported that body composition was influenced by altering the calorie : protein ratio primarily through its effect on appetite.

Dawson *et al.* (1957) studied the relationship between meat type score and percentage of edible meat in broilers. The average yield of edible meat ranged from 47.51 to 51.05%, cooking losses from 22.72 to 24.5% bone from 21.16 to 23.85% in terms of ready to cook weight. Their result also indicated that a pound of ready to cook meat could yield approximately 50% edible meat, 22% bone, 23% loss due to cooking and 5% due to evaporation respectively.

Rand *et al.* (1957) showed on diets varying in protein, fat and energy content that increased protein consumption reduced the percentage of fat in carcass. The amount of carcass was found to be inversely correlated with protein : energy ratio.

Spring and Wilkinson (1957) showed that increasing the dietary protein from 22 to 28% had no effect on gain but increased body protein and water decreased body fat while increasing dietary energy from 1200 to 1500

Cal/lb decreased body protein and water and increased body fat both at 2 weeks and 8 weeks of age, respectively.

Hizikura and Morimoto (1962) reported that low energy and high protein diet reduced the percentage of carcass fat and retention of nitrogen and also increased the water percentage of carcass.

Combs *et al.*, (1964), voluntary energy consumption increased in relation to energy needs as the protein level was reduced. This was accomplished by progressive increased in percentage body fat and decreases in percentage body protein and water.

Summer *et al.* (1965) observed that carcass protein was increased and decreased in a linear manner with increased levels of dietary energy. Conversely, increasing levels of dietary energy resulted in decreased carcass protein and increased carcass fat with practical diets, little or no improvement in weight gain was achieved by increasing the protein level beyond 20% but marked changes in carcass composition were noted.

Essary *et al.* (1965) formulated rations to give C:P ratio (ME/Ib: CP) ranging from 35.7-50.1 and fed these to broiler chicken. Warm eviscerated yields were not appreciably affected by the different levels of protein and fat in the diet. Birds fed rations containing high levels of fat in relationship to the level of protein (Wide ratio and high PE levels) deposited significantly more fat while ration containing low levels of fat in relationship to percentage of protein (C:P ratio from 35.7-42.8) resulted in no significant difference in fat deposition. Thus it appears that the level of fat and protein in diet influenced a larger percentage of weight of live birds fed the high-energy ration than those fed the low energy one. Voluntary energy consumption increased in relation to energy needs as the protein level was

reduced. This was accomplished by progressive increased in relation to energy needs as the protein level was reduced.

Halvorson and Jacobson (1970) noted that net meat increase of the broiler chicken between 5 and 8 weeks of age was largely the consequence of breast muscle growth.

Han (1970) observed that in carcass of 6 weeks old chicken protein content increased with the increase of dietary protein but there was no difference at 12 weeks. Fat content of the carcass directly reflected energy value of the diet.

Gooch *et al.* (1972) to produce broiler carcasses having poor fleshing and finish grade.

Kiclanowski (1972) indicated that in the more rapidly growing birds the lean body mass to protein ratio in the live weight gains declined at a faster rate than in the slow growing ones and that not only protein deposition but also deposition of fat was greater in birds fed at a higher level.

Levielle *et al.* (1975) it appears that percent body fat will decrease as the calorie : protein ratio decreases. However the mechanism by which this occurs and the magnitude of the effect may depend on whether the calorie: protein ratio is altered via changes in the concentration of dietary energy, dietary protein or a combination of the two.

Lipstein *et al.* (1975) have shown that marginal dietary levels for broilers caused an over consumption of feed which they believed was an effort to satisfy requirement.

Janky *et al.* (1976) has shown that reducing dietary energy with broiler chicken lowers yield upon processing.

Cal/lb decreased body protein and water and increased body fat both at 2 weeks and 8 weeks of age, respectively.

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Pffaf and Austric (1976) demonstrated that increasing dietary protein from adequate to super adequate levels in high-energy isocaloric diets resulted in decreased body fat. This latter observation is therefore, not due to simple differences in feed consumption, but due to decreased activity of some key enzymes involved in lipid synthesis when excess protein is consumed.

Prasad (1976) found no marked differences in dressing percentage and carcass composition when ME : protein ratio was reduced from 134 to 122 at 23% protein and 153 to 144 at 19% protein for starter and finisher ration, respectively.

Mohan and Reddy *et al.* (1977), studies in a 4 x 4 factorial experimental with 11, 13, 15 and 17% dietary protein levels, each containing 2550, 2650, 2750 and 2850 k.cal ME/Kg was conducted. The test criteria included percent feed efficiency, body weight gain and body composition. The results indicated a significantly better-feed efficiency on 15 and 17% dietary protein levels as compared to 11 or 13% dietary protein level. The protein X energy interaction showed that an increase in energy level in the diet did not have any significant effect on feed efficiency. The average body weight gains increased with corresponding increase in protein level. An increase in dietary protein level resulted in increased carcass moisture and protein content, while an increase in dietary energy level resulted in decreased moisture and protein content, with simultaneous increase in fat content of the carcass. Considering the overall performance in this study a C:P ratio of 177 : 1 with 15% dietary protein and 2650 k.cal ME/Kg appears to be adequate for optimum performance of caged layers.

Sunaria (1977) obtained a ratio of 2.18 : 1 when broiler chicken were fed a ration containing 23% to 20% C.P. and 3200 k.cal/kg diet for starting & finishing phases, respectively.

Haskanson (1978) has shown that a 2500 k.cal ME/kg broiler ration promoted a large intestine, gizzard and liver with less eviscerated abdominal fat than if a 3000 k.cal ME/kg feed were given.

Raina (1979) obtained a wider meat bone ratio (5.5:1) in broiler chicken receiving 22% protein with medium level of energy while the narrowest (3:1) was in the groups receiving high level of protein with low level of energy.

Raina (1979) chemical composition of thigh and breast muscles estimation showed that with an increase in dietary energy, an increase in ether extract content and a decrease in moisture content resulted.

Moran (1980) pointed out that under normal circumstances, protein became marginal in relation to dietary energy and sample reduction of dietary protein in the finishing ration for the broiler chicken affect both in production and quality loss. However, protein above requirement doesnot benefit performance not alter carcass quality in a way that is meaningful to the consumer. Inadequate protein increases finish because calories in excess of need are consumed.

Pejon *et al.* (1980) reported to the contrary. Breast and drumstick are the only parts appreciably altered by the pattern of growth during finishing period.

Robbinson (1981) obtained increased body fat content of male broilers when dietary crude protein was increased in direct proportion with dietary

energy (constant C:P) ratio or when dietary energy level was increased in isonitrogenous diets (Variable C:P ratio).

Sheriff *et al.* (1981) studied the effect of feeding different dietary level of crude protein (CP) and ME on performance and economics of white leghorn male chicks. They formulated diets to contain 20% crude protein (CP) with 2400, 2500 and 2700 k.cal ME/kg of feed and 23% and 26% crude protein (CP) with 2400 and 2500 k.cal ME/Kg of feed for a period of 0-10 weeks of age. Birds reared on 27% CP and 2470 k.cal ME/kg had highest body weight gain and best feed efficiency. They concluded from their results that birds reared on 21% to 24% CP with 2400 to 2500 k.cal ME/kg at 10 weeks of age were economical. They also suggested that the diet with high protein and low energy (28% CP with 2470 k.cal ME/Kg) may be fed when the prevailing cost of protein supplement will be lower.

Mahapatra *et al.* (1984) studied the effect of diet on carcass characteristics and meat availability under two dietary regiment (27.7% and 2800 Kcal ME/kg and 24.4% protein and 3000 k.cal ME/kg, up to 8 week of age. Diet did not influence preslaughter eviscerated weight giblet weight and total yield. The percent of moisture protein, either extract and ash content of whole carcass varied from 73.27 to 75.08, 19.72, 2.99 to 4.88 and 0.94 to 1.21 respectively, which were not significantly different among dietary treatments.

Toyormizu *et al.* (1985) studied the responses of metabolisable energy on body protein gain in white leghorn male chicks and reported that body protein gain was not very much affected by the calorie ratio of dietary carbohydrate to fat.

Butala *et al.* (1990) incorporated different level of dietary, tallow in the rations of WLH male chicks to study the carcass characteristic and meat quality for a period of 12 weeks. Results revealed no significant differences in slaughter characteristics as well as in carcass composition. They obtained on an average as dressing percentage 68.2 and meat-bone ratio of 4.2:1

Butala and Rajagopal (1991) prepared diet containing graded level of tallow (0, 2, 4 and 6%)) with boiled rice bran as an ingredient for 12 weeks in WLH chicks. It was observed that the carcass protein decreased significantly and carcass fat increased significantly with inclusion of 6% tallow in the diet having 3280 k.cal ME/Kg than other level of ME (2290 k.cal ME/Kg to 2840 k.cal ME/Kg).

Holsheimer and Veerkamp (1992) studied the effect of dietary protein and energy on performance and yield in two strains of male broiler chicks. Dietary energy and protein level affected the slaughter characteristics and carcass yield in which higher energy level gave high carcass yield while normal CP gave the best over all yield.

Nagra and Sethi (1993) employed 20,22and 24% protein level with 2500,2700 and 2900 k.cal ME/kg in broiler ration in order to determine the energy and protein requirements. The abdominal fat deposition, meat to bone ratio and dressing percentage increased significantly with each increment in the energy content while no significant effect of protein level in these parameters was recorded.

Nwokoro and Tewe, (1995) while studying the lysine requirement of growing cockerel between8 and 16 weeks of age. With the supplementation of L. lysine 0.10% in 16% CP and 2250 k.cal ME/kg basaldioest diets in a stepwise increments such that dietary lysine level used between 0.52 and

1.12%. A control diet, using fish meal as supplement was also formulated. Results indicated that dietary level of lysine had significant ($P<0.05$) influence on the efficiency of feed utilization, nitrogen retention and dressing percentage but not on weight gains, feed consumption, protein efficiency ratio and serum metabolites. Higher dressing percentages were obtained with higher dietary lysine (0.92,1.020 and 1.12%)

Bambgose (1999) investigated the effect of feeding cockerel chicks with maggot meal with or without methionine on a ration containing 21% CP and 2700 k.cal ME/kg for a period of 8th week. Results showed slight variation in dressing (65.35to 71.03%)meat bone ratio (1.85to2.01) among treatment.

Kumar, S. (2000). Conducted an experiment on growing cockerels fed with different protein and energy concentration, observed that higher levels of protein and energy concentration in the diet influenced carcass trait in terms of dressing %, eviscerated % and meat-bone ratio. Chicks fed high protein, higher energy diet had high degree of fleshing in comparison to bone.

Marjhi, P.K. (2002). In an experiment on growing cockerels fed with different protein and Energy concentration, observed that higher levels of protein and energy concentration in the diet influenced carcass traits in terms of dressing percentage, Eviscerated percentage and Meat-bone ratio, chick fed high protein, higher energy diet had high degree of fleshing in comparison to bone.

C. Miscellaneous :

Prasad *et al.* (1973) suggested protein and energy requirement for optimum protein 23% and 2840-3100 k.cal ME/Kg diet.

Rao *et al.* (1974) reported best results with protein 22% and 19% with energy level of 2900 and 3040 k.cal ME/kg diet.

