Effect of Replacement of Fish Meal by Full Fat Soyaon the Performance of Cockerel

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

(ANIMAL NUTRITION)

By

Prakash Chandra Himanshu

Reg. No. - M/AN/33/2002-2003

Department of Animal Nutrition

BIHAR VETERINARY COLLEGE

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DEPARTMENT OF ANIMAL NUTRITION

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PATNA

2004

Dedicated to

benevolent adorable

Parents

Dr. Ayodhya Prasad
M.V. Sc., Ph.D.
Dean, Associate Professor & Head
Department of Animal Nutrition
Bihar Veterinary College,
Patna- 14 (Bihar)

CERTIFICATE – I

This is to certify that the thesis entitled **"EFFECT OF REPLACEMENT OF FISH MEAL BY FULL FAT SOYA ON THE PERFORMANCE OF COCKEREL"** submitted in partial fulfilment of the requirement of the award of Master of Veterinary Science (Animal Nutrition) of the faculty of Post-Graduate Studies, Rajendra Agricultural University, Bihar, Pusa is the record of bonafide research work carried out by **Dr. Prakash Chandra Himanshu, Registration no. M/AN/33/2002-2003**, 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 the sources of literature have been fully acknowledged.

A. Prasad
24.5.04

(Ayodhya Prasad)
Major Advisor

Endorsed A. Prasad 24.5.04

(Chairman/Head of the Department)

CERTIFICATE – II

We, the undersigned members of the Advisory Committee of **Dr. Prakash Chandra Himanshu, Registration no. M/AN/33/2002-2003**, a candidate for the degree of Master of Veterinary Science with major in Animal Nutrition, have gone through the manuscript of the thesis and agree that the thesis entitled "**EFFECT OF REPLACEMENT OF FISH MEAL BY FULL FAT SOYA ON THE PERFORMANCE OF COCKEREL**" may be submitted by **Dr. Prakash Chandra Himanshu** in partial fulfillment of the requirements for the degree.

A. Prasad
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CERTIFICATE – III

This is to certify that the thesis entitled "**EFFECT OF REPLACEMENT OF FISH MEAL BY FULL FAT SOYA IN THE PERFORMANCE OF COCKEREL**" submitted by **Dr. Prakash Chandra Himanshu, Registration no. M/AN/33/2002-2003**,in partial fulfilment of the requirement for the degree of Master of Veterinary Science (Animal Nutrition) of the faculty of Post-Graduate studies, Rajendra Agricultural University, Bihar, Pusa, was examined and approved on 9.10. 2004

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Place : Patna

Date : 19/5/04

Prakash chandra himanshu

Dr. Prakash Chandra Himanshu

LIST OF ABBREVATIONS

AOAC :	Association of official Methods of Analytical chemists.
°C :	Degree Celsius.
Ca :	Calcium.
CF :	Crude fibre.
CP :	Crude Protein.
DM :	Dry Matter.
DORB :	Deoiled rice bran.
EE :	Ether extract.
EFFS :	Extruded full fat Soyabean.
FCR :	Feed conversion ratio.
FFS :	Full fat Soyabean.
FM :	Fish meal.
g :	Gram.
G.E. :	Gross energy.
k.cal :	Kilo calories.
k.cal /g :	Kilo calories per gram.
kg :	Kilogram.
M.cal :	Mega calories.
ME :	Metabolizable energy.
mg :	Milligram.
MJ :	Mega Joule.
% :	Percentage.
P :	Phosphorus.
PI :	Performance index.
SBM :	Soyabean meal.
T :	Ton.

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CHAPTER - I

INTRODUCTION

INTRODUCTION

With changing socio-economic scenario of India where income of citizen is fast growing, taste is also changing besides eating habit. Consumers now prefer lean meat and cockerel is proving to be a very good alternative.

Expanding the production of poultry and its products is very useful way to meet the essential requirements of our increasing population. Scientific investigations of meat production problems are helping to give the consumer a cheap and satisfying product, in the form of young broilers or cockerels as compared to mutton or pork. Cockerels are the immature male bird, which is mandatory component of our poultry industry and must be utilized to the best of its profitability.

Regardless of the nutritional excellence the meat and meat products as an items of the diet will be consumed in adequate and increasing quantities, only if it is accepted by the consumer on the basis of its deliciousness and palatability. The palatability of the chicken meat depends upon qualities such as tenderness, juiciness, flavour, colour and texture etc. Among these, tenderness of the meat stands first to consumers in organoleptic qualities, besides age, feeding and management practice. The effect of age on tenderness of the meat is quite evident due to it changes in the connective tissue content of the muscle, which increases with maturity. It is because of their size and age (tenderness) meat and its products have immense importance in the fast food stall in tandoory chicken, chicken curry and chicken fry etc.

More over in broiler production high technical skill, expansive feed and medicine are required unlike cockerel rearing. As such the demands of

cockerels are increasing day by day, which fetches high returns. At the same time cockerel are ready to sell in 5 to 6 weeks time.

Although its feed conversion ratio is somewhat higher as compared to broiler, but can be compensated in part by the lower cost of day old cockerels, which is equivalent to 25 – 30 % of total feed cost for the period.

Feed constitute approximately 60 – 65% of the total input in poultry rearing. So proper and scientific attention on feeding is of prime importance in its farming. Fish meal due to its high biological value is invariably used in poultry ration as the main protein source. However, due to its high cost and scarce and limited availability specially in remote places, besides its common and usual contamination with bacteria, fungus, salts and sands etc., it posses a great stumbling block in way of small poultry entrepreneurs and farmers. Alternatively, scientists are exploring the other protein resources to overcome these constraints with good quality vegetable protein in general.

Recent experimentation with full fat Soya has shown a great promise in this respect for substituting fish meal. The contents and quality of protein in FFS, is comparable to a great extent to fish meal carrying methionine and lysine content but are slightly deficient.

Some study have indicated that SBM based diet supplemented with quantities of methionine and lysine can successfully replace fish meal in broiler ration.

However studies are scanty and require further authentification of the above facts. FFS base ration also showed an economic viability in replacing fish meal in cockerel ration. But some other constraints, which have to be looked before in corporating Soyabean meal as such in the ration of poultry. The raw Soyabean in their natural state contain enzyme in their active forms – Urase, lipolipoxidase, trypsine and chymotrypsine inhibitor etc. which retard normal growth. They, however are destroyed during oil extraction.

Some researcher claim that the heat treatment of Soyabean meal improved the availability.

In another words, if FFS are not properly subjected to some form of heat treatment their nutritive values are bound to be impaired and will adversely influence health, if fed.

Replacements of fish meal by FFS may reduce the feed cost and increase the margin of profit of cockerel rearing farmers. The present investigation was planned to evaluate full fat Soya (FFS) in various dietary combinations as replacer of fish meal in cockerel ration with the following objectives :-

(1) To determine the extent of replacement of fish meal by FFS in cockerel ration.

(2) To study the effect of total replacement of fish meal by FFS without and with supplementation of methionine in cockerel ration.

(3) To determine the potentiality of inorganic sulphate as a chief supplement to cover up methionine deficiency in all vegetable protein based cockerel ration.

(4) To study the effect of different dietary treatments on carcass quality of cockerel.

(5) To develop economic ration for cockerels in Indian condition, based on above finding.

****

REVIEW OF LITERATURE

Poultry diet in India are formulated using conventional feed stuffs. Unconventional feed ingredients are added to reduce cost of compounded feed. Full fat Soya (FFS) is an unconventional feed stuffs. The purpose of this study is to find out specific nutritional quality of FFS and to study economic implications associated with the use of FFS in cockerel diets. In order to achieve optimum performance, the feed should not only be balanced nutritionally but should also be economical one. Protein, the most important and costly component in practical ration in poultry, is required in large amount next to energy. Thus its most efficient use is critical in the economic production of meat. Research has indicated that amino acid balance is most important in formulation of feed. Mostly vegetable protein used in cockerel ration, are usually deficient in some of the essential amino acids. To overcome the deficiency of these amino acids, animal protein source such as fish meal are invariably incorporated in the rations but available fish meal is of such quality that it can not be relied as a rich source of these amino acids and also its availability is limited. Therefore, researches were conducted to replace or to reduce its level to maximum extent by different ways and methods. Full fat Soya (FFS) has been claimed to replace fish meal along with little supplementation of deficient amino acid methionine for maximum advantage.

Chemical composition and nutritional quality of Full fat Soya (FFS) (% air dry basis).

Particulars	NRC (1989)	AEC (1987)	Indian Source *
Moisture %	10.00	10.00	11.00
Crude protein %	38.00	37.00	40.00
Total ash %	4.60	5.00	6.00
Crude fiber %	5.00	5.50	5.00
Crude fat %	18.00	18.50	18.00
Methionine %	0.46	0.51	0.50
Cystine %	0.55	0.55	0.56
Lysine %	2.25	2.39	2.30
Linoleic acid %	9.40	-	-
Vit E (mg/kg)	40.00	55.00	-
Choline (mg/kg)	2860.00	2000.00	-
Selenium (mg/kg)	0.11	0.50	-
M.E (k.cal/kg)	3750.00	3800.00	-

* Zombade, 1999

Comparison of composition of Full fat Soya (FFS), Fish meal (FM) and Soyabean meal (SBM) (% Air dry basis).