Sheriff *et al.* (1981) conducted experiment on white leghorn male chicks from 0-10 weeks on 7 different dietary proteins and energy level on performance and ready to cook yield. Their results revealed no significant differences in ready to cook yield with giblets either among treatments or ages and the value obtained for this parameter ranged from 70.21 to 71.51% at 8^{th} week and 69.7 to 72.89 at 10^{th} week of age. In a later experiment while studying the effect of dietary protein and energy level on male white leghorn chicken found decrease a moisture and fat % at 10^{th} week age than 8^{th} week of age. They also observed that there was increase in fat% as energy level in feed was increased while the increasing of dietary protein level resulted a higher protein content of carcass with proportionated reduction is fat %.

Sheriff *et al.* (1981) calculated the economics of rearing white leghorn male chicks on different dietary energy and protein levels on 20% crude protein with 2400, 2550, 2700 k.cal ME/kg of feed and 22 and 26% crude protein with 2400, 2550 k.cal ME/kg of feed at eight week and 10 week of age. They obtained highest profit margin of Rs. 1.55 with 27% CP and 2470 Kcal ME/kg followed by 24% CP and 2470 Kcal ME/kg, 28% CP and 2600 Kcal ME/kg and 21% CP and 2430 k.cal ME/kg diet. They suggested white leghorn male chicks could be profitable reared on diets containing 21 to 24% CP with 2400 to 2500 k.cal ME/kg up to 10 weeks of age.

Sudhakar *et al.* (1988) studied the comparative economics of sexed broilers and white leghorn cockerel at two protein and two energy level up to 8 week of broiler and up to 12 weeks in cockerel. While the variable cost expressed as percent of total cost was highest in cockerel (86.77%) followed

by broiler (70.78%), the reverse was in the trend of the fixed cost which was lowest in cockerel. Since the cockerel chick's cost was much lower as compared to broiler, the fixed cost of cockerel decreased while proportionally the variable cost increase. Age did not influence the variable and fixed cost in cockerel. The total cost of production per bird basis was least for cockerel and highest in broiler. Low energy and other protein level resulted in the lowest cost/kg live weight in both broiler and cockerel. The average cost of production per kg live weight of cockerels and broiler were found to be 16.6 and 14.0 respectively.

Mohan *et al.* (1990) studied the economics of cockerel production and around Namakal. The total cost per bird was found to Rs. 9.45 of which fixed and variable cost constituted 86 and 14% respectively. Among variable cost of feed accounted 65.4% of total cost while cost of chicks accounted for 6.36%. The income from sale of one live bird worked out to be Rs. 36.62 at the rate Rs. 60/kg and the cost of production was found to Rs. 14.00 with a net income was about of 22.00 and benefit cost ratio for the cockerel farming was 1.18. They recommended that cockerel could be reared as substitute for broiler at places where the consumers prefer light meat and shortages in the availability of broiler chicks.

Bertechini, Silva *et al.* (1991) experimented 20 days, 216 male and female Hubbard chickens initially 28 days old were given diets to supply metabolizable energy (ME) 2800, 3000 and 3200 k.cal/Kg and were kept in batteries at environmental temperature of 17.1°, 22.2° and 27.9° C. Diets were composed of maize, soybean oil meal, wheat bran and vegetable oil with mineral and vitamins and had constant energy : nutrient rations. When energy intake increase, weight gain and carcass yield increased and feed

intake and feed conversion decreased there was a linear decrease ($P<0.05$) in weight gain, feed intake, and ME intake. Feed conversion was best at 22.2° ($P<0.05$) with no difference between values at 17.1° and 27.9°. Weight gain, feed intake, ME intake, dressed carcass yield and free abdominal fat were greater in males than in females ($P<0.05$).

Hussein *et al.* (1996) studied the effects of protein and energy levels in rearing diets and protein levels in layer diets on pullet development and subsequent layer performance were studies using 576 single comb white Leghorn pullets of a commercial strain. Twelve group of 16 one day old chicks were assigned to each of three (3) dietary treatments. All chicks were fed a 19% CP starter diet during fed during week 2 through 6, 7 through 14 and 15 through 18 were 13.5, 15.8 and 15.8% for the constant protein treatment, and 18.9, 15.8 and 13.5% for the decreasing protein treatment. During weeks 15 through 18, half of the groups in each protein treatment were assigned to a high (3.09 M.cal AMEn/Kg) on a low (2.78 M.cal AmEn/Kg) energy diet. After 18 week, half of the pullets within each rearing treatment were fed a layer diet with 19% CP and 0.40% methionine. Increasing the level of protein fed during weeks 2 through 6 significantly ($P<0.05$) increased body weight and feed intake upto 14 weeks of age. High dietary energy increased weight gain and decreased feed intake during weeks 15 through 18. Mortality and days to 50% egg productions as well as egg production, feed intake, feed conversion. Egg weight during the first 16 week following photostimulation was not affected by rearing dietary treatments. Egg weight, but not other production parameters, was significantly increased by raising CP in the layer diet from 16 to 19%.

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CHAPTER - III

MATERIALS AND METHODS

MATERIAL AND METHODS

The present investigation was carried out with day old male chicks of layer strain for a period of eight (8^{th}) weeks at poultry research unit of live stocks production and management Department, Bihar veterinary college, Patna.

The experimental techniques used in investigation are recorded below.

A. Experimental techniques :

160 day old male chicks of WLH layer strain were procured from Varanasi Hatcheries, U.P. The schedule vaccinations of the chicks were done against marek's disease at the time of procurement and against Ranikhet (New castle) disease on 3^{rd} day of procurement. The experimental chicks were given only crushed maize on first day and then given standard broiler starter ration upto 3 days. On 4^{th} day 150 normal male chicks are selected discarding cripped and over weighed. Selected chicks are randomly distributed into 5 experimental groups of 30 chicks in each treatment replicated thrice and kept in separate pen. On the day of assigning the treatment, the live weights of chicks were ranged from 42-48 gms. On 15^{th} day of procurement the chicks were vaccinated against Gumboro disease.

The chicks were reared on deep litter consisting of dry sawdust as bedding materials. The litter was kept 2.5 inch thick for the first month and the thickness was raised to one inch more after that the litter was racked weekly to prevent any cake formation. In rearing pens, the chicks were served fresh and clean drinking water ad libitum through fountain system, which was changed twice daily. The birds were offered feed ad libitum in the linear feeders. All mash system of feeding was followed. The cockerels were

reared under uniform condition of housing including brooding, feeding, watering, lighting and other managements.

B. Preparation of experimental rations and their Analysis :

The feed ingredients were procured in one lot before the start of experiment. All the ingradients were analysed for proximate principles (AOAC, 1975) along with calcium and phosphorous using the method of Meruden modified by Talapatra *et al.* 1940 and are presented in table – 1. Based on the analysed value of crude protein and standard published value of metabolisable energy. 5 different experimental rations were formulated with 5 levels of energy (2500, 2700, 2900, 3100, 3300 k.cal ME/Kg) with similar level of crude protein viz. 22 percent. The above formulated rations were again analysed for their crude protein content and other proximate principles and the composition of experimental ration and analytical values are presented in table – 2. The dietary treatment were as follows.

T_1 - 22% crude protein and 2500 k.cal ME/Kg.

T_2 - 22% crude protein and 2700 k.cal ME/Kg.

T_3 - 22% crude protein and 2900 k.cal ME/Kg.

T_4 - 22% crude protein and 3100 k.cal ME/Kg.

T_5 - 22% crude protein and 3300 k.cal ME/Kg.

C. Observation and sampling :

The following recording and sampling procedure were adopted during the experimental period.

(1) **Feed intake :** A weekly record of feed offered and weigh back was maintained for each group to calculate the feed consumption.

(2) The chicks were weighed individually at the start of the experiment and subsequently at weekly intervals. The weekly weight gain was

Table – 1 : Percentage chemical composition and M.E. of feed ingredients used in expt. (on D.M. Basis).

Ingredients	Analysed value								Published value
	D.M.	C.P.	C.F.	E.E.	N.F.E.	Total ash	Ca	P	ME (k.cal/Kg)
Maize	90.10	9.72	2.13	2.55	84.00	1.60	0.11	0.49	3417.00 (NRC 1971)
DORB	91.50	14.94	11.39	1.68	61.14	10.85	0.35	1.36	2000.00 (Pandey 1992)
Fishmeal	90.25	42.18	02.75	4.22	30.88	20.00	8.80	2.96	1940.00 (Reddy and Vaidaya 1973)
Soybean meal	90.70	48.89	6.00	1.05	35.64	8.42	0.36	0.65	2500.00 (Banerjee 1995)
Sunflower cake	91.64	32.56	19.68	1.84	38.02	7.90	0.39	1.25	2230.00 (Raj *et al.* 1977)
Soybean oil	00	00	00	00	00	00	00	00	9000 (ISI 1961)
Saw dust	--	0.34	83.35	0.44	3.25	12.62	--	--	--

Table – 2 : Percentage composition of experimental diets.

	Crude protein percentage				
	22				
	k.cal ME/Kg				
	2500	2700	2900	3100	3300
Treatment groups	T_1	T_2	T_3	T_4	T_5
Maize	39	47	57	54	54
DORB	14	7	-	-	-
Fish meal	9	9	9	10	10
Soybean meal	14	14	16	21	23
Sunflower meal	18	18	15	8	3.5
Soybean oil	-	-	-	4	6.5
Saw dust	3	2	-	-	-
Common salt	0.5	0.5	0.5	0.5	0.5
Mineral mixture*	2.5	2.5	2.5	2.5	2.5
Vitamin mixture** (gm)	25	25	25	25	25
Analysed value					
Crude protein	22.38	22.31	21.70	22.32	21.83
ME (K.Cal/Kg) calculated	2518.63	2739.33	2856.79	3100.00	3277.00
ME : protein ratio	112.53	122.78	131.64	138.88	150.11

* Mineral mixture contained (per kg), copper – 312 mg; cobalt-45mg; Magnesium-2.114gm; Iron – 979 mg; Zinc – 2.13gm; Iodine – 156mg; DL methionine-1.92 gm, L - Lysine mono HCl – 4.4gm; calcium – 30%; Phosphorous – 8.25%; Aspargus recimosus – 10 mg; and yeast – 1 gm.

** Rovimix AB2 D3 contained (per gm); vit– A- 4000 I.U.; vita – B2-20mg; D3 – 5000 I.U.

calculated from the difference in body weight attainted at the end and at the start of the period in question.

(3) **Feed convertion ratio :** The feed convertion ratio (FCR) was calculated by using the following formulae.

$$FCR = \frac{\text{Total amount of feed consumed (gm)}}{\text{Body weight gain (gm)}}$$

(4) **Performance Index :** In order to take account the feed efficiency as well as growth rate, an index was obtained for each experimental diet by dividing the average weight gained by the feed conversion ratio figure (Bird, 1955). It was calculated as :

$$\text{Performance index (PI)} = \frac{\text{Body weight gain (gm)}}{\text{FCR}}$$

(5) Regular observations were made to record the occurrence of death in experimental birds to estimate mortalities relative to experimental groups.

(6) **Carcass study :** At the end of eight week, three birds from each group and one from each replicate were randomly selected for slaughter and processing. The birds were starved 24 hours before slaughter without with–drawing drinking water. Each bird was weighed twice, just prior to starvation and again immediately before slaughter. The birds were bled by clean incision at the base of ear lobes and allowed to bleed. The birds were immersed in hot water (70°C) for 30 seconds (Hard Scalding). The scalded birds were hand plucked to remove body feathers perfectly. The head was removed by severing the 1st cervical vertebra and occipital bone. The feet and shank were cut at the tibiotarsal joints, wing tips was removed and dressed weight of the carcass was recorded. The birds were then

eviscerated by removing the crop, gullet, trachea and viscera. The lungs were scrapped off. The giblet (heart, liver and gizzard) were removed from the viscera.