Particulars	Fish meal*	FFS (NRC 1989)	Soyabean meal*
Dry matter (%)	92.50	90.00	90.45
Crude protein (%)	50.76	38.00	49.01
Crude fiber (%)	3.18	5.00	6.00
Ether extract (%)	4.15	18.00	0.90
Total ash (%)	20.15	4.60	6.58
Nitrogen free extract (%)	21.76	34.40	37.51
Calcium (%)	9.55	0.25	0.32
Phosphorus %	1.92	0.59	0.67
Lysine (%)	5.40	2.25	3.07
Methionine %	1.80	0.46	0.72
M.E (k.cal/kg)	2000	3750	2800

* (Pandey 1992)

AMINO ACIDS CONTENT IN FULL FAT SOYA (FFS) :

(% air dry basis)

Amino Acids	Feed stuffs (1987)	AEC (1987)	NRC (1988)	Degussa (1990)	SEE (1992)
Methionine	0.54	0.51	0.46	0.51	0.52
Cystine	0.55	0.55	0.55	0.53	0.63
Lysine	2.40	2.39	2.25	2.21	2.35
Tryptophan	0.52	0.48	0.54	0.53	0.48
Threonine	1.69	1.48	1.42	1.42	1.44
Isoleucine	2.18	1.80	1.60	1.56	1.78
Histidine	1.01	1.01	0.87	0.96	-
Valine	2.02	1.84	1.62	1.74	1.77
Leucine	2.80	2.87	2.64	2.74	-
Arginine	2.80	2.76	2.54	2.61	2.81
Phenylalanine	2.10	1.89	1.80	1.82	-
Glycine	2.00	1.58	-	1.52	-
Tyrosine	-	1.36	1.26	1.32	-
Serine	-	1.95	-	1.86	-

VITAMIN AND MINERAL CONTENTS IN FFS

(mg/kg; air dry basis)

Vitamins	INRA/AEC 1984/87	NRC 19884/88	Feed stuffs analysis table (1987)
Vitamin E	55	40	31
Thiamine (Vitamin B_1)	10	11	6.6
Riboflavin (Vitamin B_2)	2.6	2.6	2.64
Pyridoxine (Vitamin B_6)	10	10.8	-
Pantothenic acid	16	11	15.62
Niacin	23	22	22
Choline	2000	2860	2420
Folic acid	3.5	4.2	3.52
Biotin	0.3	0.24	2.86

Methods of processing to reduce or remove the antinutritional factors present in FFS –

Raw full fat Soyabeans contain some biologically active compounds with an antinutritive action for example- protease (trypsin and chymotrypsin) inhibitors, haemagglutinins/lectins, saponins, goitrogenic factors, rachitogenic factors, allergenic factors, metal chelating factors etc. If full fat Soyabeans are not previously subjected to some form of heat treatment, their

nutritive value is low. Furthermore, it may adversely affect animal health if fed. The most important antinutritional factors present in raw Soyabeans are trypsin and chymotrypsin inhibitors. These inhibitors bind trypsin and chymotrypsin enzymes secreted by pancreas and reduce the digestibility of proteins. Binding causes increased secretion of these enzymes by the pancreas and therefore, the size of pancreas may increase. Further, as these enzymes contain high proportion of methionine and cystine, their excessive secretion causes a loss of methionine and cystine from the body. So raw Soyabeans are processed mainly by three type to produce FFS :-

(A) Soaking and cooking process :

In this process, the raw Soyabeans are soaked for 5 –6 hours and then boiled for a fixed period of 15 minutes. The seeds are then dried and ground to produce full fat Soyabean (FFS).

(B) Cooking and flaking process :

This is most elaborated system and consists of cracking, cooking in cooker under system and then flaking by passing them through two rollers .

(C) Extrusion process :

In this procedure, which may be with or without previous conditioning, the Soyabean products are forced through a die. There is a high accompanying temperature which results either directly through friction (dry extrusion) or partly by steam injection (wet extrusion).

(D) Infra Red processing :

Electromagnietic wave like Infrared used in processing of FFS.

Mustakas *et al.* (1970) and Lorenz *et al.* (1980) studied different parameter on processing of Soyabean which are presented in table

Table Showing changes in FFS.

Extrusion temperature (°C)	Moisture (%)	Urease activity (change in pH)	Reduction in trypsin inhibitor activity (%)	Protein efficiency ratio (PER) casein = 2.5
121		1.96	0	1.35
132		1.46	30	1.41
138		0.34	27	1.55
143		0.02	57	1.94
149		0.01	74	1.78
By Lorenz *et al.* (1980)				
135	15	1.0	12	1.82
101	20	0.9	43	1.96
135	25	0.2	62	2.03
135	20	0.1	89	2.15
148	20	0.0	98	1.98

Mustakas *et al.* 1970

Full fat Soya in poultry, layers and turkeys Feeding :

Moran *et al.* (1973) replaced Soyabean oil meal entirely with raw or extruded full fat Soyabeans in diets for turkeys from 8 to 23 weeks of age. They did not observed any difference in weight gain and feed conversion ratio when the Soyabean meal of control diet was replaced either with raw or extruded full fat Soyabean (FFS).

Turner *et al.* (1973) replaced Soyabean oil meal wholly with roasted full fat Soyabeans by including even more than 23% level but no beneficial effect in the performance of *turkeys* was observed from 10 to 23 weeks of age.

Waldroup and cotton (1974) and waldroup (1985) included full fat Soya up to 40% in the dites of *broilers*. They found that up to 25% level, the growth rates was a high as those of control diet based on Soyabean oil meal.

Latshaw (1974) indicated that roasted Soyabeans were suitable for feeding to *laying hens* and suggested that raw full fat Soyabeans, if supplemented with methionine could support quite acceptable levels of performance.

Arscott (1975) observed some improvement in egg shell quality associated with the use of either raw or treated full fat Soyabean and a decline in feed intake of *hens* fed the diet based on extruded full fat Soyabean.

Waldroup and Hazen (1978) obtained decreased performance with diet based on raw Soyabeans even with an addition of methionine. On the other hand, diets containing roasted or extruded FFS improved production in *turkeys* and *layers*.

British company, Favor Parker Ltd. (1983), manufacturers of extruded FFS, conducted two experiments on commercial *broiler farms* using isocaloric and nutritionally balanced diets containing either Soyabean oil meal or extruded FFS. An improvement in weight gain and FCR was seen in FFS group as compared to Soyabean oil meal fed group.

Sell (1984), Indicated from the results of number of trials that isocaloric and isonitrogenous diets containing various levels of extruded FFS yielded excellent results as compared to control diets based on Soyabean oil meals plus animal fat in poultry.

Papadopoulos (1987) formulated *broiler starter* and *finisher* diets assumed to be isocaloric and balanced with respect to nutrients, containing progressively increasing amounts of roasted FFS. These diets were fed to broilers on the commercial farm. Results indicated that the presence of FFS, though reduced feed consumption had no effect on live weight gain, feed conversion ratio and carcass characteristics.

Horani (1987) In poultry, investigated the inclusion limits of infrared processed FFS. He suggested that inclusion of FFS should be limited to maximum of 20% in mash form while in pelleted feeds higher level could be used.

Lessire (1992), however reported that the inclusion of FFS increases growth rates and feed conversion in *broilers*.

Shinde *et al.* (1996) conducted an experiment on *broilers* to evaluate extruded FFS and toasted non extruded FFS in *broiler diets*. Five isocaloric and isonitrogenous diets were prepared and fed to the broilers in which the first group served as control and received a corn-Soyabean meal diet while group B and C received diets containing 5% extruded FFS or non-extruded

FFS and group D and E received diets containing 10% extruded FFS or non-extruded FFS respectively, they observed that the diets containing 10% extruded FFS or non-extruded FFS recorded significantly higher body weight and efficient convertors of feed as compared to control and other groups.

C and M Hatcheries, Nasik Maharastra (1998) A feeding trial for a period of five weeks was conducted in four groups of *broiler* and were provided four different types of feeds. Group A received fish meal containing standard diet as per requirements, group B received a standard diet containing Soyabean meal to replace fish meal in group A, group C and D received diets containing 5 and 10% toasted FFS, respectively. Their results indicated that the birds in group D (receiving 10% FFS) gained the most followed by the birds from group C (receiving 5% FFS), B (receiving SBM to replace (FM) and A (control receiving FM) with respective total gain in weight as 1574.11, 1551.78, 1470.59 and 1240.02 g. The overall feed efficiency ratio (2.34, 1.96, 1.91 and 1.94, respectively) showed non-significant difference.

Effect of replacing and or reducing Fish meal in broiler ration :

Hammond and Titus (1944), Heuser *et al.* (1946) Bruggeman *et al.* (1960) and Agarwal and Gilmore (1966) showed that some amount of animal protein should be included in ration of chicks for maximum growth even if they contain Soyabean meal as main vegetable protein.

Bai *et al.* (1982), concluded from results of 4 weeks trial with crossbred chicks that the nutritional value of fish meal and that of Soyabean meal supplemented with methionine were not significantly different.

Subbaiah and Rao (1984) prepared two all vegetable protein diets consisting of groundunt cake 40% and Soyabean meal 38.2% as a single source of protein supplement and fed to broiler from 0 –6 weeks of age. Body weight gain, feed consumption and feed efficiency were significantly poor compared to other diets which had fish meal or fish meal substituted by feather meal.

Ichhponani *et al.* (1984) recommended that combination of vegetable protein sources improved the protein quality of ration and allowed the use of lower level of fish meal in poultry ration. In a report of ICAR sctheme on "The investigation of economic poultry ration in Punjab".

Ókons (1985) observed that there was no need to include fish meal in finisher ration of broiler and can be reared even with single source of vegetable protein supplement from 5 weeks onwards.

Inam –ul –Haq *et al.* (1986) found no significant difference among the groups in weight gain, feed intake and feed efficiency when broiler chickens were fed diet consisting of mixture of vegetable protein sources with 4% blood meal and 12% fish meal or with 4, 8 and 12% Soyabean meal replacing fish meal.

Baghel and Netke (1987) conducted experiments to determine the most suitable combination of Soyabean meal and sesame cake in diet of broilers. Compared to control diet, containing Soyabean supplemented with 0.10% methionine, the weight gain and feed efficiency was found to be superior when different combinations of Soyabean meal and sesame cake without any supplementation were included in the diet. They suggested that a combination of 23.5% Soyabean meal and 28% sesame meal as a protein

supplement in broiler ration was economical and give maximum performance in broilers.

Inam –Ul –Haz *et al.* (1988) conducted an experiment in broiler chicks fed rations containing 12% fish meal replaced by Soyabean oil meal at the rate of 0, 4, 8 and 12% for a period of 7 weeks. Feed consumption and dressing percentage did not differ significantly between treatment but weight gain and feed efficiency improved in chickens given the diets containing Soyabean oil meal, the best results being recorded on rations containing 8% Soyabean oil meal and 4% fish meal.

Nigerian workers (Aletor *et al.*, 1989) fed isonitrogenous and isocaloric diets to day old broiler chicks in which Soyabean meal (SBM) replaced 0, 20, 40, 60, 80 and 100% fish meal (FM). Replacement of 60% FM with SBM was the most efficient in terms of average weekly weight gain and feed efficiency, protein efficiency ratio (PER) and nitrogen retension values were also highest in the diet with 60% SBM replacing FM. The cost of feeding the chickens decreased with increasing replacement of FM by SBM.

Reddy and Eshwariah (1989) conducted an experiment in which broiler starter containing 12% fish meal was used as control. Experimental diets were constituted by inclusion of Soyabean meal as sesame cake for graded replacement of fish meal at 25, 50, 75 and 100% substitution levels. The weight gains and feed efficiency of the group receiving diet with 75% fish meal replacement was comparable to the control. The diet containing fish meal replaced at 25% level was significantly better than other groups. However, diet totally devoid of fish meal revealed significantly lowest body weight gain and feed efficiency.

Nagra (1990) made 22 combinations of sunflower / cotton seed/mustard cake/til cake/maize gluten with Soyabean meal and/or groundnut cake (GNC) in different proportions in order to develop efficient combination of proteins of vegetable origin. Efforts were also made to reduce the level of fish meal with the use of most efficient combination of proteins of vegetable origin. Results indicated that a part of fish meal (50% conventional ration) could be eliminated with the use of combination of GNC and Soyabean meal with maize gluten or mustard oil cake in the ratio of 1 : 2 : 1.

Devegowda (1990) found satisfactory performance in broiler when fish meal was completely replaced with Soyabean meal supplemented with methionine. He further suggested that care should be taken to balance other nutrients such as Vit B_{12}, selenium, calcium, phosphorus and common salts when Soyabean meal completely replaced fish meal in broiler diets.

Rao (1990) indicated that Soyabean meal based diet supplemented with adequate quantity of lysine and methionine could successfully replace the fish meal protein in the broiler ration. A study conducted on computed formulation of broiler ration in their laboratory with Soyabean and 0.24% methionine or Soyabean meal and sesame cake in equal proportion with 0.31% lysine and 0.14% methionine gave superior body weight gain in comparison to control diet containing Soyabean meal and 12% fish meal. He suggested that Soyabean meal combined well with other protein sources replacing the fish meal.

Palod and Baghel (1996) fed varying levels of fish meal protein (from 0.5% to 6%) to broilers and on the basis of result, they suggested that 2%

fish meal protein was optimum level for broiler diet along with extracted Soyabean meal as sole source of vegetable protein supplement.

Effect of Methionine and/or sulphate supplementation in Soyabean meal and/or full fat Soya based diets of broilers :

Total replacement of fish meal by FFS, deficiency of methionine was observed which was reflected by depression in body weight. These observation were also corroborated by Morris *et al.* (1987) who found that for maximum performance methionine requirement increased as a linear function of dietary crude protein concentration.

Baldini and Rosenberg (1955) found that *dl*–methionine or a combination of *dl*–methionine and *l* –lysine were the limiting amino acids in proteins supplied by corn and Soyabean meal.

Gordon and Sizer (1955) also reported growth response from feeding sulphate to chickens. They stated further that large quantities of methionine did not completely satisfy the total sulphur requirement when adminstered to rapidly growing chickens fed a low cystine, inorganic sulphur free diet.

Almquist (1964) indicated that although inorganic sulphate can spare some of the total sulphur containing amino acid requirement, it was not an efficient means as sulphur containing amino acids. He further stated that sodium sulphate was about 40% as efficient as sulphur containing amino acid in producing growth response.

Moran (1971) showed that the diets having sub marginal level of methionine (0.31%) but not excessively deficient when supplemented with 0.10% methionine resulted in carcasses having a greater degree of fleshing and a reduction in finish.

Almquist (1970) has reviewed the role of inorganic sulphur in *poultry nutrition*. He had concluded that it exerted considerable sparing action on the sulphur containing amino acids.

Ross and Harms (1970) also found that sodium sulphate could spare the sulphur containing amino acids in practical diet of chickens (In poultry).

Ross *et al.* (1972) studied that effect of feeding various levels of sodium sulphate and methionine on weight gain and feed efficiency of chicks. In two experiments, *broiler chicks* showed consistent increase in weight gain when the methionine deficient diet low in inorganic sulphur was supplemented with 0.08 to 0.32% Na_2So_4, although no response to added sulphate was elicited when the basal diet contained no supplemental methionine. The methionine requirement for maximum weight gain was found to be independent of sulphate level. Sulphate was also responsive for small but consistent improvement in feed efficiency.

Harms (1972) showed that peak growth rate of *broiler chicks* was obtained when a corn- Soyabean basal diet (0.40% methionine and 0.39 cystine) was supplemented with 0.1% methionine and 0.1% sodium sulphate.

Martin (1972) obtained growth response in chicks from sulphate addition even when methionine was present in diet at adequate to excess level (In poultry).

Soars *et al.* (1974) studied the effects of inorganic sulphate supplementation in *broiler diets*. A significant growth response was obtained by the addition of 0.15% *dl*–methionine to a corn –soy basal ration containing 0.66% total sulphur amino acids. Increasing the methionine level up to 0.30% did not produce a further significant growth response. The addition 0.16% sodium sulphate was most effective in stimulating growth in

chicks. Furthermore, supplementing the diet with *dl*–methionine produced a significant improvement in feed conversion while the addition of up to 0.64% sodium sulphate did not have a similar effect.

Van Weeden *et al.* (1976) In poultry emphasized that the addition of inorganic sulphate to practical type formulation can indeed have a positive influence in weight gain and feed conversion irrespective of the level of sulphur containing amino acids.

Devegowda and Jain (1989) found satisfactory performance in a feeding trial with *broiler* when fish meal was completely replaced with Soyabean meal supplementation along with methionine. They further suggested that care should be taken to balance other nutrients such as Vit B_{12}, Ca, P, Se, NaCl, when soyabean completely replaced fish meal in broiler diets.

He –chun Mei *et al.* (1996) prepared diets in which Soyabean cakes or linseed cakes were used in place of fish meal as the protein source in *broiler rations*. Supplementation of methionine and lysine to the ration gave similar growth rate with respect to control. They further suggested that production cost in broilers could be reduced with such replacement and supplementation.

NUTRITIONAL EFFECT ON CARCASS YIELD AND QUALITY OF BROILERS :

(i) NUTRITION AND CARCASS QUALITY AND CARCASS YIELD :

Harms *et al.* (1957) and Janky *et al.* (1976) reported that reducing dietary energy with broiler chicken lowered yield upon processing.

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

Summers *et al.* (1963) reported a leaner carcass if the energy was kept constant and protein level was increased. They further observed that carcass protein was increased and fat decreased in linear manner with increased level of dietary protein.

Raina (1974) obtained 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. However, sunaria (1977) obtained a ratio of 2.18 :1 (meat : bone) when broiler chickens were fed a ration containing 23% and 20% CP and 3200 k.cal /kg ME diet for starting and finishing phase respectively.

Singh and Essary (1981) showed from their results that breast muscle contained a high moisture (74.3%) as compared to thigh muscle (74.1%). Further breast and thigh muscle for males contained less fat, (2.0 vs 3.5% and 7.9 vs 9.3%) slight high moisture content (74.7 vs 73.9%) and more protein (21.3 vs 21.07 and 17.6 vs 16.1%) than female. Their results also indicated a relationship among moisture, protein and fat content of breast and thigh muscle. Fat and moisture were inversely related. Breast contained high protein and lower fat levels than thigh muscles. Similar observation were also reported by Marion *et al.* (1958) and Hundspeth and May (1867).

Palod and Baghel (1998) studied the effect of feeding varying levels of fish meal protein (FMP) on carcass traits of broilers. Their study indicated that dressed weight of broilers were maximum in groups given 1% FMP.

Eviscerated weight and carcass yield were maximum in groups fed 5.0% FMP. Liver weight were higher in groups fed 1% FMP diet. In processing losses, blood loss was maximum in groups fed 4.5% FMP. Visceral losses were maximum in groups given 1.5% FMP. Abdominal fat loss was higher in broilers given 1 to 3% FMP. It was concluded that 5% FMP and Soyabean meal were best for efficient carcass yield.

(ii) AMINO ACID ADEQUACY AND CARCASS QUALITY :

Methionine and Lysine :

Carew and Hill (1961) observed that the chicks fed *methionine* deficient diet had gained more tissue fat and less tissue protein.

Thomas and Combs (1967) reported that when the diet was marginally deficient in lysine, the birds tended to over consume the ration and there was resultant increase in body fat.

Moran (1971) showed that the diets having submarginal but not excessively deficient level of methionine (0.31%) when supplemented with 0.1% methionine resulted in carcasses having a greater degree of fleshing and a reduction in finish. Moran (1971) concluded that when the sub marginal deficiency of lysine (0.85%) was adjusted with supplementation (0.2%), it resulted in carcasses with improved fleshing and reduced finish.

In all vegetable diet low in sulphur containing amino acids, Marinov *et al.* (1974) he found that methionine supplementation decreased fat and increased protein content of meat of carcasses and also the protein utilization in birds was better.

Lipstein, *et al.* (1975) found that a reduction of protein level in the diet with a consequent decrease in limiting amino acids increased the fat

content of the carcasses while the effects were reversed when the ration was supplemented with deficient amino acids (Lysine and methionine).

Prasad (1976) observed that the deposition of fat was inversely related to the dietary methionine and tissue protein was more in birds fed on the diet adequate in methionine than metthionine deficient diet.

Maybray and Waldroup. (1981) reported that increasing dietary energy resulted in heavier birds and a large abdominal fat while increasing the amino acids to (Methionine) balance the ration increased the gains in terms of flesh and reduced the size of pad.

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CHAPTER - III

MATERIALS AND METHODS

MATERIAL AND METHODS

The present investigation was carried out on 210 a day-old cockerel chicks for a period of six weeks at Poultry Research Unit of Animal Nutrition Department, Bihar Veterinary College, Patna to evaluate full fat soybean (FFS) in various dietary combinations as a replacer of fish meal in cockerel ration. The experimental procedures and analytical techniques followed in the present study are described below.

Preparation of Experimental Rations and their Analysis :

Feed ingredients used in the experiment like maize, deoiled rice bran, soybean meal, fish meal and full fat soybean were procured in one lot and its proximate principles were determined as per AOAC (1990) method before compounding experimental rations. Lysine, methionine, cystine and M.E. contents were calculated from the published values. A standard cockerel ration with 10% fish meal were formulated as per standard recommendation (ICAR 1985, NRC 1984) which served as control (T_1). Other six experimental rations were made isocaloric and isonitrogenous to that of control ration. The four experimental rations (T_2 to T_5) were formulated in such a way that 25%, 50%, 75% and 100% of fish meal was replaced by FFS. The other two experimental ration (T_6 and T_7) were as T_5 but were supplemented with methionine and sodium sulphate, respectively to cover the deficiency of sulphur containing amino acids in ration.

Outline of Plan of Work.

Treatment Number	(0 – 6) weeks of Growth
T_1	Control group with 10% fish meal
T_2	25% Fish meal of control diet replaced by FFS
T_3	50% Fish meal of control diet replaced by FFS
T_4	75% Fish meal of control diet replaced by FFS
T_5	100% Fish meal of control diet replaced by FFS
T_6	As in T_5 but supplemented with methionine @ 5 g/kg of FFS
T_7	As in T_5 but supplemented with sodium sulphate @ 5 g/kg of FFS.

Table 1 : Percentage chemical composition of feed ingredients used in the experiment (Dry matter basis).