Gall bladder was removed from liver, Gizzard was opened the contents were washed out and lining was pulled off and the contents were washed. The heart was freed from blood clot and adhering vessels. The weight of the carcass along with giblet was recorded as eviscerated weight. The dressing percentage and eviscerated percentage were calculated on the basis of pre slaughter live weight at 8^{th} week of age.

Samples of breast and thigh muscles were taken from carcasses of each group and the sample were wrapped in polythene bags and kept in deep freeze for proximate analysis.

For determination of meat / bone ratio, the carcass were taken cooked in ena-melled tray for 1.5 hours in an oven at 163°C (Dawson, *et al.* 1957). After every 25 minutes the chicks were turned side up so that, each chicken was cooked uniformly at every position. Cooking was completed by cooking the carcass until the internal temperature of breast muscle reached 94°C. After cooking, the edible meat and bone was separated manually. The bone were dried in oven to a constant weight at 80°C. The weight of the dried bone was recorded. The meat/bone ratio was calculated by dividing the weight of the raw edible meat with weight of the bone.

$$\text{Meat/Bone ratio} = \frac{\text{Ready to cook wt} - \text{wt. Of oven dried bones.}}{\text{Wt. Of oven dried bone}}$$

(D) Method of analysis :

Samples of feed ingredients and formulated rations were analysed for proximate principles as per procedure laid down by AOAC (1975). The moisture content of breast and thigh muscle were determined by drying 10 gm samples in oven at 100°C for 18 hours. For ether extract and nitrogen determination the samples were grinded in a glass peste and mortars and representatives sample were taken for determining nitrogen and ether extract as out lined by AOAC (1975).

(E) Statistical analysis : Data will be subjected to statistical analysis as per Snedecor and Cochran (1967). The recorded data of significant difference between treatment means with respect to parameters set into 5 x 3 factorial (Crude protein and ME/Kg) arrangement and analysed in completely randomized design. Analysis of varience were done for different recorded parameters with respect to protein and ME level. The difference between treatments were tested for significance by Duncan's new multiple range test (1955). Parameters expressed in percentage figure were statically analysed by converting the percentage figure into Arcsin with their standard error as per C.I. Bliss.

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CHAPTER - IV

RESULT AND DISCUSSIONS

RESULT AND DISCUSSION

The average weekly body weight gain and feed consumption (gm/chick) in different dietary treatments has been presented in table no. - 3. The treatment means of body weight gain (gm/chick) during 2nd week, 4th week, 6th week and 8th week as well as during entire experimental periods (0-8) week and their analysis of variance has been presented in table - 4 and appendix table - 1.

2nd week :

The body weight gain during 2nd week was not significantly ($P<0.05$) influenced by dietary treatments. The average body weight gain of cockerels by different dietary treatments ranged between 45 to 61 gm. Chicks fed diet containing 3100 k.cal ME/kg (T_4) showed significantly ($P<0.05$) higher body weight gain than T_1 (2500 k.cal ME/kg), T_2 (2700), T_3 (2900) and T_5 (3300). There was no significant ($P<0.05$) difference between T_3 and T_5.

Pooling the data for energy level showed better weight gain at high energy level.

4th week :

The weight gain during 4th week was significantly ($P<0.05$) influenced by the dietary level of energy. The average weight gain ranged from 78 to 92gm. Chicks fed diet containing 3100 k.cal ME/kg (T_4) showed significantly ($P<0.05$) higher body weight gain than T_1, T_2, T_3 but comparable with T_5. No significant ($P<0.05$) differences was obtained between T_2 and T_3.

Pooling the data for energy showed better weight gain at an energy level of 3100 k.cal ME/kg at protein level of 22%.

Table – 3 Treatment means of weekly body weight gain and feed consumption (gm/chick).

No. of treatment	Initial body weight (gm)	1st week		2nd week		3rd week		4th week		5th week		6th week		7th week		8th week	
		Wt gain (gm)	Feed consume (gm)	Wt gain (gm)	Feed consume (gm)	Wt gain (gm)	Feed consume (gm)	Wt gain (gm)	Feed consume (gm)	Wt gain (gm)	Feed consume (gm)	Wt gain (gm)	Feed consume (gm)	Wt gain (gm)	Feed consume (gm)	Wt gain (gm)	Feed consume (gm)
T_1	43.80	32.38	72.33	45.15	147.18	65.17	166.67	78.22	351.10	85.25	376.33	101.63	518.28	89.21	594.67	85.52	454.60
T_2	44.50	34.21	70.00	48.26	143.77	72.38	161.23	84.50	345.33	93.24	372.07	105.24	537.33	95.20	601.49	89.51	466.84
T_3	42.25	43.05	74.33	58.08	140.67	79.02	155.70	85.17	336.43	116.10	360.06	137.13	535.01	119.15	593.00	88.09	448.07
T_4	46.87	40.07	72.96	61.07	138.03	77.04	152.06	91.16	332.09	114.23	355.10	135.04	529.07	117.13	586.07	95.11	449.08
T_5	45.90	45.10	70.16	57.10	141.03	80.99	150.07	88.03	334.12	119.99	354.12	139.98	526.87	122.00	584.09	83.02	460.07

6th week :

The body weight gain during 6th week was significantly (P<0.05) influenced by the dietary level of energy. The average weight gain during this period ranged from 101 to 140 gm. Chicks fed diet containing 3300 k.cal ME/kg (T_5) showed significantly (P<0.05) higher body weight gain than T_1, T_2 and T_4 but comparable with T_3. There were no significant (P<0.05) differences between T_1 and T_2. Pooling the data for energy showed better weight gain at an energy level of 3300 k.cal ME/kg at protein level of 22%.

8th week :

The body weight gain during 8th week ranging from 83 to 96gm was not significantly (P<0.05) affected by dietary treatments. Chick fed diet containing 3100 k.cal ME/kg (T_4) showed significantly (P<0.05) higher body weight gain than T_1 and T_5 but comparable with T_2 and T_3. There were not significant (P<0.05) differences among T_1, T_2, T_3 and T_5. Considering the energy level, diets with 3100 k.cal ME/kg (T_4) showed significantly higher body weight gain followed by 2700 k.cal and 2900 k.cal and the lowest body weight gain in 3300 k.cal followed by 2500 k.cal ME/kg.

(0-8) week :

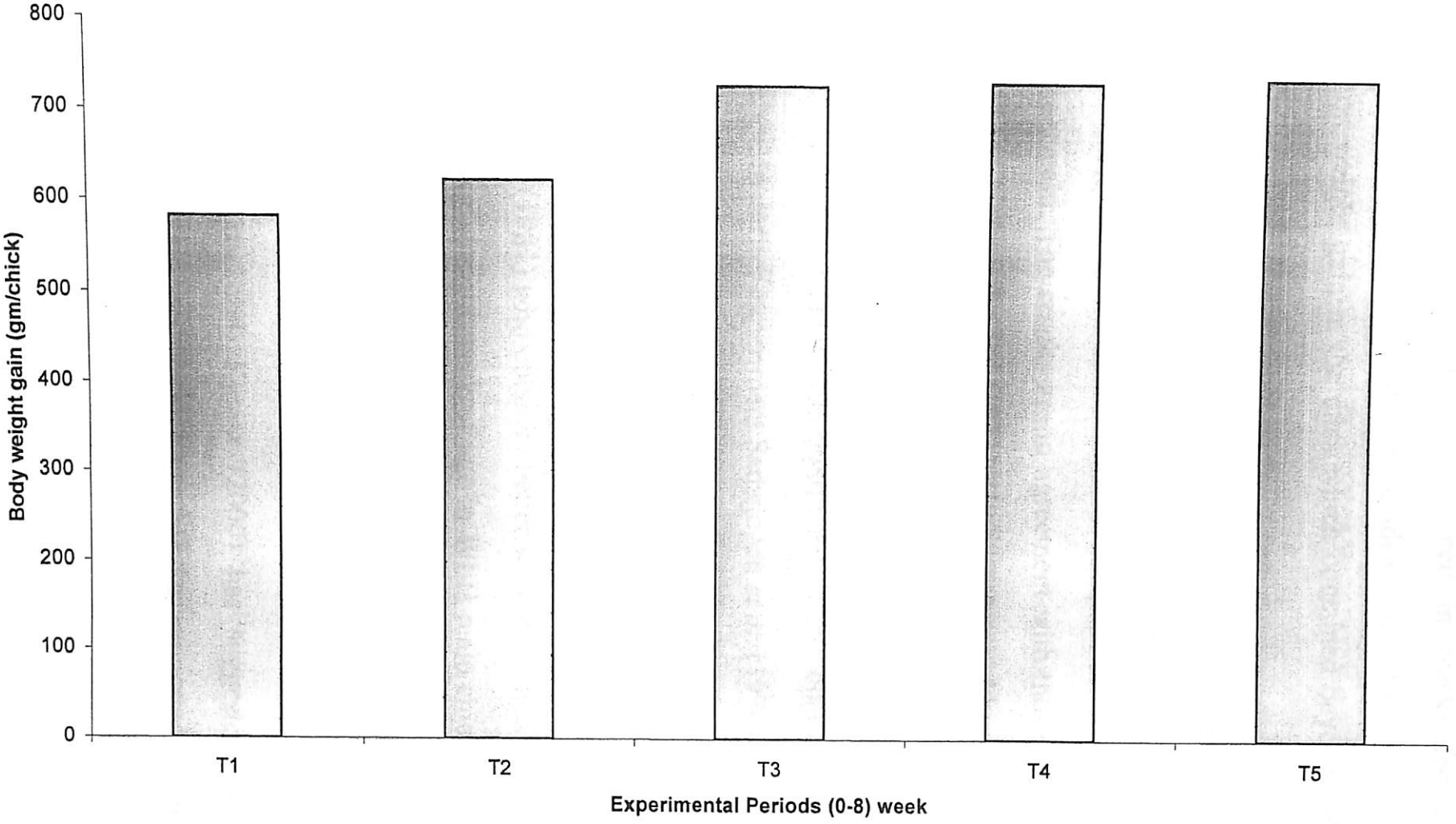
The weight gain during entire experimental period Varied (0-8) week significantly (P<0.05) in different treatments. The average weight gain in different treatment is ranged from 582 to 737gm. The highest weight gain was obtained in chicks fed diet containing 3300 k.cal ME/kg (T_5) and was not significantly (P<0.05) different from the chicks fed diet containing 3100 k.cal ME/kg (T_4) and 2900 k.cal ME/kg. These groups reflected significantly

Table – 4 Treatment means of body weight gain (gm/chick) of cockerels at different experimental periods.

Crude protein (%) 22					
	k.cal ME/kg				
	2500	2700	2900	3100	3300
Treatment groups	T_1	T_2	T_3	T_4	T_5
Week					
2nd week	45.15^{a} ± .56	48.26^{b} ± 1.54	58.08^{c} ± 0.53	61.07^{d} ± 1.01	57.10^{c} ± 0.58
4th week	78.22^{a} ± 3.07	84.50^{b} ± .53	87.15^{b} ± 1.06	91.19^{c} ± 2.67	88.03^{c} ± 1.70
6th week	101.63^{a} ± 1.64	105.24^{a} ± 1.54	137.13^{c} ± 3.50	135.04^{b} ± 1.15	139.98^{c} ± 0.92
8th week	85.52^{a} ± 1.31	89.51^{ab} ± 6.77	88.09^{ab} ± 0.59	95.11^{b} ± 1.15	83.02^{a} ± 0.76
(0-8) week	582.54^{a} ± 1.21	622.53^{b} ± 8.63	725.79^{c} ± 7.07	730.88^{c} ± 3.39	736.21^{c} ± 3.47

Means bearing the common letter superscripts in a row do not differ significantly ($P<0.05$).