Sl. No.	Feed ingredients	Estimated value								Tabulated value			
		DM	CP	E.E	C.F.	NFE	Total ash	Ca	P	ME* (kcal/kg)	Lysine**	Methionine**	TSAA**
1	Maize	91.30	8.98	2.85	2.98	82.98	1.79	0.12	0.45	3417	0.26	0.18	0.36
2	Deoiled rice bran	90.80	14.00	1.80	14.99	60.80	9.40	0.36	1.25	1800	0.57	0.22	0.32
3	Soybeen meal	91.00	45.00	1.30	6.40	42.01	5.89	0.32	0.69	2500	2.69	0.62	1.28
4	Full fat Soya	90.20	38.00	18.50	5.50	33.30	5.30	0.37	0.65	3750	2.25	0.46	1.01
5	Fish meal	91.80	42.90	4.81	3.58	13.00	35.64	8.69	1.72	1940	4.53	1.68	2.43

* Values taken from reference cited (1) NRC (1971)

(2) Reddy and vaidya (1973)

(3) NRC (1989)

(4) Mehta (1991)

(5) Banerjee (1995)

** Values taken from reference cited – NRC (1989 and 1994)

TSAA = Total sulpher containing amino acid.

Table 2 : Percentage composition of the experimental diet.

Feed Ingredients	Treatment Diet						
	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Maize	56.8	54.4	51.20	48.50	45.80	45.80	45.80
Deoiled rice bran	0.20	2.60	6.30	8.80	11.70	11.65	11.65
Soybean meal	30.50	30.50	30.00	30.20	30.00	30.00	30.00
Fish meal	10	7.50	5.00	2.50	-	-	-
Full bat soya	-	2.50	5.00	7.50	10	10	10
Mincral mixture	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Additives	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Methionine						0.05	-
Sodium sulphate							0.05
Calculated value							
Crude protein %	23.14	23.14	23.02	23.09	23.05	23.04	23.04
M.E. (K.cal/g)	2900.96	2907.30	2897.4	2900.39	2900.58	2899.68	2899.68
Lysine %	1.4223	1.3727	1.3179	1.2706	1.2178	1.2175	1.2175
Methionine %	0.4598	0.4302	0.3990	0.3704	0.3402	0.3900	0.340
TSAA %	0.8385	0.8020	0.7605	0.7258	0.6873	0.6872	0.6872
Lysine Methionine ratio	3.09	3.19	3.30	3.43	3.58	3.12	3.58

TSAA = Total sulphur containing amino acid.

Detailed composition of all the experimental rations and their proximate compositions are presented in table No. 1 to 2, respectively.

Experimental Technique

225 day old white leghorn male chicks (Hubbard BV 300 strain) were procured from Varanasi Hacheries (U.P.) for the experiment. The chicks were vaccinated against Marek's disease at the time of procurement and against Ranikhet disease (New castle disease) and Gumboro disease on 4^{th} and 15^{th} day of procurement, respectively.

The crippled chicks and those with extreme body weight were discarded from study. On 1^{st} day, the chicks were given crushed maize and *ad lib* water to drink followed by standard cockerel ration. On 4^{th} day, 210 chicks were wing banded, weighed and randomly divided into seven experimental groups having 30 chicks in each group. Each group was replicated thrice containing 10 chicks in each replicate.

The chicks were reared on deep litter system. In rearing pens, the chicks were served fresh and clean drinking water *ad lib* through fountain system which was changed twice daily. The chicks were reared under uniform condition of housing including brooding, feeding, watering, lighting and other managements.

OBSERVATION AND SAMPLING

(A) RELATED TO COCKEREL PERFORMANCE

(i) Body weight gain :-

The body weight of individual cockerel were recorded at the start of experiment and recorded then at weekly intervals. Body weight gain for a particular week was taken as the live weight gain of cockerels in particular week after deducting initial live weight.

(ii) Feed consumption :-

Weekly feed consumption was recorded by the difference of feed given and residue left during a particular week.

(iii) Feed conversion ratio (FCR) :-

FCR was calculated from the feed consumption and body weight gain to show the feed efficiency.

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

(iv) Performance Index (PI) :

Performance Index was calculated from body weight gain (g) and feed conversion ratio by following formula.

$$PI = \frac{\text{Body weight gain (g)}}{FCR}$$

Mortality rate :

The regular observation were made to record the occurrence of death, if any, in experimental birds to estimate mortalities relative to experimental group during different experimental period.

Carcass study :

At the end of experiment i.e. after 6 weeks, four birds from each dietary treatment, taking two from each replicate, were randomly selected for slaughter and processing. Standard slaughter method for poultry as described by Thronton (1974) was followed during carcass study. The bird to be slaughtered were kept under fasting condition for 24 hours and water was

offered *ad lib*. Each bird was weighed immediately before slaughter. The birds were bled by clean incision at the bases of ear lobe and allowed to bleed. Blood loss was calculated by initial weight before slaughter minus final weight after bleeding. The birds were immersed in hot water (70°C) for 30 sec. (hard Scalding). Body feather from scalded birds were removed by hand plucking then dried and weighed. Feather weight was estimated by deducting feather loss weight from blood loss weight. The head was removed by severing the cervical vertebrae at the base of the occipital bone and the feet and shanks were cut at the tibio-tarsal joint, wing tips were removed and dressed weight of carcass was recorded. Thus the dressed weight consisted of fasted weight minus blood, feather, head, feet, shanks and wing tips keeping the viscera intact. The birds were then eviscerated by removing the crops, gullet, trachea and viscera. The lung were scrapped off. The giblets (liver, heart and gizzard) were removed from the viscera and weight of carcass was recorded. Gall bladder was removed from the liver with care to avoid puncture and was discarded. Gizzard was opened, the contents were washed out and the lining was pulled off and the weight was recorded. The heart was freed from the blood clots and adhering vessels. The weight of carcass along with giblet was recorded as eviscerated weight. The dressing and evisceration percentage were calculated on the basis of preslaughter live weight at 6^{th} week of age.

Outline of carcass studiare as follows

(i) Preslaughtered weight (g) = Live weight (g) – Live wat of after 24 hours fasting (g).

(ii) Blood loss weight (g) = Preslaughtered wight (g) – Slaughtered weight (g)

(iii) Feather weight (g) = Slaughtered weight (g) – Defeathered weight.

(iv) Dressed weight (g) = Preslaughted weight (g) – (blood loss + feather + head + feet + shank) weight.

(v) $$\text{Dressing \%} = \frac{\text{Dressed weight x 100}}{\text{Preslaughtered weight}}$$

(vi) Eviscerated weight (g) =

[Dressed weight (g) – {crop + gullet + trachea + lung + (viscera – pure giblet) weight]

Pure giblet = clotted blood removed heart + Gall bladder removed liver + content removed gizzard.

(vii) $$\text{Eviscerated \%} = \frac{\text{Eviscerated weight x 100}}{\text{Preslaughtered weight}}$$

This type of relation was also reported by Richard and Nesheim (1990).

Samples of thigh and breast muscle were taken from carcass of each group with a scissor and sharp knife. The samples were wrapped in a polythene bag and kept in a freeze for proximate analysis. The moisture content of breast and thigh muscles were determined by drying 10 g samples

in hot-air oven at 100°C ± 5°C for 18 hours. For ether extract and nitrogen determination the samples were grinded in glass pestle and mortars and representative sample were taken for determination of nitrogen and ether extract as outlined by AOAC (1990).

For the determination of meat to bone ratio, the carcass was first weighed and then cooked in an enameled tray for 1.5 hours in an oven at 163°C (Dawson *et al.*, 1957). After every 25 minutes the carcass were turned side up, so that each part was cooked uniformly at every position. Broiling was completed by cooking the carcass until the internal temperature of breast muscle reached 94°C. After broiling, the carcass were removed along with tray from the oven. Edible meat and bone were separated manually. The separated bones were dried in oven to a constant weight at 80°C. The weight of oven dried bone was recorded and ratio of meat to bone was calculated as follows.

$$\text{Meat : Bone ratio} = \frac{\text{Ready to cook weight} - \text{Weight of oven dried bone}}{\text{Weight of oven dried bone.}}$$

ECONOMICS OF PRODUCTION :

The economics of cockerel production was calculated on the cost of feed per kg live weight gain. The economics is thus dependent on the cost of different feed ingredients used in the experiment along with feed efficiency of various treatments. Thus, most profitable diets for cockerels have been chosen by comparing diets on body weight gain at the end of experiment to the investment on feed. Actual cost of feed was calculated on the basis of

rates on which the different feed ingredients were purchased from the local market used for the experiment.

Profit per kg live weight was calculated as follows.

Profit (Rs.) = Cost per kg live weight – (Feed cost per kg live weight + cost of per live chick + cost of management inducing medicine, vaccine, electricity etc.)

STATISTICAL ANALYSIS :

Data generated during the experiment were subjected to statistical analysis following the procedure of Snedecor and Cochran (1968).

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CHAPTER - IV

RESULTS AND DISCUSSIONS

RESULT AND DISCUSSION

Body weight gain :

The average weekly body weight gain of chicks in different dietary treatments are presented in table 3. The treatment means of body weight gain during different experimental periods and their analysis of variance are presented in table 4 and appendix table 1, respectively. The body weight gain during entire experimental period was significantly ($P<0.05$) influenced by different dietary treatments. Average body weight gain of cockerels by different dietary treatments ranged between 402.63 and 576.03 g. Chicks fed diet with 25% replacement of fish meal by Full fat Soya (T_2) reflected highest body weight gain and was significantly ($P<0.05$) higher as compared to other experimental diets. Improvement in body weight gain was observed up to 75% replacement of fish meal by FFS, though there was no significant difference between T_1 and T_4. However, complete replacement of fish meal with Full fat Soya (T_5) resulted in significantly ($P<0.05$) lower body weight gain than all experimental diets. This lower body weight gain in T_5 was reversed after supplementation of methionine, i.e. in T6 the body weight gain was similar to that of control (T_1). Similarly, sulphate supplementation in diet (T_7) showed better performance in terms of body weight than the group fed only FFS and no fish meal, however, it was significantly ($P<0.05$) lower than control.

Results of body weight gain indicated that rations in which Full fat Soya was used to replace fish meal gave better body weight gain on the contrary, when the ration consisting of FFS only without fish meal (T_5) at the same level of protein, body weight gain was the lowest. This might not gave

a suitable balance of limiting amino acids, thereby reflecting a lower body weight gain. The lowest weight gain in all vegetable protein diet consisting of Soyabean meal and Full fat Soya (T_5) was probably due to deficiency of sulphur containing amino acid in ration. The increased body weight gain in methionine or sulphate supplemented diet in vegetable protein diet testified the fact. Ration with Soyabean meal and full fat Soya was also found to be deficient in sulphur containing amino acids Hayward, 1959; Jain, 1985; Devegowda and Jain, 1989. Singhal (1988) recommended that SBM being adequate in all amino acid except methionine, should be supplemented with synthetic source of methionine for better performance.

Lysine : Methionine ratio also plays a vital role in growth. Lysine : Methionine ratio in the experiment ranged from 3.09 to 3.58 ratio become gradually wider with replacement of fish meal

The poor growth rate observed in T_5 due to the reason that the ratio between lysine and metionine became wider resulting in amino acid imbalance as also observed by Scott *et al.* (1976). Subbaiah and Rao (1984) also observed significantly ($P<0.05$) lower body weight in broilers on all vegetable protein diets as compared to rations containing groundnut cake (GNC) or SBM with animal protein like fish meal. On the other hand Sell (1984) observed that isocaloric and isonitrogenous diet containing various amount of extruded full fat Soybeans produced better result as compared to diet based on Soybean oil meal plus animals fat. Further, a higher content of linoleic acid in FFS is responsible for reflecting higher body weight gain.