Fig. 1 : Histogram showing treatment means body weight gain (gm/chick) during experimental periods.



($P<0.05$) higher body weight as compared to chicks fed diet containing 2700 k.cal ME/kg (T_2) and 2500 k.cal ME/kg (T_1).

The lowest body weight gain was obtained in chicks fed diet containing 2500 k.cal ME/kg (T_1). It was evident that there was not beneficial effect on weight gain in the diets which contained beyond 2900 k.cal ME/kg.

Results of body weight gain indicated that rations containing 22% crude protein at 3300 k.cal ME/kg diet caused maximum growth. 22% crude protein and lower energy level was found to be in-adequate for performing optimal body weight gain. The results are in agreement with the finding of Malik *et al.* (1966) and Verma and Pal (1971). High energy and high protein diet had positive effect of growth rate was also reported by Sibbald *et al.* (1961). Haque and Agarwal, (1975) obtained greater body weight gain in chick fed ration containing 23 % C.P. with 2950 k.cal ME/kg than low level of protein and energy. In earlier experiment Sadagopan *et al.* (1971) reported that laying type starter chicks gave maximum weight gain in a diet having 21% crude protein and 2717 k.cal ME/kg with a protein : energy ratio 1 : 123. However, present result do not agree with the findings of Reddy *et al.* (1973) and Sheriff *et al.* (1981) who obtained better weight in birds fed 22% CP and 2470 k.cal ME/kg at eight week of age in WLH male chicks. They showed that with a decreasing energy level and increasing protein level had resulted in better weight gain. The recommendation given by ISI (1968) for protein (22%) and energy (2900 k.cal ME/kg) in broiler starter will more or less hold good also for cockerel. Kumar (2000) has suggested ration containing 22% crude protein and 2900 k.cal ME/kg supported highest

weight gain in growing cockerels. Similar result was also obtained by Manjhi (2002).

Feed consumption :

The treatment means of feed consumption of chick during 2nd, 4th, 6th, 8th and total feed consumption (0-8 weeks) fed different ration at the same crude protein level (22% CP) but different energy levels are presented in table 5 and their analysis of varience in appendix table 2.

2nd week :

Feed consumption for different dietary treatments ranging from 138.03 to 147.18 gm. during this period was significantly ($P<0.05$) influenced by dietary treatments. The highest feed consumption (147.18gm) was observed in chicks fed diet with 2500 k.cal ME/kg (T_1) but not significantly ($P<0.05$) different from group T_2. The lowest feed consumption (138.03 gm) was observed in chicks fed diet with 3100 k.cal ME/kg (T_4) and was not significantly ($P<0.05$) different with group T_3 and T_4. T_2, T_4 and T_5 treatment groups also did not differ significantly ($P<0.05$) among each other.

4th week :

The feed consumption during this period ranging from 332.09 to 351.10 gm. The highest feed consumption (351.10gm) was observed in chicks fed diet containing 2500 k.cal ME/kg (T_1) and was not significantly ($P<0.05$) different with T_2. Birds reared on 3100 k.cal ME/kg (T_4) had lowest feed consumption (332.09 gm) and was not significantly ($P<0.05$) different with groups T_3 and T_4 but differed with other dietary treatment groups.

6th week :

The feed consumption during this period ranged from 518.28 to 537.33gm. The highest feed consumption (537.33gm) was observed in birds reared on 2700 k.cal ME/kg (T_2) and was not significantly ($P<0.05$) different with group T_3. The lowest feed consumption (518.28gm) was observed in birds reared on 2500 k.cal ME/kg (T_1) and was significantly ($P<0.05$) different with other treatment groups. T_2 and T_3 also not differ significantly ($P<0.05$) between each other.

8th week :

The feed consumption during 8th week ranged from 448.07 to 460.07gm. The highest feed consumption (460.07gm) was observed in birds reared an energy level 3300 k.cal ME/kg (T_5) and was significantly ($P<0.05$) higher than other treatment groups. The lowest feed consumption was observed in birds reared on energy level 2900 k.cal ME/kg (T_3) but was not significantly ($P<0.05$) different with T_4.

(0-8) week :

The feed consumption during entire experimental period ranged from 2614.47 to 2698.40 gm. The highest feed consumption (2698.40) was observed in birds fed diet containing energy level 2700 k.cal ME/kg (T_2) and was not significantly ($P<0.05$) different with T_1 treatment group. The lowest feed consumption was observed in birds feed diet having energy level 3100 k.cal ME/kg (T_4) and was not significantly ($P<0.05$) different with T_5 treatment group. Treatment group T_3 consumed 2643.31gm of feed having energy level 3100 k.cal ME/kg and was significantly ($P<0.05$) different than other treatment groups.

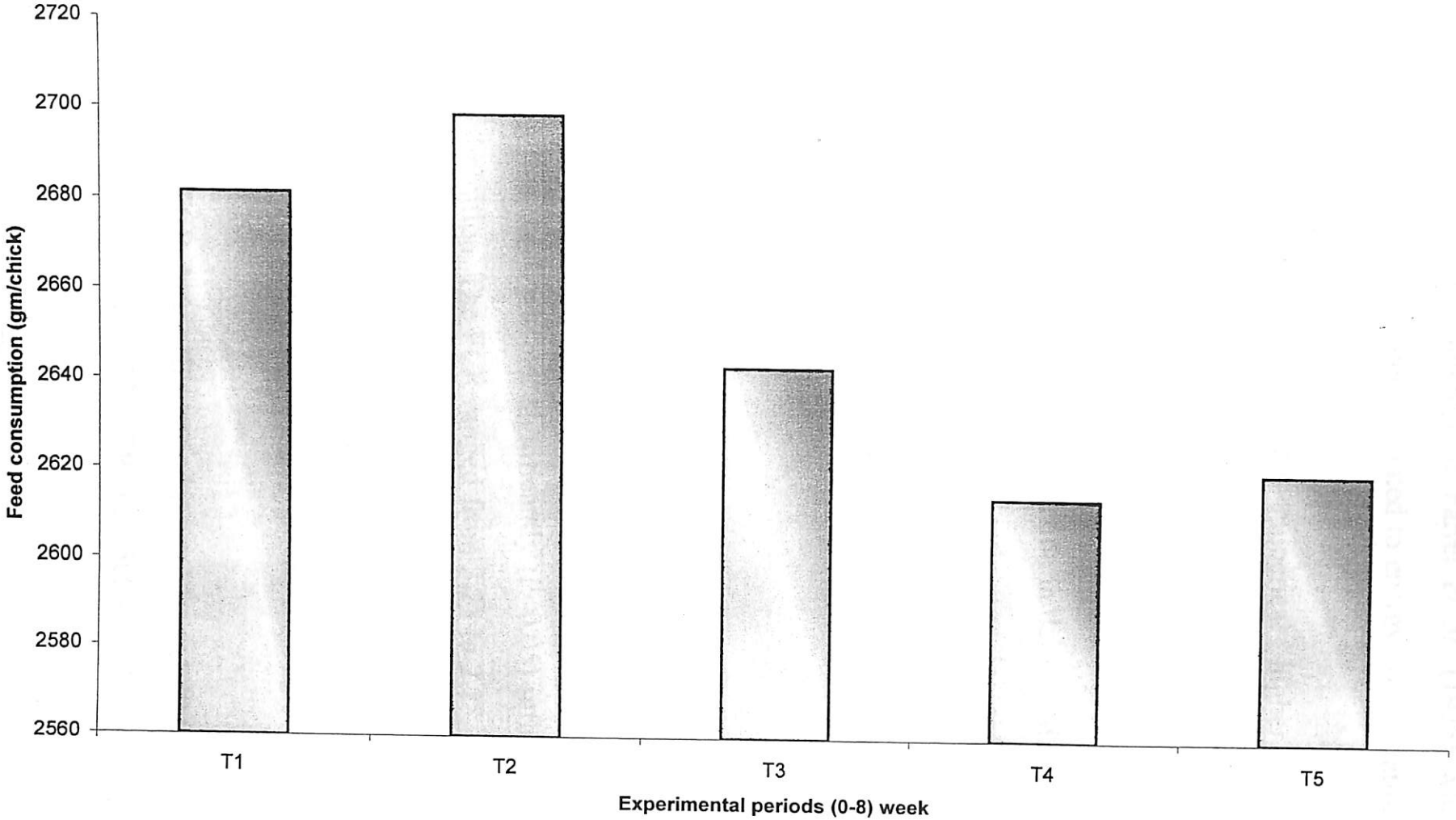
Results indicated that birds reared on higher level of energy consumed comparatably lower feed. The present result is some what similar to Kumar's

Table – 5 Treatment means of feed consumption (gm/chick) of cockerels at different experimental periods.

Crude protein (%) 22					
	k.cal ME/kg				
	2500	2700	2900	3100	3300
Treatment groups	T_1	T_2	T_3	T_4	T_5
Week					
2nd week	147.18^{c} ± 2.14	143.77^{bc} ± 1.98	140.67^{ab} ± 2.33	138.03^{a} ± 1.78	141.03^{ab} ± 2.60
4th week	351.10^{b} ± 2.05	345.33^{b} ± 1.60	336.43^{a} ± 2.61	332.09^{a} ± 2.50	334.12^{a} ± 4.01
6th week	518.28^{a} ± 1.13	537.33^{c} ± 1.75	535.01^{c} ± 2.21	529.07^{b} ± 5.83	526.87^{b} ± 8.64
8th week	454.60^{b} ± 2.38	466.84^{d} ± 1.46	448.07^{a} ± 3.48	449.08^{a} ± 1.14	460.07^{c} ± 2.62
(0-8) week	2681.50^{c} ± 9.57	2698.40^{c} ± 10.89	2643.31^{b} ± 8.56	2614.47^{a} ± 5.20	2620.53^{a} ± 6.08

Means bearing the common letter superscripts in a row do not differ significantly ($P<0.05$).

Fig. 2 : Histogram showing treatment means feed consumption (gm/chick) during experimental periods.



(2000) result as he found the consumption of feed more in chicks fed diet with 22% crude protein and at a lower level of energy. Results of feed intake in this study also corroborate the findings of Farrel *et al.* (1975) who concluded that the feed intake was inversely related to energy concentration in the diet.

Haque and Agarwal (1975) obtained numerical higher feed consumption in chicks fed ration with higher level of protein and energy. The variations in feed intake could be due to energy content of diet associated with increased dietary energy concentration.

Bamghose (1999) obtained a significant reduction in daily feed intake in chicks when the energy concentration of the ratio was increased by incorporating high fat content maggot meal at a level of 8% in the diet. Thus a proper calorie protein ratio is needed in the ration for optimum intake of nutrient through feed consumption.

Feed conversion ratio :

The data for FCR for 2^{nd}, 4^{th}, 6^{th}, 8^{th} week and (0-8) week with their analysis of variance are presented in table 6 and appendix 3.

2^{nd} week :

The FCR during this week was not significantly ($P<0.05$) influenced by energy content in the ration. The FCR ranged from 3.25 to 2.25, during this period. The lowest FCR was obtained in chicks fed diet containing 22% crude protein and 3100 k.cal ME/Kg (T_4) and highest FCR was found in chicks fed diet containing 22% crude protein and 2500 k.cal ME/kg (T_1).

4^{th} week :

Treatment means of FCR during this period ranged from 4.49 to 3.64. It was highest for chicks fed diet having 22% CP and 2500 k.cal ME/kg (T_1)

and lowest FCR value was obtained in chicks was fed diet containing 22% CP and 3100 k.cal ME/kg (T_4) and was not significantly ($P<0.05$) different from treatment group having crude protein 22% and energy level 3300 k.cal ME/kg (T_5). The highest value for T_1 differ significantly ($P<0.05$) with all other groups. Treatment T_2 and T_3 also do not differ significantly ($P<0.05$) each other.

6th week :

The FCR value ranging from 3.76 to 5.10 was significantly ($P<0.05$) influenced by level of energy. The lowest FCR value was obtained in chick fed diet having 22% crude protein and 3300 k.cal ME/kg (T_5) and was not significantly different ($P<0.05$) from T_3 and T_4. The highest FCR value were obtained in chick fed diet with 22% CP and 2500 k.cal ME/kg (T_1) and 2700 k.cal ME/kg.

8th week :

The FCR value during this week ranging from 4.72 to 5.53 and was significantly ($P<0.05$) influenced by dietary treatments. The lowest FCR value was obtained in chick fed diet containing 22% CP and 3100 k.cal ME/kg (T_4) and was not significantly different ($P<0.05$) from T_3. Chicks fed diet containing 22% CP and 3300 k.cal ME/kg (T5) showed higher FCR value and was not significantly different ($P<0.05$) from T_1 and T_2. T_1, T_2 and T_3 also did not differ significantly ($P<0.05$) among each other.

(0-8) week :

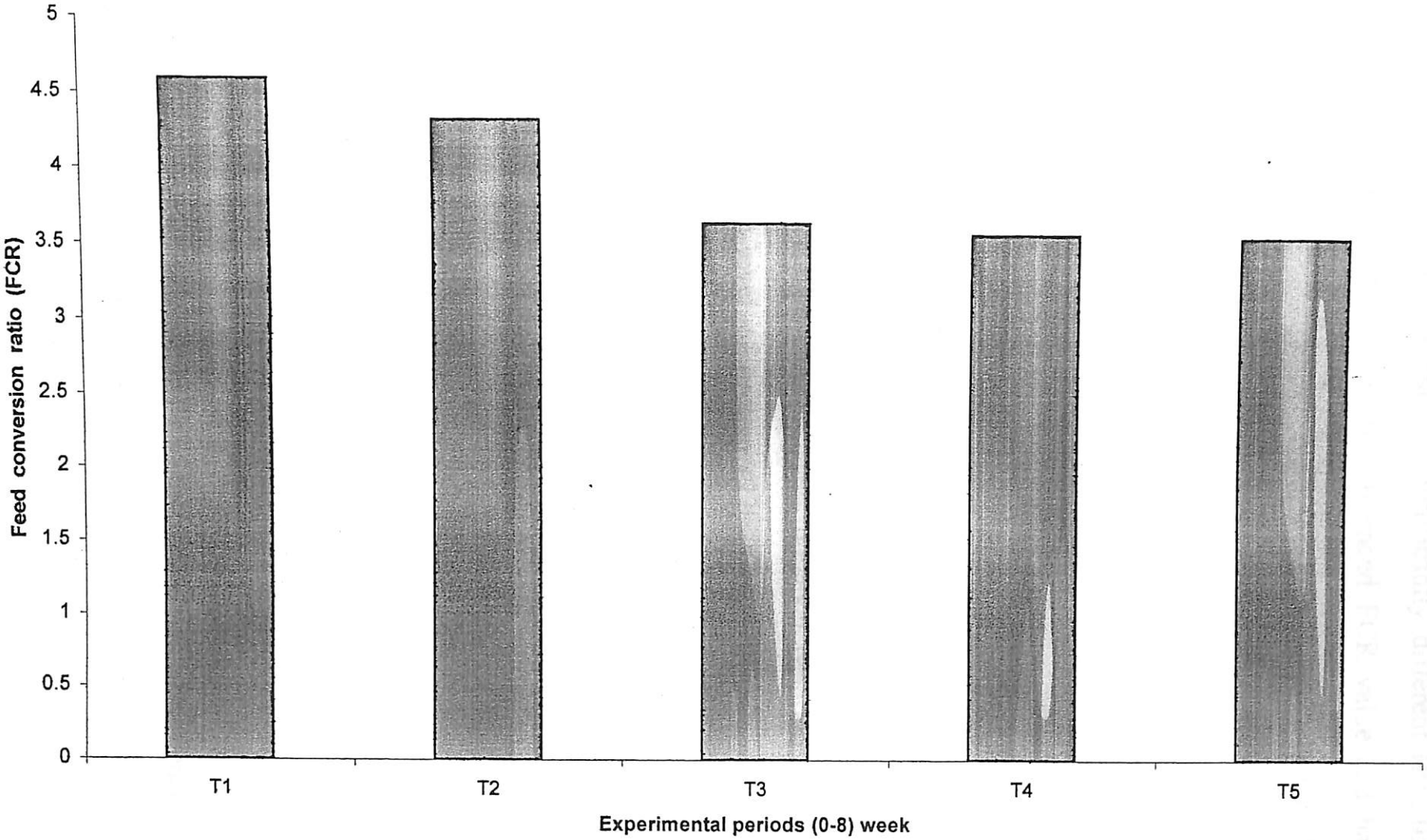
During the entire experimental period, the feed conversion ratio (FCR) was significantly ($P<0.05$) influenced by dietary treatments and level of energy. Feed utilization was found to be significantly ($P<0.05$) higher in chicks fed diet with 22% CP and 3300 k.cal ME/kg energy than T_1 and T_2

Table – 6 Treatment means of feed conversion ratio of cockerel at different experimental period.

Crude protein (%) 22					
	ME k.cal/kg				
	2500	2700	2900	3100	3300
Treatment groups	T_1	T_2	T_3	T_4	T_5
Week					
2nd week	3.25^{a} ± .054	2.98^{a} ± .12	2.41^{a} ± .021	2.25^{a} ± .04	2.46^{a} ± .043
4th week	4.49^{d} ± .18	4.08^{c} ± .02	3.94^{bc} ± .05	3.64^{a} ± .10	3.79^{ab} ± .11
6th week	5.10^{b} ± .09	5.10^{b} ± .08	3.90^{a} ± .10	3.91^{a} ± .03	3.76^{a} ± .02
8th week	5.31^{bc} ± .10	5.26^{bc} ± .37	5.08^{ab} ± .03	4.72^{a} ± .06	5.53^{c} ± .08
(0-8) week	4.59^{b} ± .005	4.32^{b} ± 0.057	3.64^{a} ± 0.057	3.57^{a} ± .005	3.55^{a} ± 0.013

Means bearing the common letter superscripts in a row do not differ significantly ($P<0.05$).

Fig. 3 : Histogram showing feed conversion ratio (FCR) during experimental periods.



but was not significantly different from T_3 and T_4. The FCR value of chicks fed diet with 22% CP and 2500 k.cal ME/kg (T_1) was significantly ($P<0.05$) higher than all dietary treatments but not significantly different ($P<0.05$) with T_2. Higher concentration of energy influenced FCR value and had significantly lower FCR value than lower energy concentration diet 2900 k.cal ME/kg, 3100 k.cal ME/kg and 3300 k.cal ME/kg of energy in diet showed comparable but significant lower FCR than the diets having 2500 k.cal ME/kg and 2700 k.cal ME/kg of energy.

Results of present study indicated that the chicks fed diet with 22% crude protein with 2900 k.cal ME/kg, 3100 k.cal ME/kg and 3300 k.cal ME/kg utilized feed more efficiently than lower level of energy in the diet. Results obtained in present study are in agreement with Malik (1966), Fisher and Wilson, (1974), Farrel *et al.* (1975), Sudhakar *et al.* (1988), Kumar (2000) and Manjhi (2002). The latter workers however reported that the rations containing higher level of protein (22% CP) and lower level of energy (2470 k.cal ME/kg) gave highest body weight gain and best feed efficiency.

Haque and Agarwal (1975) obtained improvement in feed efficiency with increased protein level and decreased calorie protein ratio of the rations. Most of the works related to the feed efficiency were in accordance with the calorie : protein ratio of the diet and results of these studies suggested that a balanced calorie protein is necessary for maximum feed utilization in birds.

Performance Index (PI) :

The data for performance index (PI) for 2^{nd}, 4^{th}, 6^{th}, 8^{th} and during entire experimental period (0-8 weeks) and their Analysis of varience are presented in table-7 and appendix table 4.

2nd week :

The performance index (PI) value during this period ranging from 13.87 to 27.17 was significantly ($P<0.05$) influenced by dietary treatments with different level of energy in the ration. A higher index was obtained in chicks fed diet with 22% crude protein with 3100 k.cal ME/kg (T_4) and was significantly different ($P<0.05$) with other treatments. T_3 and T_5 did not differ significantly ($P<0.05$). However, higher concentration energy in diet showed numerically better index value.

4th week :

The PI during 4th week was also significantly ($P<0.05$) influenced by dietary treatments. The highest value of PI was obtained in chicks fed diet with 22% crude protein and 3100 k.cal ME/kg (T_4) and was not significantly different ($P<0.05$) with 3300 k.cal ME/kg (T5). Lowest value of PI was obtained in chick fed diet with 22% crude protein and 2500 k.cal ME/kg (T_1) was significantly different with 2700 k.cal ME/kg (T_2), 3100 k.cal ME/kg (T_4) and 3300 k.cal ME/kg (T_5) but not significantly different with 2900 k.cal ME/kg (T_3). 2700 k.cal ME/kg (T_2) and 2900 k.cal ME/kg (T_3) did not differed significantly ($P<0.05$) between each other. Similarly 2700 k.cal ME/kg (T_2) and 3300 k.cal ME/kg (T_5) did not differ significantly ($P<0.05$) between each other.