However, Papadopulos (1987) did not obtained any improvement in body weight gain in isocaloric diets containing progressively increasing amounts of roasted full fat Soybeans. The better growth rate in rations

containing a combination of SBM and FFS along with animal protein source may be due to complementary and supplementary effects of amino acids from different sources. The improvement in the rate of growth as obtained in this study was also reported by Waldroup and Cotton (1974) and Waldroup (1985). Baghel and Netke (1987) and Nagra (1990) reported that all vegetable protein diet consisting of groundnut cake as single source of vegetable protein gave lower body weight gain in comparison to the ration consisting of two sources of vegetable protein.

Combination of FFS and SBM improved the protein quality of ration and allowed the use of lower level of fish meal in poultry ration (Ichhponani *et al.* 1984). In a subsequent report Nagra (1990) indicated that there was an improvement in body weight gain in broilers when fish meal was reduced from 8% to 4% in ration consisting of combination of three vegetable protein sources. The same worker also reported that higher level of fish meal did not produce better effect in weight gain than a reduced level of fish meal with combination of vegetable protein sources. Several workers have shown that satisfactory performance in chickens could be obtained with reduced dietary protein intake provided the protein balance and level of essential amino acids are maintained (Mitoku *et al.* 1970; Blair *et al.* 1976 and Piccard, 1979).

The higher weight gain achieved in 25% replacement group might be due to higher content of lysine and methionine in the ration which satisfied the requirment (as per NRC 1977). Improved weight gain in methionine and sulphate supplemented diet could be due to make up the deficiency of methionine and sulphur containing amino acid.

Table 3 : Treatment means of weekly body weight gain and feed consumption (g/chick)

No. of treatment	Initial body weight (g)	1st week		2nd week		3rd week		4th week		5th week		6th week	
		Wt gain (g)	Feed consumed (g)	Wt gain (g)	Feed consumed (g)	Wt gain (g)	Feed consumed (g)	Wt gain (g)	Feed consumed (g)	Wt gain (g)	Feed consumed (g)	Wt gain (g)	Feed consumed (g)
T_1	48.60	53.00	103.50	58.20	177.80	94.50	255.50	106.30	314.20	107.60	386.70	95.17	502.30
T_2	49.40	56.90	101.40	64.35	175.50	100.80	251.50	118.72	340.20	126.50	381.00	108.76	540.00
T_3	50.00	54.30	110.60	62.25	183.20	96.45	241.20	108.20	300.00	110.30	382.00	93.80	537.80
T_4	48.50	54.00	110.00	61.35	188.50	95.90	266.20	106.45	330.00	109.80	400.00	93.16	522.00
T_5	48.80	45.00	105.00	51.20	171.20	70.50	249.50	82.70	311.00	90.80	380.00	62.43	503.20
T_6	50.20	52.80	106.50	56.95	177.50	93.30	261.50	104.50	306.50	105.90	365.50	94.32	510.00
T_7	50.40	52.55	95.90	55.80	160.00	92.75	242.60	103.25	309.50	104.80	371.00	94.25	465.00

Feed consumption :

The data on weekly feed consumption and the average feed consumption of chicks during experimental periods are presented in table 3 and table 4, respectively and their analysis of variance are presented in appendix table 2.

Feed consumption during 0 – 6 weeks ranged from 1644 g to 1816.7 g. per chick. Dietary treatments significantly ($P<0.05$) influenced the feed consumption. Chicks fed diet in which 75% of Fish meal was replaced by full fat Soya (T_4) showed significantly ($P<0.05$) highest feed intake and was significantly ($P<0.05$) higher than all other groups. The lowest feed intake was recorded in chicks fed diet based on sodium sulphate (Na_2So_4) supplementation. Feed intake by chicks in experimental group T_7 was significantly ($P<0.05$) lower as compared to control (T_1) and other experimental diets. Similarly the diet consisting of 100% replaced fish meal diet (T_5) and methionine supplemented diet (T_6) were comparable between themselves and not significantly ($P<0.05$) different from that of control. In the diet consisting of 25% and 50% replaced fish meal with full fat Soya (T_2 and T_3) were comparable in which T_2 is significantly ($P<0.05$) different from control (T_1) but T_3 is not significantly ($P<0.05$) different from control (T_1)

Results indicated that with gradual reduction of animal protein source in the diet there was an increase in feed intake to compensate protein intake and amino acid balance. However, feed intake was lower numerically but not significantly ($P<0.05$) different from control group, in 100% fish meal replaced diet which might be due to amino acid imbalance through vegetable protein. Numerically, this effect was compensated on supplementation of methionine in the diet (T_6) but no effect was noted due to sulphate

Result of group T_6 or T_7 was similar to that of control group. Chicks fed diet with 25% replaced F.M diet (T_2) showed significantly ($P<0.05$) lowest ratio than all other groups. The highest ratio (4.27) was obtained in chicks fed 100% replaced fish meal diet (T_5) which was significantly ($P<0.05$) higher in comparison to other experimental and control groups. Chicks fed diet with 75% replaced fish meal (T_4) showed significantly ($P<0.05$) different FCR from control as well as other experimental groups except T_6 group.

Performance Index (P.I) :

The P.I. was significantly ($P<0.05$) influenced by different dietary treatments. The value ranged from 94.28 to 185.46. Replacement of fish meal affected P.I. value among all the groups. The highest PI value (185.46) was observed in 25% replacement group (T_2) followed by 50% (T_3) and 75% (T_4) replacement group. Significantly ($P<0.05$) lowest P.I. was observed in only vegetable protein fed group (T_5). A reduction in P.I. value was obtained in replacement groups as the amount of fish meal was progressively decreased in the ration. Methionine and sulphate supplementation in all vegetable protein diet i.e. T_6 and T_7 group made the result comparable to that of control group T_1.

Results of present study indicated that the replacement of fish meal by vegetable protein up to 50% in the diet was more efficiently so for FCR and P.I. showed that might be due to the complementary and supplementary effects of amino acids from different protein sources. Even 75% replacement of FM (T4) showed comparable result to that of control. The rations containing FFS improved growith rate, feed utilization in terms of P.I. and FCR was reported by Waldroup and Cotton, (1974) and Lessire, (1992).

Results also indicated that supplementation with methionine or sulphate utilized feed more efficiently than without supplementation. Supplemented diet (T_6 and T_7) increased feed utilization, were also reported by Baghel and Netke (1987), Devegowda (1990) and Rao (1990).

The inefficient utilization of feed in the chicks fed all vegetable protein sources based diet might be due to deficiency of methionine, resulting in a wider lysine and methionine ratio as well as imbalance of certain amino acids. In this study lysine to methionine ratio increased from 3.09 in the control group (T_1) to 3.58 in 100% vegetable protein group (T_5). After supplementation ration T6 was comparable to control ration (T_1) and again fluctuated to 3.58 on sodium sulphate supplementation (T_7). A wider lysine and methionine ratio in the ration could effect the efficiency of feed utilization was also reported by Scott *et al.* (1976). Subbaiah and Rao (1984) also obtained poor efficiency (2.54 and 2.37) in the rations containing SBM or GNC as single source of vegetable protein in comparison to the ration containing SBM or GNC supplemented with Fish meal (1.87 and 1.86) during the six weeks period in broilers. They attributed the poor efficiency of birds on ration containing GNC or SBM as single source of vegetable protein to decreased feed consumption and improper balance of amino acids. Devegowda (1990) also reported depressed growth rate in broilers by feeding SBM without any supplementation. However, Rao (1990) was of the view that SBM could successfully replace fish meal protein when adequate quantity of lysine and methionine was ensured in the diet.

Such an improvement in the efficiency of feed utilization in broiler with the inclusion of FFS was also reported by Sell (1984). However, no

increase in feed efficiency was noted with the inclusion of FFS in turkey's dite (Moran *et al.*, 1973 : Turner *et al.*, 1973; Sell, 1984.

Overall results, clearly showed that inclusion of FFS in cockerel ration improved feed efficiency in terms of body weight gain and FCR. The above study also indicates that substitution of fish meal by FFS to the extent of 75% in the standard cockerel diet could be achieved successfully which can give better performance and higher profitability.

Table 4 : Treatment means ± S.E. of body weight gain (g/chick) and Feed consumption (g/chick) of cockerel at the end of experiment.

No. of treatment	Body weight gain (0 –6) week	Feed consumption (0 –6) weeks
T_1	$514.76^{cd} \pm 4.93$	$1740.0^{b} \pm 18.05$
T_2	$576.03^{f} \pm 2.91$	$1789.6^{cd} \pm 15.12$
T_3	$525.30^{e} \pm 2.73$	$1754.8^{bc} \pm 13.00$
T_4	$520.67^{de} \pm 2.22$	$1816.7^{d} \pm 17.58$
T_5	$402.63^{a} \pm 1.65$	$1719.9^{b} \pm 11.20$
T_6	$507.77^{bc} \pm 1.46$	$1727.5^{b} \pm 8.50$
T_7	$503.40^{b} \pm 1.24$	$1644.0^{a} \pm 7.57$
CD value ($P<0.05$)	7.53	41.15

Means bearing a common superscript in a column do not differ significantly ($P<0.05$).

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

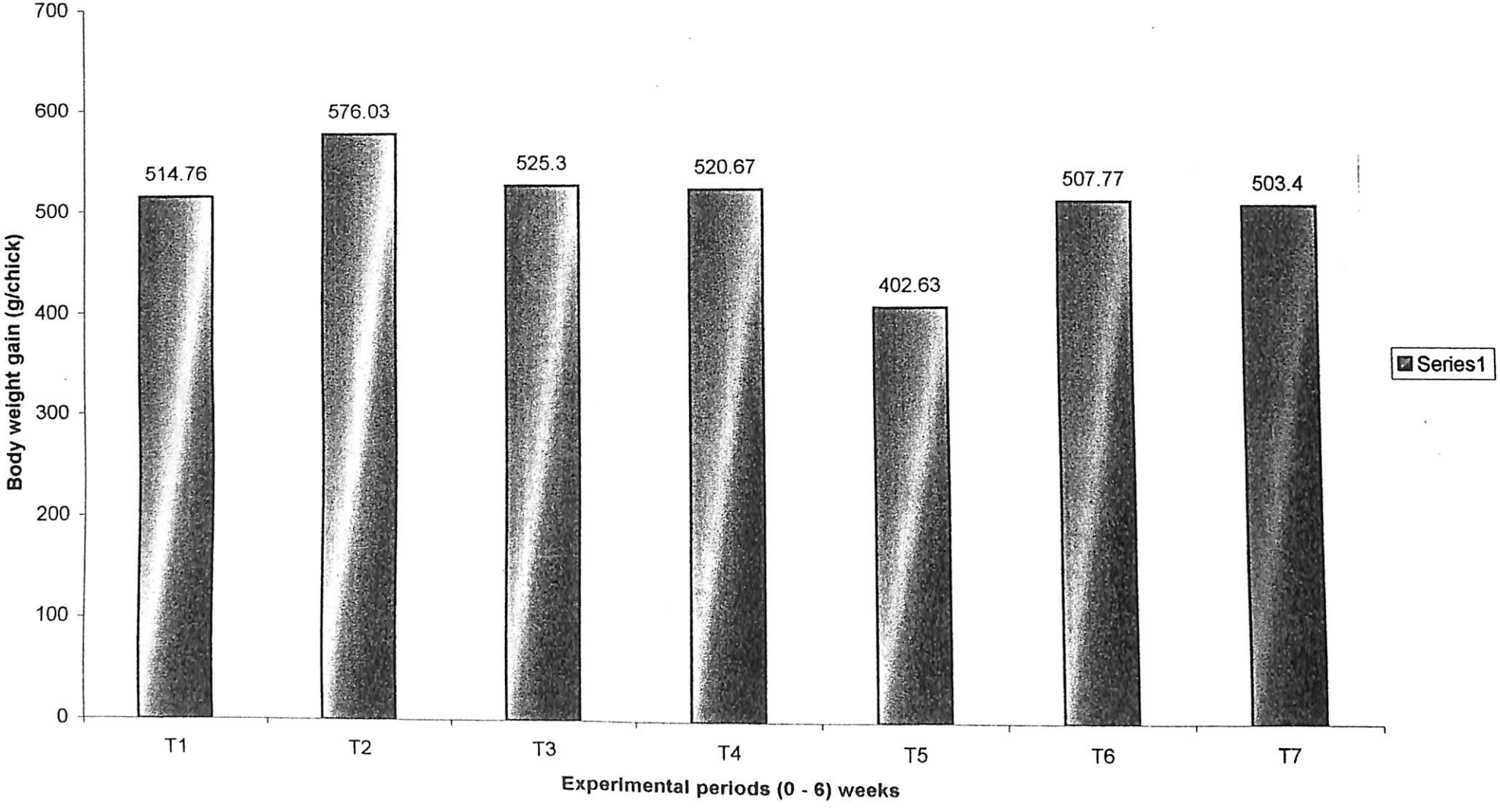


Fig. 2 : Histogram showing treatment means feed consumption (g/chick) during experimentl periods.

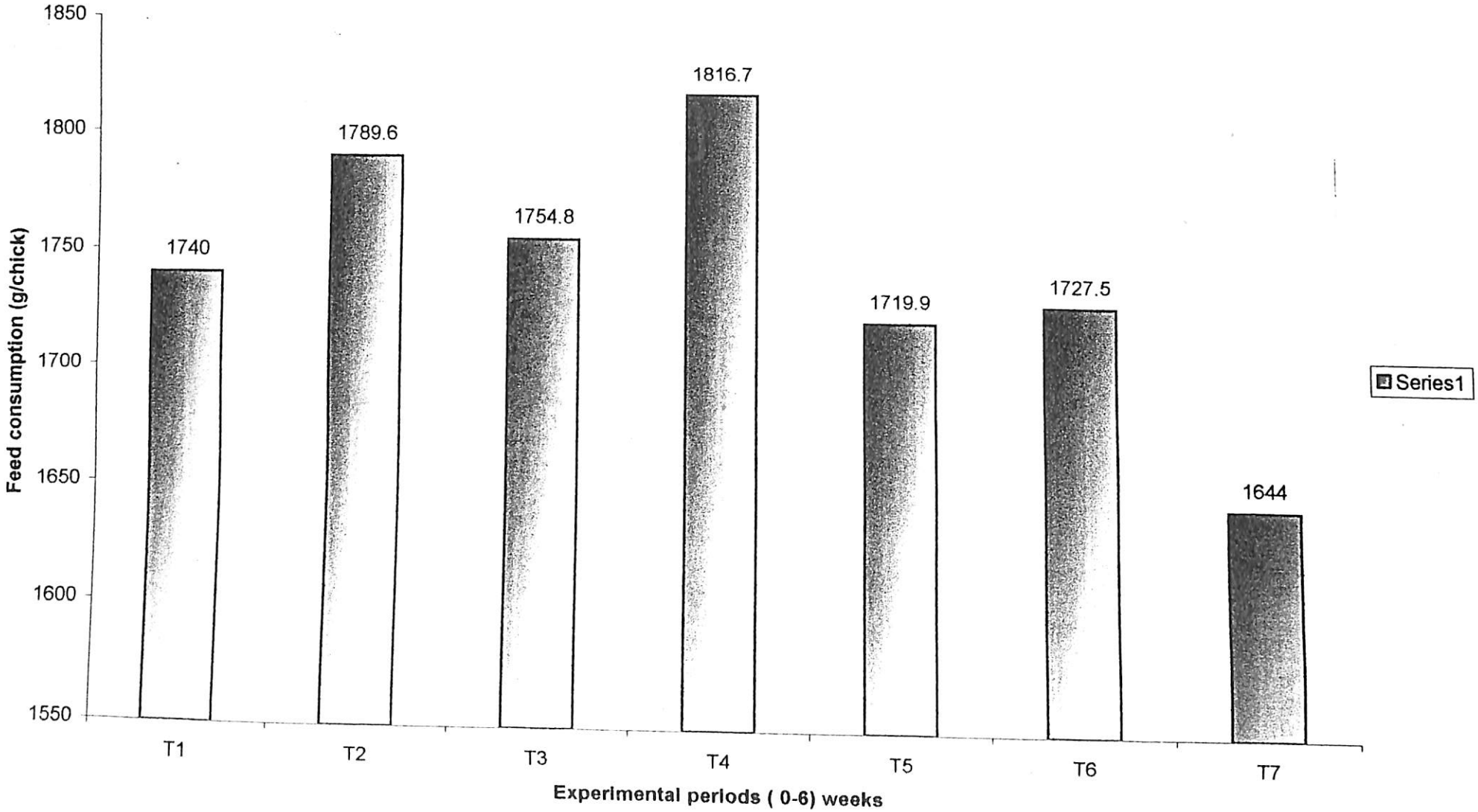


Table 5 : Treatment means ± S.E. of feed conversion ratio (FCR) and performance Index (P.I.) of cockerel at the end of experiment.

No. of treatment	Feed conversion (FCR) (0 –6) weeks	Performance Index (PI) (0 –6) weeks
T_1	$3.38^{c} \pm 0.041$	$152.35^{b} \pm 2.163$
T_2	$3.11^{a} \pm 0.019$	$185.46^{d} \pm 1.064$
T_3	$3.34^{bc} \pm 0.025$	$157.29^{c} \pm 1.250$
T_4	$3.49^{d} \pm 0.038$	$149.27^{b} \pm 1.818$
T_5	$4.27^{e} \pm 0.039$	$94.28^{a} \pm 1.136$
T_6	$3.40^{cd} \pm 0.016$	$149.29^{b} \pm 0.694$
T_7	$3.26^{b} \pm 0.016$	$153.28^{bc} \pm 0.596$
CD value (P<0.05)	0.0879	4.104

Means bearing a common superscript in a column do not differ significantly (P<0.05).

CARCASS QUALITY :

The data on carcass quality with respect to different parameters are given in table 6 and table 7 and their analysis of variance are given in appendix table – 5.

Processing losses :

The shrinkage percentage expressed as percentage of live weight ranged from 10.03 (3.031) and was not significantly (P<0.05) influenced by different dietary treatment. The lowest shrinkage percentage was observed in the chicks fed diet in which 25% Fish meal was replaced by FFS (T_2).

Fig. 3 : Histogram showing treatment means feed conversion ratio (FCR) during experimentl periods.