6th week :

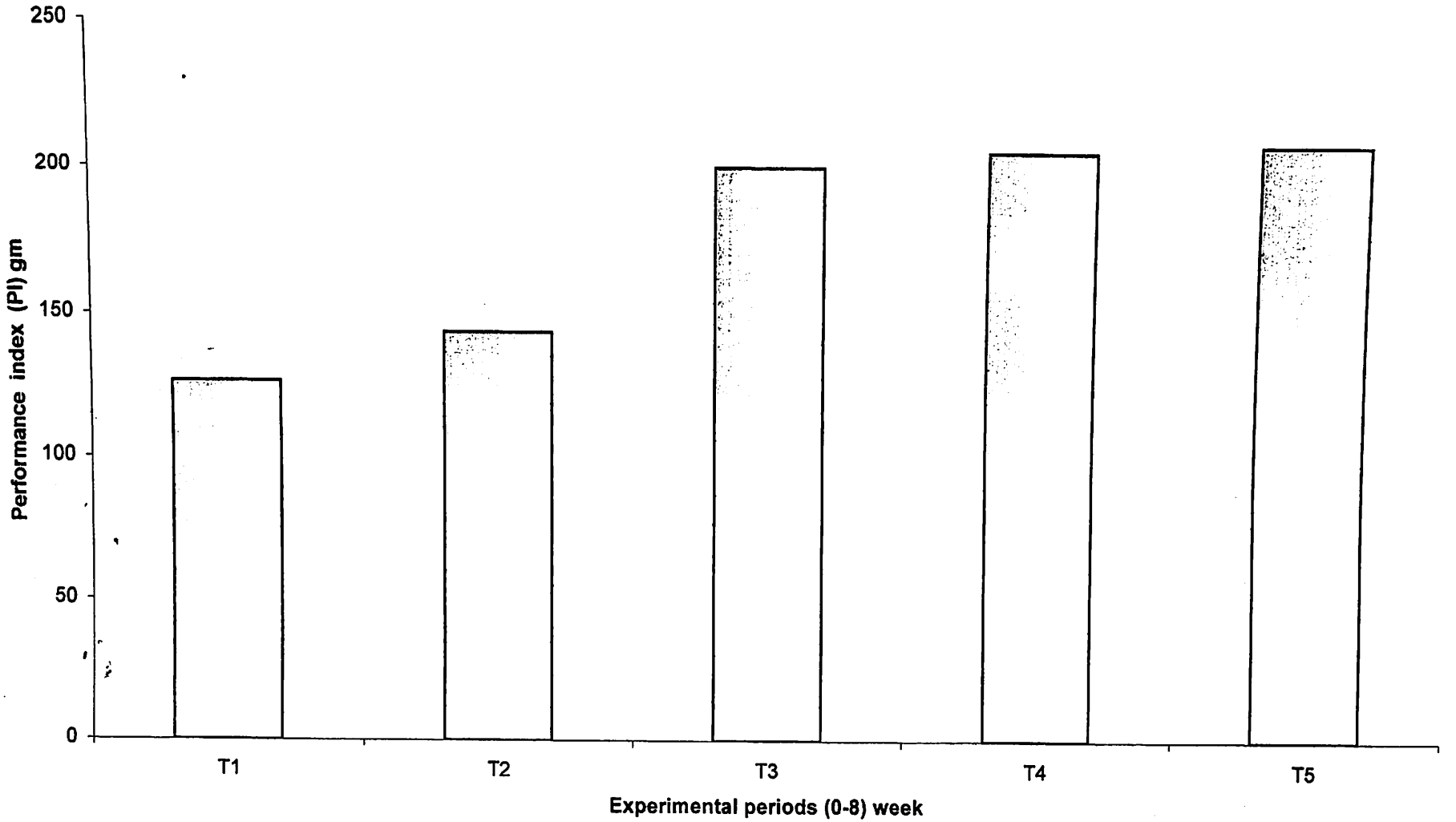
Highest value of PI was seen in treatment having energy level 3100 k.cal ME/kg (T_4) and lowest value of PI was obtained in group having energy level 2500 k.cal ME/kg (T_1) and was not significantly different ($P<0.05$) with 2700 k.cal ME/kg (T_2), 2900 k.cal ME/kg (T_3) and 3300 k.cal ME/kg (T_5).

Table – 7 Treatment means of performance index of cockerel at different experimental period.

	Crude protein (%) 22				
	k.cal ME /kg				
	2500	2700	2900	3100	3300
Treatment groups	T_1	T_2	T_3	T_4	T_5
Week					
2nd week	13.87^{a} ± .36	16.28^{b} ± 1.25	24.06^{c} ± .21	27.17^{d} ± .89	23.16^{c} ± .49
4th week	17.50^{a} ± 1.43	20.72^{bc} ± .22	20.03^{ab} ± 1.23	25.11^{d} ± 1.46	23.25^{cd} ± 1.19
6th week	19.94^{a} ± .69	20.65^{a} ± .62	35.23^{bc} ± 1.82	34.44^{b} ± .57	37.23^{c} ± .48
8th week	16.12^{a} ± .58	17.36^{a} ± 2.65	17.34^{a} ± .20	20.16^{b} ± .51	15.00^{a} ± .35
(0-8) week	126.63^{a} ± .21	143.76^{b} ± 3.92	199.50^{c} ± 4.48	204.54^{cd} ± 1.43	207.00^{d} ± 1.72

Means bearing the common letter superscripts in a row do not differ significantly ($P<0.05$).

Fig. 4 : Histogram showing treatment means of performance index (PI) during experimental periods.



8th week :

The performance index value during this period ranging from 19.94 to 37.23. Highest value of PI was obtained in treatment group having energy level 3300 k.cal ME/kg (T_5) and was not significantly different from each other. Lowest value of PI was seen in treatment group 2500 k.cal ME/kg (T_1) and was not significantly different ($P<0.05$) with treatment group with 2700 k.cal ME/kg) (T_2). 2900 k.cal ME/kg (T_3) and 3100 k.cal ME/kg (T_4).

(0-8) week :

Overall performance index value during this period ranging between 126.63 to 207.00 was significantly ($P<0.05$) affected by dietary treatments. A significantly higher PI (207.00) was obtained in chick fed diet with 22% crude protein and 3300 k.cal ME/kg (T_5) than all other dietary treatments and was not significantly different ($P<0.05$) with 3100 k.cal ME/kg (T_4). Birds reared on 22% crude protein and 2500 k.cal ME/kg (T_1) showed significantly ($P<0.05$) lowest performance index value than all other treatment groups. Treatment group 2900 k.cal ME/kg (T_3) and 3100 k.cal ME/kg (T_4) did not differ significant between each other.

Results of performance index indicated a higher index value in chicks fed diet with higher concentration of energy. As the index is an indicator of feed utilization and body weight gain, therefore the present result of PI tested the results of feed efficiency and body weight gain. Results obtained also corroborated the finding of Sadagopan *et al.* (1971), Sheriff *et al.* (1981), Kumar (2000) and Manjhi (2002). However, Sibbald *et al.* (1961) showed that higher energy and high protein diet had no effect of growth and feed efficiency.

Carcass traits :

Table – 8 Treatments means of carcass trait at the end of experimental period in the growing cockerel.

Treatments	Dressing Percentage Mean*	Eviscerated percentage Mean*	Meat/Bone ratio Mean*
T_1	64.65 ($53.49^{a} \pm .13$)	59.51 ($50.48^{a} \pm .35$)	$3.73^{a} \pm .04$
T_2	66.57 ($54.70^{ab} \pm .25$)	61.40 ($51.59^{b} \pm .17$)	$3.90^{b} \pm .03$
T_3	68.62 ($55.92^{ab} \pm .22$)	63.65 ($52.89^{c} \pm .04$)	$4.08^{cd} \pm 0.02$
T_4	69.00 ($56.17^{b} \pm .09$)	64.10 ($53.19^{c} \pm .12$)	$4.16^{de} \pm .05$
T_5	69.12 ($56.23^{b} \pm .22$)	64.12 ($53.19^{c} \pm .15$)	$4.27^{e} \pm .13$

* Geomatric mean of percentage.

Figures in the parentheses indicate angles corresponding to percentage asper CI Bliss and standard errors of means with different superscripts differ-significantly ($P<0.05$).

Treatment means of carcass traits with respect to different parameters like dressed weight, eviscerated weight as percent of preslaughter weight and meat : bone ratio of chicks fed different ration and their Analysis of variance are presented in the table-8 and appendix table-5. The percent figure of different parameters were converted to *Arcsin* as per Bliss.

Dressed weight :

The mean dressing percentage was ranged from 64.65 to 69.12%. The dressed weight expressed as percentage of preslaughter weight was significantly ($P<0.05$) influenced by dietary treatments. Chicks fed diet 22% CP and 3300 k.cal ME/kg showed significantly ($P<0.05$) higher dressing percentage than other treatment groups but not significantly different ($P<0.05$) with T_3 and T_4. 2500 k.cal ME/kg (T_1) energy level showed lowest dressing percentage but not significantly different with 2700 k.cal ME/kg (T_2) energy level group.

Eviscerated weight :

The eviscerated percentage in various dietary treatments ranging from 59.51 to 64.12 was significantly ($P<0.05$) influenced by dietary treatments. Chicks fed diet containing 22% CP with 3300 k.cal ME/kg (T_5) group showed significantly higher eviscerated percentages than other groups The group fed diet containing 22% CP and 2500 k.cal ME/kg (T_1) showed lowest eviscerated percentages. Treatment groups T_3 (2900 k.cal ME/kg), T_4 (3100 k.cal ME/kg) and T_5 (3300 k.cal ME/kg) were not significantly different ($P<0.05$) among each other. In general birds of higher body weight reflected higher dressing and eviscerated percentages.

Meat bone ratio :

The ratio of meat to bone was significantly ($P<0.05$) affected by dietary treatments. It ranged from 3.7 to 4.27. The highest ratio (4.27) was obtained in the chicks fed diet containing 22% CP with 3300 k.cal ME/kg (T_5) and was not significantly ($P<0.05$) different from the groups fed diet containing 22% CP and 3100 k.cal ME/kg (T_4) but differed significantly ($P<0.05$) with 2900 k.cal ME/kg (T_3). The lowest ratio (3.73) was obtained in the group fed diet containing 22% CP with 2500 k.cal ME/kg (T_1), Diets containing 2900 k.cal ME/kg (T_3) and 3100 k.cal ME/kg (T_4) was not significantly, ($P<0.05$) different between each other.

Results of carcass traits with respect to dressed weight, eviscerated weight and meat bone ratio indicated a higher percentage of these parameters in chicks fed diet containing higher level of energy. Similar observations were also recorded by Harms *et al.* (1957), Raina (1979), Holsheimer and Veerkamp (1992), Kumar (2000) and Manjhi (2002). Dansky and Hill (1952) indicated that as the content of both energy and protein was reduced the carcass become progressively poor in fleshing and finish. The above view was confirmed by Gooch *et al.* (1972), who also obtained poor fleshing in finished broiler fed computerised least cost rations of lower nutrient concentration. Similarly Janky *et al.* (1976) indicated that reducing the dietary energy reflected lower yield upon processing contrary to their result, Prasad (1976) and Mahapatra *et al.* (1984) found no marked differences on dressing, eviscerated weight and giblet yield in different dietary treatments with different levels of protein and energy. However, Nagra and Sethi (1993) in an experiments with three (3) levels of protein (20, 22 & 24% CP) and three (3) levels of energy (2500, 2700 & 2900 k.cal ME/kg) obtained a significant ($P<0.05$) increased in dressing percentage (%) and meat to bone

Table – 9 Treatment means of the chemical composition of thigh and breast muscle.