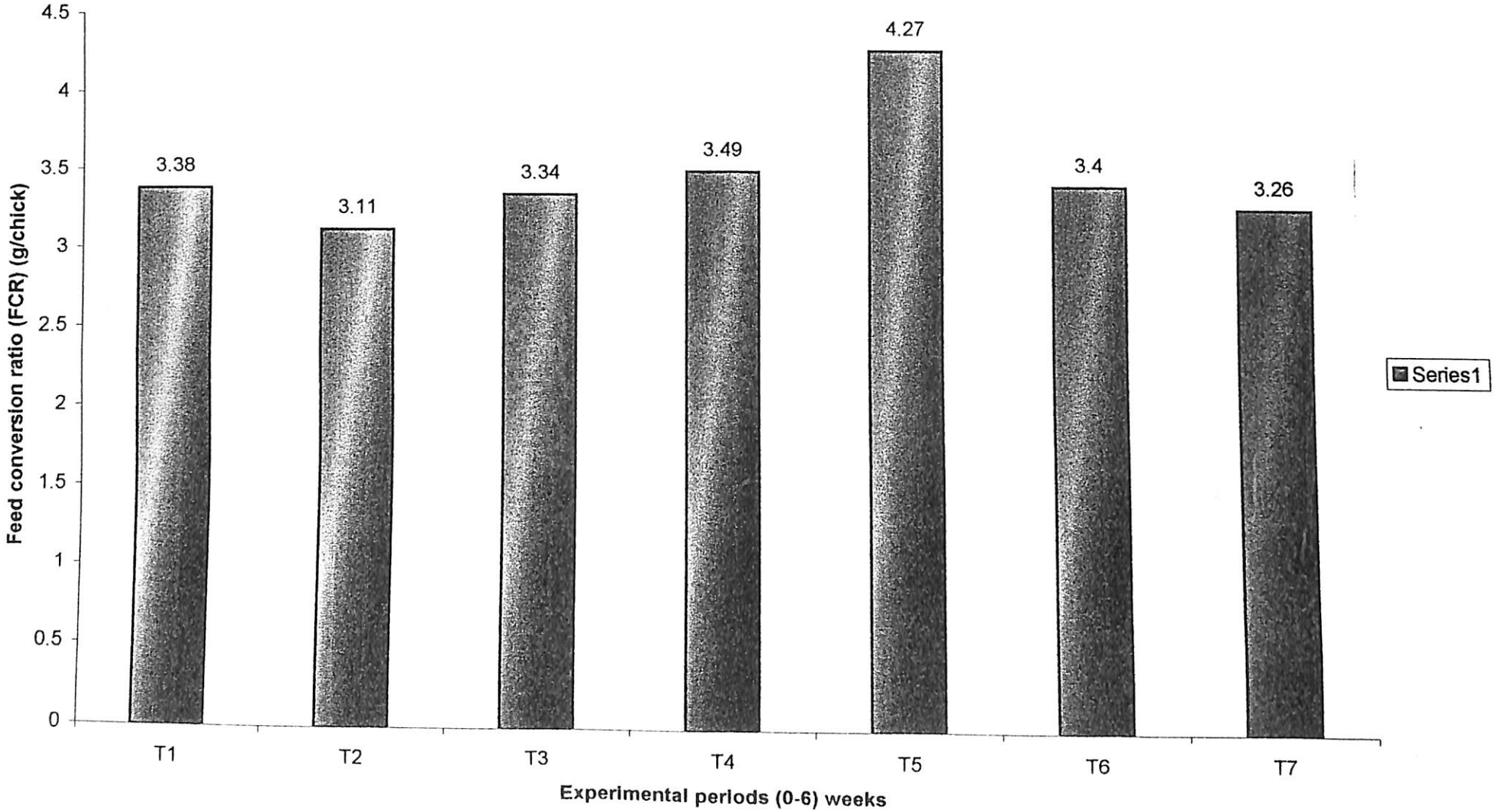
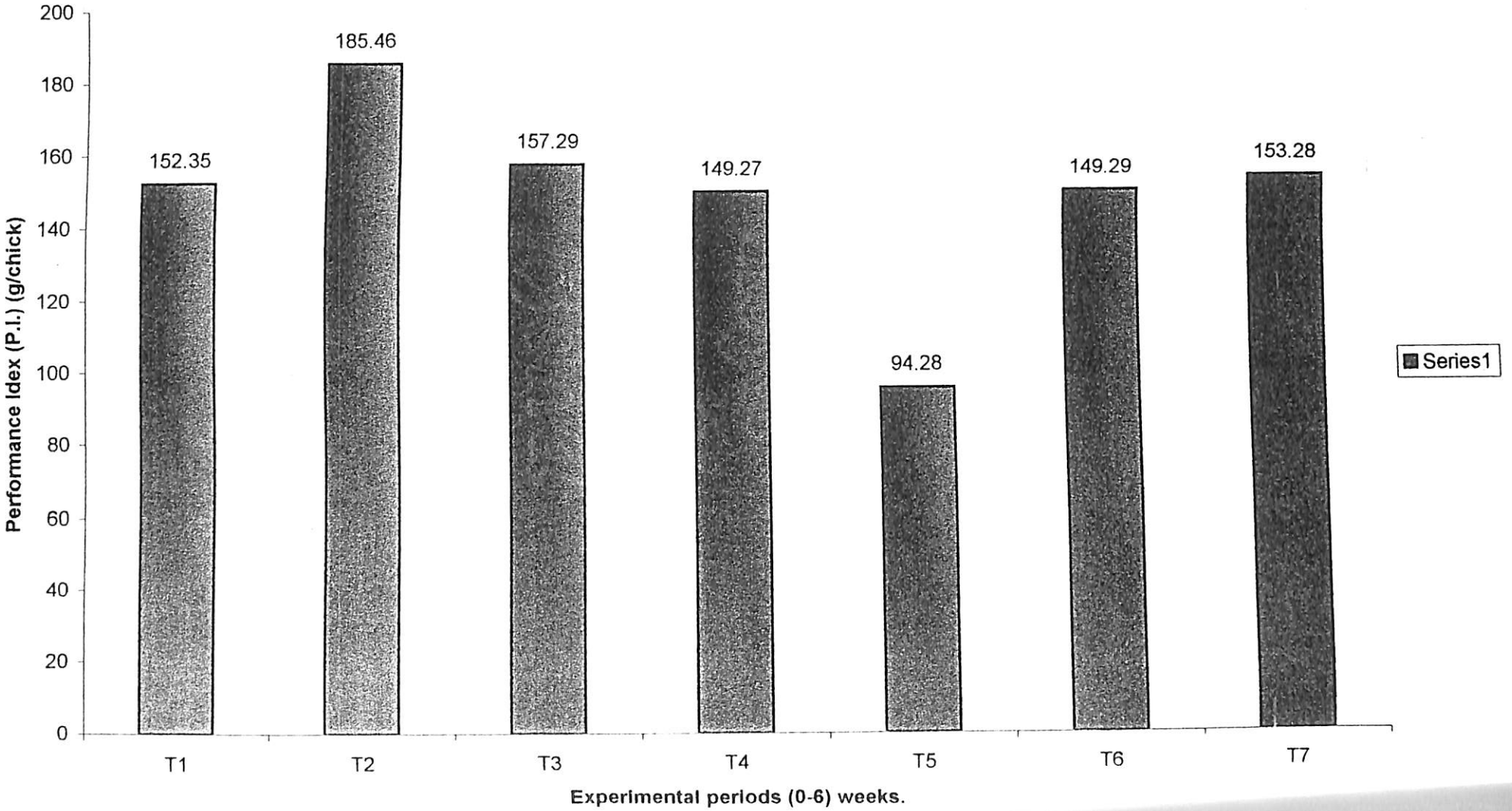


Fig. 4 : Histogram showing treatment means of performance index (P.I.) during experimentl periods.



Highest shrinkage percentage was obtained in the chicks fed diet in which 100% fish meal was replaced by FFS (T_5). In shrinkage percentage all the different dietary treatment was non significant.

The blood loss percentage and feather loss percentage expressed as percent of preslaughter weight ranged from 9.80 (2.89) to 11.39 (3.89) and 14.51 (6.28) to 15.02 (6.71), respectively and were significantly ($P<0.05$) influenced by different dietary treatment. The groups fed all vegetable protein diet based on FFS and SBM (T_5) showed significantly ($P<0.05$) higher blood loss percentage in comparison to other groups. The feather loss percentage showed more or less similar pattern as was observed in blood loss percentage.

Results indicated that blood loss and feather loss percentage were found to be more in birds which had lower body weight. The results agreed well with the finding of Pandey (1992) who obtained higher blood loss percentage in the birds which had lower body weight. Thakur (2000) in his study obtained higher blood and feather losses in broiler with higher live weight of birds.

Dressing and Eviscerate Percentage :

The dressing percentage expressed as percentage of preslaughter weight was significantly ($P<0.05$) influenced by different dietary treatments and ranged from 55.37 (67.70) to 56.45 (69.45). The dressing percentage of chicks receiving diets in which 25% and 50% replacement of fish meal by FFS was done (T_2 and T_3) showed significantly ($P<0.05$) higher dressing percentage in comparison to other groups. However T_3 group did not differ significantly ($P<0.05$) from 75% replacement group (T_4). The lowest

dressing percentage was observed in the birds fed diet based on only vegetable protein Soyabean and FFS (T_5).

Results indicated that those groups which had higher body weight reflected higher dressing percentage. The eviscerated percentage ranging from 52.14 (62.33) to 53.51 (64.64) was significantly ($P<0.05$) influenced by different dietary treatments. It followed almost similar patern as was observed in dressing percentage. Results indicated that higher body weight showed higher dressing and eviscerated percentage which was due to better utilization of feed in chicks.

As such similar reports were given by Thakur (2000), Pandey (1992) and Raina (1974). However, Sunaria (1977) reported no significant effect on dressing or eviscerated percentage though the live weight was significantly ($P<0.05$) reduced by the different dietary treatments.

Table 6 : Treatment means ± S.E. of carcass traits (Processing losses) of cockerel at the end of experimental period *(Percentage value Arc Sin transformed)*.

No. of Treatment	As % of live weight			As % preslaughter weight			
	Live weight (g)	Preslaught weight (g)	Shrinkage %	Slaughtered weight (g)	Blood loss %	Defeathered weight (g)	Feather loss %
T_1	$547.83^{b} \pm 12.00$	$530.22^{b} \pm 11.70$	10.33 ± 0.116	$513.79^{b} \pm 11.39$	$10.14^{b} \pm 0.085$	$481.05^{b} \pm 10.40$	$14.61^{ab} \pm 0.08$
T_2	$607.66^{c} \pm 8.43$	$589.25^{c} \pm 8.40$	10.03 ± 0.082	$569.79^{c} \pm 7.96$	$10.47^{c} \pm 0.058$	$533.98^{c} \pm 7.46$	$14.51^{a} \pm 0.102$
T_3	$556.33^{b} \pm 10.44$	$538.25^{b} \pm 10.17$	10.39 ± 0.131	$519.41^{b} \pm 9.70$	$10.78^{d} \pm 0.057$	$486.53^{b} \pm 9.28$	$14.57^{ab} \pm 0.137$
T_4	$549.83^{b} \pm 11.91$	$532.25^{b} \pm 11.58$	10.30 ± 0.104	$516.84^{b} \pm 11.45$	$9.80^{a} \pm 0.098$	$484.33^{b} \pm 11.14$	$14.53^{ab} \pm 0.113$
T_5	$434.33^{a} \pm 6.42$	$436.60^{a} \pm 18.08$	10.49 ± 0.113	$435.60^{a} \pm 23.98$	$11.39^{e} \pm 0.145$	$405.97^{a} \pm 22.26$	$15.02^{c} \pm 0.101$
T_6	$535.66^{b} \pm 9.02$	$518.96^{b} \pm 8.66$	10.17 ± 0.050	$502.36^{b} \pm 8.31$	$10.30^{bc} \pm 0.094$	$469.44^{b} \pm 7.68$	$14.83^{bc} \pm 0.098$
T_7	$531.83^{b} \pm 6.13$	$515.07^{b} \pm 5.80$	10.23 ± 0.110	$496.5^{b} \pm 5.67$	$10.94^{d} \pm 0.056$	$464.42^{b} \pm 5.70$	$14.73^{ac} \pm 0.103$
CD (P<0.05)	27.16	32.209	NS	35.91	0.259	33.65	0.306

Means bearing common superscript in a column do not differ significantly (P<0.05).

Table 7 : Treatment means ± S.E. of carcass traits (Dressing and Eviscerated percentage) of cockerel at the end of experimental periods *(Arc sin transformed values).*

No. of treatment	As % of preslaughter weight	
	Dressing %	Eviscerated %
T_1	$55.72^{ab} \pm 0.189$	$52.78^{bc} \pm 0.207$
T_2	$56.45^{c} \pm 0.239$	$53.51^{d} \pm 0.213$
T_3	$55.94^{bc} \pm 0.214$	$53.07^{cd} \pm 0.142$
T_4	$55.77^{ab} \pm 0.187$	$52.89^{bc} \pm 0.147$
T_5	$55.37^{a} \pm 0.127$	$52.14^{a} \pm 0.106$
T_6	$55.67^{ab} \pm 0.160$	$52.60^{abc} \pm 0.195$
T_7	$55.56^{ab} \pm 0.151$	$52.48^{ab} \pm 0.098$
CD value ($P<0.05$)	0.529	0.472

Means bearing a common superscript in a column do not differ significantly ($P<0.05$).