Treatment	Thigh muscle			Breast muscle		
	Moisture % mean*	Protein % Mean*	Ether extract Mean*	Moisture % Mean*	Protein % Mean*	Ether extract mean*
T_1	63.34 ($52.71^{c} \pm 0.13$)	21.27 ($27.49^{c} \pm 0.19$)	8.67 ($17.16^{a} \pm 0.04$)	64.13 ($53.19^{b} \pm 0$)	22.24 ($28.11^{b} \pm 0.09$)	6.45 ($14.65^{c} \pm 0.04$)
T_2	61.91 ($51.88^{a} \pm 0.12$)	19.95 ($26.49^{a} \pm 0.13$)	10.54 ($18.91^{b} \pm 0.06$)	63.26 ($52.67^{a} \pm 0.05$)	20.97 ($27.28^{a} \pm 0.19$)	4.87 ($12.79^{a} \pm 0.04$)
T_3	62.25 ($52.06^{ab} \pm 0.09$)	20.23 ($26.71^{ab} \pm 0.02$)	10.95 ($19.28^{c} \pm 0.08$)	63.29 ($52.69^{a} \pm 0.04$)	20.95 ($27.20^{a} \pm 0.29$)	5.59 ($13.69^{b} \pm 0.07$)
T_4	63.18 ($52.65^{c} \pm 0.06$)	21.15 ($27.35^{c} \pm 0.03$)	11.03 ($19.37^{c} \pm 0.14$)	64.08 ($53.17^{b} \pm 0.02$)	22.20 ($28.11^{b} \pm 0.04$)	6.43 ($14.65^{c} \pm 0.05$)
T_5	62.45 ($52.18^{b} \pm 0.07$)	20.26 ($26.78^{b} \pm 0.10$)	11.10 ($19.46^{c} \pm 0.14$)	63.37 ($52.75^{a} \pm 0.15$)	21.05 ($27.28^{a} \pm 0.02$)	4.92 ($12.79^{a} \pm 0.06$)

* Geometric mean of percentage

Figure in the parentheses indicate angles corresponding to percentage as per CI Bliss and standard errors of means with different superscripts differ significantly ($P<0.05$).

ratio with and increment of energy but not with respect to protein level. Similarly Kumar (2000) and Manjhi (2002), obtained significantly ($P<0.05$) higher dressing %, eviscerated % and meat bone ratio in cockerel as the level of energy and protein increased in the rations.

Chemical composition :

The chemical composition of thigh and breast muscle in terms of moisture, protein and ether extract percentage of cockerel fed different ration are presented in table-9 and their analysis of variance in appendix table 6.

Moisture percentage : The moisture percentage of thigh and breast muscle ranged from 61.91 to 63.34 and 63.26 to 64.13 % respectively and were significantly ($P<0.05$) influenced by different dietary treatments and levels of energy. High moisture content was observed in thigh muscle than breast muscle. The highest moisture percentage (%) in thigh muscle was obtained in the group fed diet containing 22% CP with 2500 k.cal ME/kg (T_1) and was not significantly ($P<0.05$) different from T_4. The lowest moisture percentage (%) in thigh muscle obtained in groups fed diet containing 22% CP and 2700 k.cal ME/kg (T_2) but not significantly ($P<0.05$) different between each other. The highest moisture percentage in breast muscle was obtained in group fed diet containing 22% CP and 2500 k.cal ME/kg (T_1) and was not significantly ($P<0.05$) different with T_4. The lowest moisture percentage (%) was obtained in the group fed diet containing 22% CP and 2700 k.cal ME/kg (T_2) and was not significantly ($P<0.05$) different with T_3 and T_5.

Considering the level of energy the moisture percentages (%) in both thigh and breast muscles, rations containing 2500 k.cal ME/kg (T_1) showed higher moisture percentage in comparison to T_2, T_3, T_4 and T_5 energy levels at the same level of CP.

Protein percentage :

On the wet basis, protein percentage of thigh and breast muscle ranged from 19.95 to 21.27 and 20.95 to 22.24% respectively. The protein percentage (%) with respect to thigh muscle was significantly ($P<0.05$) influenced by the dietary treatment, the level of energy in the rations. No definite trend of protein percentage (%) in differents dietary treatments was evident. The higher protein percentage in thigh muscle was obtained in the group fed diet containing 22% CP and 2500 k.cal ME/kg. (T_1) and was not significantly ($P<0.05$) different from T_4.

The lowest protein percentage (%) was obtained in the group fed diet containing 22% CP with 2700 k.cal ME/kg (T_2) and was not significantly ($P<0.05$) different from T_3. Similarly T_3 and T_5 did not differ significantly ($P<0.05$) from each other. The lowest protein percentage (%) in breast muscle obtained in the group fed diet containing 22% CP and 2900 k.cal ME/kg (T_3) and was not significantly ($P<0.05$) different from (T_2) and T_5 the highest protein percentage (%) was obtained in group fed diet containing 22% CP with 2500 k.cal ME/kg (T_1) and was not significantly ($P<0.05$) different from T_4 at the same level of CP.

Ether extract (EE) :

The date pertaining to ether extract (EE) content of both thigh and breast muscles on wet basis were ranged from 8.67 to 11.10 and 4.87 to 6.45% respectively. Dietary treatments the level of energy significantly ($P<0.05$) affected the ether extract (EE) contents of both thigh and breast muscle. Thigh muscle showed higher EE percentage than breast muscle. As the energy level increased, the ether extract percentage increased in case of thigh muscle, but not similar trend was seen in case of breast muscle.

Table – 10 : Mortality in different week.

Treatment group	Treatment identification					Birds left over	Total mortality %
	T_1	T_2	T_3	T_4	T_5		
Age/week							
1	-	1	-	1	1	147	2%
2	1	-	1	-	-	145	3.33
3	-	1	-	-	-	144	4
4	1	-	-	-	-	143	4.66
5	-	-	-	-	-	-	4.66
6	-	-	-	-	-	-	4.66
7	-	-	-	-	-	-	4.66
8	-	-	-	-	-	-	4.66
Total	1	2	1	1	1	-	4.66
Mortality %	6.6	6.6	3.3	6.3	3.3		4.66

The group feed diet containing 22% CP and 3300 k.cal ME/kg (T_5) showed higher ether extract percentage in thigh muscle than other groups and was not significantly ($P<0.05$) different with T_3 and T_4 treatment group but in case of breast muscle diet containing 22% CP with 2500 k.cal ME/kg (T_1) showed highest ether extract percentage and was not significantly ($P<0.05$) different from T_4. T_2 and T_5 which also not differ significantly ($P<0.05$) from each other.

Data indicated that carcass composition with respect to thigh and breast muscles in terms of moisture, protein and ether extract (EE) was affected by level of energy. Chicks fed high-energy ration had higher ether extract (EE) percentage (%) in Thigh muscle. The findings are in agreement with result reported by Kumar (2000) and Manjhi (2002). Donaldson *et al.* (1956) stated that marked change in body composition could be achieved by altering protein and energy level in ration. Spring and Summer *et al.* (1965) indicated that increasing level of dietary energy resulted an increased carcass fat. However, Pffuf and Austric (1976) demonstrated that increasing dietary protein from adequate to super higher in energy isocaloric diet resulted in decreased body fat. They attributed the differences was due to decrease activity of some enzyme involved in lipid synthesis. Sheriff *et al.* (1981) observed an increase in fat % as the energy level of feed was increased while high dietary protein level resulted an increase in protein percent of carcass with reduction in fat%. Results of similar nature was also obtained by Nagra and Sethi (1993) and Raina (1979).

Mortality :

Mortality during different weeks is given in table-10. Out of total 150 chicks used for the study 7 died during the course of entire experimental

Table – 11 : Economics as influenced by different dietary treatment.

No. of Treatments	Cost of per kg feed (Rs.)	Average live wt. Gain per bird (gm)	Cost of feed consume per bird (Rs.)	Other expenditure per bird (Rs.)	Cost of feed per kg live wt. gain (Rs.)	Total input per kg live weight (Rs.)	Total out put per kg live weight (Rs.)	Net profit per kg live weight (Rs.)	% profit per kg live weight (Rs.)
T_1	8.80	582.53	23.59	7.50	40.50	48.00	58.00	10.00	20.38
T_2	9.71	622.53	24.74	7.50	39.74	47.24	58.00	10.76	22.77
T_3	9.75	725.79	25.76	7.50	35.49	42.99	58.00	15.01	34.01
T_4	10.50	730.88	27.44	7.50	37.54	45.04	58.00	12.96	28.77
T_5	10.75	736.21	28.16	7.50	38.24	45.74	58.00	12.26	26.80

periods thus the mortality was 4.66% of the total. Table also revealed that during 1st week 3 chicks died thus the total mortality during this week was 2%. There was no particular trend of death among the chicks on various dietary regimens. During 2nd week two chicken died raising the total mortility from 2 to 3.33%. During 3rd week only one chick died bring the total mortality to 4%. During 4th week one chick died raising the total mortality 4.66%. No further mortality was found during the rest of experimental period. Seems not to be associated with the dietary treatments and it was within the normal range.

Economics :

Economics was calculated on the basis of cost of feed consumed and fixed cost. Actual cost of feed was calculated on the basis of rate on which different feed ingredient and supplements were purchased. The costs of ration/kg were from 8.80 to 9.93 rupees. Table-11 showed total feed cost of those dietary treatments in which concentration of energy was high was found to be higher but the fixed cost was similar in all dietary treatment. The variability in the cost of ration used in different dietary treatments was due to mainly varying levels of energy employed in the formulation of rations. Net profit per kg live weight of chickens was found to be more in the diet having 22% CP and 2900 k.cal ME/kg. Low energy diet showed lower profit in rearing of cockerel. Therefore a ration containing 22% crude protein diet at 2900 k.cal ME/kg may be adopted for economically rearing of cockerel.

Results of economics also indicate that the margin of profit was found to more on the ration containing 22% crude protein with 2900 k.cal ME/kg than other dietary energy levels. Results obtained in present study are in agreement with Kumar (2000). Other worker contrary to our finding

obtained more profit in rearing of cockerel fed a rations containing 27% CP and 2470 k.cal ME/kg than the ration containing 24% CP at the same energy level (Sheriff *et al.*, 1981). They suggested that WLH male chicks could be profitably reared on the diet with 21-24% CP and 2500-2900 k.cal ME/kg.

Results of present finding suggest that 2900 k.cal ME/kg at a crude protein level of 22% in cockerel ration would be more beneficial. Higher than 2900 k.cal ME/kg energy level in their diet had no beneficial effect on body weight gain.

The optimum age to rear cockerel seems to be up to 8 weeks as per market demand and economic consideration. Result of Sudhakar *et al.* (1988) also indicated that cockerels may be profitably reared up to 8-10 week of age as the cost of production will increase with the increase in age.

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CHAPTER - V

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

The increased demand for egg type pullet chicks in recent year has resulted in the stagnation of the male chicks at hatchery. It has been observed that during hatching the percentage of sexes reckoned at least as fifty-fifty, that means the ratio between male and female chick is 1:1. The usual tradition in that few cockerels are kept for breeding purposes and rest are discarded due to uneconomical rearing up to slaughter age. However, discarding the male chicks at day old stage will cause huge monetary loss for the poultry industry. Due to high price as well as fluctuating market price for broiler and its inadequate and unassured supply consumer's population belonging to middle class family prefer cockerel for its light weight and tender meat. They even purchase it at higher rate than broiler. Considering the lower price of day old chicks and high marketable potency, attempts have been made by many workers to raise cockerels from surplus male chicks in a profitable way. It is well known that male chicks could grow faster than female and the nutrient requirement may differ in order to gain maximum growth at a particular age. No standard recommendations are available with respect to different dietary nutrient requirement for meat production of cockerel. Most of workers are using standard recommendation for broiler for its raising. Hence, an experiment was conducted to find out the optimum level of energy in diets containing a fixed level of crude protein (22%) for performance and economics of white leghorn (WLH) male chicks.

150 day old male chicks of WLH layer strain were procured from Varanasi hatcheries, U.P. and were divided into five groups with 3 replicates in each. Chicks were reared on deep litter from hatch to 8 weeks of age. The

experimental diets were formulated with five levels of energy (2500, 2700, 2900, 3100 and 3300 k.cal ME/kg) with fixed crude protein percentage (22% CP). The feed ingredient used in the experiment and the compounded ration were analysed for their chemical composition and ME value of the diets were calculated from the published ME value of feed ingredients. Feed and water were provided adlibitum. All the managemental procedure was rendered uniform through out the experimental periods. Three birds were picked at random from each group and one from each replicate at 8 week of age and slaughtered for carcass characteristics. The data collected with respect to various parameters were subjected to statistical analysis as per Snedecor and Cochran (1967).

The following results and conclusion drawn were as below :

Body weight gain :

The average body weight gain during 2^{nd} week ranged from 45.15 to 61.07gm. chicks fed diet containing 3100 k.cal ME/kg (T_4) obtained highest body weight gain and significantly differ ($P<0.05$) with other treatment groups.

The weight gain during 4^{th} week ranged from 78.22 to 91.19gm. The weight gain pattern during this period was some what similar to 2^{nd} week.

In 6^{th} week the weight gain ranged from 101.63 to 139.98 gm was significantly ($P<0.05$) affected by dietary treatments. The chicks fed diet with 3300 k.cal ME/kg (T_5) showed significantly ($P<0.05$) higher body weight gain than other dietary treatment except the groups fed diet containing 2900 k.cal ME/kg. Higher dietary energy showed highest body weight gain during this period.

The body weight gain during 8th week ranged from 83.02 to 95.11 gm indicating no clear-cut trend of weight gain different in dietary treatment. During entire experimental period (0-8 weeks), the body weight gain was significantly ($P<0.05$) influenced by dietary treatment. There was significantly ($P<0.05$) increase in weight gain with increase in energy levels. The body weight gain during this period ranged from 582.54 to 736.21gm. Highest body weight gain (736.21gm) was seen in 3300 k.cal ME/kg (T_5) group but not significantly ($P<0.05$) different with T_3 and T_4 groups. It was evident that not much influence in weight gain was observed in the diets contained beyond 2900 k.cal ME/kg.

Feed consumption :

The feed consumption up to 4th week showed similar trend among different dietary treatment. However, during 6th week the highest feed consumption was noted in chicks fed diet containing of 2700 & 2900 k.cal ME/kg and thereafter a reduction in feed consumption were noted. Feed consumption during entire experimental period ranging from 2614g to 2698gm was significantly affected by dietary treatment. As the concentration of energy in the diets was increased a lowered feed consumption in chicks of a particular group was lowered.

FCR :

During the early period of growth, FCR was not significantly affected among different dietary treatments but as the age advanced feed efficiency was found to differ among different groups. Energy concentration of diets on and from 2900 k.cal ME/kg had significant effect on FCR. During 6th week and onwards the group fed diets containing 2900, 3100 & 3300 kcal ME/kg had similar FCR values and were significantly lower than 2700 & 2500 k.cal

ME/kg diet fed groups. During entire experimental period chicks fed diet either with 2900 or 3100 or 3300 k.cal ME/kg utilized feed in similar for body weight gain and FCR ranged from 3.55 to 4.59 among different dietary treatments.

Performance index :

The performance index during 2nd week and 4th week was significantly ($P<0.05$) influenced by levels of energy. A significantly higher index was obtained in the diet containing 22% crude protein with 3100 k.cal ME/kg (T_4). However During 6th week highest index value was obtained in the diet containing 22% crude protein and 3300 k.cal ME/kg. (T_5). High energy level diet showed higher index value. During entire experimental period (0-8) week PI was significantly ($P<0.05$) increased as the concentration of energy in diet were increased. T5 (3300 k.cal ME/kg) energy level diet has highest value (207 gm). T_3 group (2900 k.cal ME/kg) did not differ significantly ($P<0.05$) from T_4 (3100 k.cal ME/kg) while the latter did not differ significantly from T_5 (3300 k.cal ME/kg). High energy level (2900 to 3300 k.cal ME/kg) in the diet showed better utilization of feed commensurate with the rate of growth.

Carcass characteristics :

Dressed weight :

The dressed weight expressed as percentage of preslaughter weight ranging from 64.65 to 69.12% was significantly ($P<0.05$) influenced by dietary energy levels. Chicks fed diet with 22% crude protein at 3300 k.cal ME/kg showed higher dressing percentage than other dietary treatments. As the level of energy in the diet was increased the dressing percentage was also increased.

Eviserated weight :

A similar trend in eviscerated percentage was noted as was observed in dressing %. The means of eviscerated percentage ranged from 59.51 to 64.12% was significantly ($P<0.05$) influenced by concentration of energy in the diet. Higher levels of energy showed highest eviscerated percentage.

Meat bone ratio :

Meat to bone ratio ranging from 3.73 to 4.27 was significantly ($P<0.05$) influenced by dietary energy level. Chick, fed higher energy level diets showed higher meat to bone ratio than other dietary treatments.

Carcass composition :

Moisture

The moisture of thigh and breast muscle ranging from 61.91 to 63.34 and 63.26 to 64.13% were significantly ($P<0.05$) influenced by dietary energy level. The highest moisture percentage (64.13) was obtained in thigh muscle of chick fed diet with 2500 k.cal ME/kg (T_1) and lowest percentage was observed in T_2 group. Lower concentration of energy in the diet increased the moisture percentage of thigh muscle while it had not much effect on breast muscle. In general thigh muscle had lower moisture % than breast muscle.

Protein :

Protein percent of thigh and breast muscle on wet basis varied from 19.95 to 21.27 and 20.95 to 22.24 percent respectively. In general the protein % of breast muscle was comparatively higher than protein percentage of thigh muscle. The highest % of protein in breast and thigh muscle was found in chicks fed diet with 2500 k.cal ME/kg of energy. The lowest percentage

of protein in breast muscle was seen in T_3 group with 2900 k.cal ME/kg and in case thigh muscle lowest protein percentage was seen in T_2 group.

Ether extract :

The ether extract contents of both thigh and breast muscle on wet basis ranged from 8.67 to 11.10 and 4.87 to 4.92 percent respectively. No clear-cut pattern of either increase or decrease in ether extract % was seen in case of breast muscle. Higher ether extract percentage was seen in 2500 k.cal ME/kg (T_1) group but in case of thigh muscle the ether extract percentage was seen in increasing order and could be correlated with concentration of energy in diet. High energy level showed high ether extract percentage. In general, the ether extract percentage in thigh muscle was found to be higher than breast muscle.

Mortality :

The mortality during different weeks was 4.66% of the total which was within the normal range. Highest mortality was obtained in 1st week which may be due to environmental factor. Mortality percent seems not to be associated with dietary treatments.

Economics :

Economics calculated on the basis of cost of feed consumed and fixed cost with respect to sale receipt of live chicken. The profit was found to be more in chicks fed diet with 22% crude protein and 2900 k.cal ME/kg. In view of above finding it may be concluded that the growing cockerel can be reared economically on a ration containing 22% crude protein and 2900 k.cal ME/kg diet having the calorie protein ratio 131.8:1 is suggest.

Conclusion :

(i) An experiment was conducted to find out the optimum level of energy in the diet of cockerel for better performance.

(ii) Diets were formulated with 5 level of energy (2500, 2700, 2900, 3100 & 3300 k.cal ME/kg) with fixed level of crude protein (22%) at each energy level.

(iii) Body weight gain were found to be increased as the energy concentration of diet was increased with no marked difference in weight gain in chicks fed diet containing either 2900, 3100 or 3300 k.cal ME/kg.

(iv) Feed consumption was inversely correlated with the energy concentration of the diet. Chicks fed diet containing higher concentration of energy had lower feed intake.

(v) Feed efficiency and performance index were found to be more in the chicks fed diets containing higher levels of energy all through. No appreciable differences in these parameters were obtained in the groups fed diets containing either 2900, 3100, 3300 k.cal ME/kg.

(vi) Carcass characteristics in term of D.P. & E.P. were found to be more in the chicks, which had higher body weight. Higher meat-bone ratios were also obtained in those groups having higher body weight indicating better fleshing. Characteristics

(vii) Among different dietary treatments the groups fed diet containing 2900 k.cal ME/kg and 22% crude protein showed more economical gain as this ration do not contain any added fat.

(viii) Mortality was shown to 4.64 %, which was within normal range.

Thus it can be concluded that the ration containing 22% crude protein and 2900 k.cal ME/kg of energy could be adopted for raising cockerel with economic advantage.

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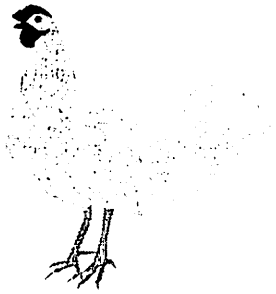

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APPENDIX

Appendix Table – 1 ANOVA showing the analysis of variance of body weight gain during different experimental periods.

	Mean square					
Source of variation	**Degree of freedom (Df)**	**2nd week**	**4th week**	**6th week**	**8th week**	**(0-8) week**
Between treatments	4	140.66	69.63	1051.46	62.53	15484.84
Within treatments	10	2.597	12.539	11.719	29.982	89.719
CD (P<0.05)		2.07	4.55	4.39	7.04	12.18

Appendix Table – 2 ANOVA showing the analysis of variance of feed consumption during different experimental periods.

	Mean square					
Source of variation	**Degree of freedom (Df)**	**2nd week**	**4th week**	**6th week**	**8th week**	**(0-8) week**
Between treatments	4	36.25	196.01	168.46	184.77	4122.87
Within treatments	10	14.399	21.62	6.211	16.926	208.783
CD (P<0.05)		4.86	5.98	3.20	5.29	18.60

Appendix Table – 3 ANOVA showing the analysis of variance of feed conversion ratio during different experimental periods.

	Mean square					
Source of variation	**Degree of freedom (Df)**	**2nd week**	**4th week**	**6th week**	**8th week**	**(0-8) week**
Between treatments	4	0.54	0.315	1.395	0.2725	0.715
Within treatments	10	0.662	0.039	0.018	0.099	0.006
CD (P<0.05)		1.04	0.25	0.17	0.40	0.099

Appendix Table – 4 ANOVA showing the analysis of variance of performance index (PI) during different experimental periods.

	Mean square					
Source of variation	**Degree of freedom (Df)**	**2nd week**	**4th week**	**6th week**	**8th week**	**(0-8) week**
Between treatments	4	93.90	25.99	215.47	11.10	4353.05
Within treatments	10	1.618	4.313	2.892	4.693	24.329
CD (P<0.05)		1.63	2.66	2.18	2.78	6.34

Appendix Table – 5 ANOVA showing the analysis of variance of carcass traits in growing cockerel during different experimental periods.

Source of variation	Mean Square			
	Degree of freedom (DF)	Dressing %	Eviscerated %	Meat/Bone ratio
Between treatments	4	12.01	11.85	0.1375
Within treatments	10	0.283	0.574	0.014
C.D. (P<0.05)		0.68	0.97	0.151

Appendix Table – 6 ANOVA showing the analysis of variance of chemical composition of thigh and breast muscle in growing cockerel.

Source of variation	Mean squares						
		Thigh muscle			Breast muscle		
	Degree of freedom (DF)	Moisture	Protein	Ether extract	Moisture	Protein	Ether extract
Between treatments	4	0.4125	0.535	2.8775	0.1975	0.6725	2.715
Within treatments	10	0.030	0.043	0.031	0.02	0.084	0.017
C.D. (P<0.05)		0.22	0.26	0.22	0.18	0.37	0.17

Effect of Various Levels of Energy on Performance and Carcass Quality of Cockerels

THESIS

SUBMITTED TO THE

RAJENDRA AGRICULTURAL UNIVERSITY

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By

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