Table 8 : Treatment means ± S.E. of different body organ cuts of cockerels (As percent of preslaughter weight) at the end of experimental period (Arc Sin transformed values).

No. of Treatment	As % preslaughter weight			
	Head %	Neck %	Giblet % (liver Heart & Gizard)	Meat bone ratio
T_1	$9.27^{b} \pm 0.133$	12.02 ± 0.125	14.69 ± 0.065	4.02 ± 0.083
T_2	$9.78^{c} \pm 0.152$	12.20 ± 0.144	14.85 ± 0.039	4.22 ± 0.079
T_3	$9.68^{bc} \pm 0.236$	12.15 ± 0.156	14.71 ± 0.066	4.18 ± 0.094
T_4	$9.60^{bc} \pm 0.115$	12.23 ± 0.083	14.67 ± 0.056	4.13 ± 0.102
T_5	$8.78^{a} \pm 0.190$	11.92 ± 0.095	14.79 ± 0.069	3.85 ± 0.125
T_6	$9.34^{bc} \pm 0.088$	12.09 ± 0.084	14.87 ± 0.036	3.98 ± 0.101
T_7	$9.30^{b} \pm 0.129$	12.11 ± 0.119	14.75 ± 0.056	3.95 ± 0.134
CD ($P<0.05$)	0.448	N.S	N.S	N.S

Means bearing common superscript in a column do not differ significantly ($P<0.05$).

Weight percent of different body organs :

Weight of different organs Head, Neck, Giblet expressed as pre slaughter weight are presented in table 8 and their analysis of variance are presented in appendix table 4 and 5.

Head percentage :

The weight of head as percentage of preslaughter weight ranging from 8.78 (2.32) to 9.78 (2.87) was significantly ($P<0.05$) influenced by different dietary treatments. Highest weight of head was observed in chicks fed diets 25% Fish meal replaced by FFS (T_2) where as lowest weight of head was recorded in chick which fed 100% replaced fish meal by FFS based diet (T_5). 25% and 75% replacement of Fish meal by FFS groups i.e. T_2, T_3, and T_4 were non significant with one another. T_2 was significantly ($P<0.05$) different from control (T_1) but T_3 and T_4 groups were not significantly ($P<0.05$) different from control groups (T_1) and supplemented with methionine and Sulphate group T_6 and T_7 also.

Neck percentage :

The neck percentage expressed as percentage of preslaughter weight was not significantly ($P<0.05$) influenced by different dietary treatments which ranged from 11.92 (4.26) to 12.23 (4.48). The highest weight of neck was recorded in chicks fed 75% replaced fish meal by FFS based diet (T_4) whereas the lowest weight of neck was observed in chicks fed 100% replaced fish meal by FFS based diet (T_5).

Giblet percentage :

The Giblet percentage ranging from 14.67 (6.41) to 14.87 (6.58) was not significantly ($P<0.05$) influence by different dietary treatments however a numerical high percent of Giblet was observed in birds which was fed supplemented diet methionine (T_6) and lowest percentage of Giblet was recorded in chicks which fed 75% replaced fish meal with FFS based diet (T_4).

Such irregular trend in the percentage of different organs was also reported by Thakur (2000), Pandey (1992) and Shankar (2003).

Meat and bone ratio :

The ratio of meat to bone was not significantly ($P<0.05$) influenced by different dietary treatments. It ranged from 3.85 to 4.22 per chick. This ratio was found to be numerically lower in the chicks fed 100% replace fish meal by FFS based ration group (T_5) and 25 % replacement of fish meal by FFS group (T_2) showed highest ratio in comparison to other groups.

Results indicated that the heavor cockerels had high degree of fleshing in comparison to bone due to the fact that muscles in comparison to bone have higher content of protein, the synthesis of which requires proper proportion of amino acids. The lower ratio observed in T_5 due to improper proportion of amino acids. Meat : bone ratio increased with higher body weight and decreased with lower body weight was reported by, Sunaria (1977), Raina (1974).

Table 9 : Treatment means ± S.E. of chemical composition of thigh and Breast muscle of the cockerels at the end of experimental period (Arc sin transformed values)

No. of Treatment	Thigh muscle			Breast muscle		
	Moisture (%)	Protein (%)	Ether extract (%)	Moisture (%)	Protein (%)	Ether extract (%)
T_1	$53.03^{a} \pm 0.110$	$27.86^{b} \pm 0.125$	$18.53^{cd} \pm 0.101$	$53.10^{ab} \pm 0.051$	$28.42^{cf} \pm 0.029$	$13.54^{d} \pm 0.123$
T_2	$52.97^{a} \pm 0.118$	$28.09^{b} \pm 0.047$	$18.67^{d} \pm 0.079$	$53.07^{a} \pm 0.058$	$28.53^{f} \pm 0.048$	$13.68^{d} \pm 0.167$
T_3	$53.16^{a} \pm 0.102$	$28.01^{b} \pm 0.090$	$18.34^{bc} \pm 0.079$	$53.18^{ab} \pm 0.065$	$28.21^{c} \pm 0.029$	$12.96^{c} \pm 0.087$
T_4	$53.21^{a} \pm 0.112$	$27.83^{b} \pm 0.111$	$18.06^{b} \pm 0.145$	$53.27^{bc} \pm 0.053$	$28.09^{b} \pm 0.056$	$12.72^{c} \pm 0.123$
T_5	$53.78^{b} \pm 0.153$	$27.42^{a} \pm 0.181$	$19.26^{e} \pm 0.076$	$53.99^{e} \pm 0.114$	$27.87^{a} \pm 0.052$	$11.71^{a} \pm 0.087$
T_6	$53.29^{a} \pm 0.063$	$27.90^{b} \pm 0.143$	$17.65^{a} \pm 0.072$	$53.60^{d} \pm 0.029$	$28.28^{cd} \pm 0.029$	$12.30^{b} \pm 0.077$
T_7	$53.24^{a} \pm 0.072$	$27.96^{b} \pm 0.132$	$17.62^{a} \pm 0.124$	$53.44^{cd} \pm 0.036$	$28.37^{de} \pm 0.019$	$12.34^{b} \pm 0.077$
CD (P<0.05)	0.473	0.357	0.287	0.181	0.114	0.317

Means bearing common superscript in a column do not differ significantly (P<0.05).

CARCASS COMPOSITION :

The chemical composition of thigh and breast muscle in terms of *moisture, protein and ether extract* percentage and analysis of variance are shown in the table 9 and appendix table 6 and 7 respectively.

Moisture percentage :

The average moisture percentage of thigh and breast muscle ranged from 52.97 (63.74) to 53.78 (65.06) and 53.07 (63.81) to 53.99 (65.42), respectively and were significantly)$P<0.05$) influenced by different dietary treatments. Chicks fed 100% replaced fish meal based diet (T_5) had higher percent of moisture in comparison to control and other experimental groups in both types of muscles. 25% replacement group showed lowest moisture percent in both types of muscles chicks fed diets FFS and SBM (T_5) differ significantly ($P<0.05$) with control (T_1) in their respective both thigh and breast muscle respectively. In General, breast muscles had higher percent age of Moisture than thigh muscles.

Results also indicated that the birds which had higher body weight had lower percent of moisture in both types of muscles.

Protein percentage :

On the wet basis, Protein percentage of thigh and breast muscle ranged from 27.42 (21.20) to 28.09 (22.16) and 27.87 (21.85) to 28.53 (22.82) respectively and was significantly ($P<0.05$) influenced by different dietary treatments in both types of muscles. Numerically higher protein percentage was observed in breast muscle than thigh muscle.

An inverse relationship was observed in protein percent of both types of muscles, the group which had lower moisture percent reflected higher percent of protein.

Results also indicated that the birds which had higher body weight showed higher percent of protein in both types of muscles.

Ether extract percentage :

On the wet basis, the ether extract percentage of thigh and breast muscle was significantly ($P<0.05$) influence by different dietary treatments and was ranging from 17.62 (9.170 to 19.26 (10.88) and 11.71 (4.12) to 13.68 (5.59) respectively. The ether extract percent of thigh muscle in chicks fed all vegetable protein diet based on FFS and SBM reflected higher ether extract percent than other groups. However, a reverse trend in ether extract percent was observed in breast muscle in which the ether extract percent was lower in comparison to other groups. Result also indicated that the birds which had lower body weight, had higher ether extract percentage in thigh muscle, indicating more fat deposition than fleshing. In general, the thigh muscle hand higher ether extract percent than breast muscle. Breast muscle containing high protein and low fat level than thigh muscle. Similar observation were reported by Hudspeth and May (1967) and Singh and Essary (1981). The high ether extract percent in vegetable protein diet based on FFS and SBM might be due to inefficient utilization of protein through limitations of sulphur containing amino acids. Carew and Hill (1961) observed that chicks fed methionine deficient diet gained more tissue fat and less tissue protein, Prasad (1978) also reported that deposition of fat in body of chickens was inversely related to dietary methionine and tissue protein

content was more in broilers fed with diet adequate in methionine than in methionine deficient diets. Breast muscles was also reported by Hudspeth and May (1967) and Singh and Essary (1981).

Mortality Rate :

During the experiment, 210 chicks were used, No mortality was observed after grouping the birds. The result of present study showed that cockerel was less susceptible to environmental stress and diseases than other type of poultry.

ECONOMICS OF PRODUCTION :

Economics as influenced by different dietary treatments shown in table No.10 :

Cost of production per kg and profit margin in Rs. and percentage are presented in table 10 Cost per kg live weight was calculated on the basis of feed cost and cost of survived chicks from 0 –6 weeks. Actual cost of feed was calculated on the basis of purchased from market and Govt. agencies. The cost of ration ranged from 10.50 to 11.35. Table no. 10 showed that the cost/kg ration was lower in replacement groups than control. The cost of feed per kg live weight was found to be lower in 25% replaced fish meal by FFS based group (T_2) in comparison to other different dietary treatments. Thus highest margin of profit was observed in 25% replaced diet (T_2).

Profit per kg like weight was calculated as follows.

Net profit = Total out put per kg live weight – Total input per kg live weight (cost of feed + cost of live chick + cost of management including medicine, vaccine, electricity labour, housing etc.)

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Table 10 : Economics as influenced by different dietary treatments.

No. of Treatment	Cost of feed per kg (Rs)	Average feed consumed per bird (kg)	Average live weight gain per bird (kg)	Cost of feed consumed per bird (Rs)	Cost of feed per kg live weight gain (Rs)	Other expanditure per bird (Rs)	Total input per kg live weight (Rs)	Total out put per kg live weight (Rs)	Net profit per kg live bird (Rs)	Net % profit per kg live weight
T_1	11.35	1.740	0.547	19.74	36.00	7.50	43.50	56	12.50	28.73
T_2	11.28	1.789	0.607	20.17	33.00	7.50	40.50	56	15.50	38.27
T_3	11.19	1.754	0.556	19.62	35.28	7.50	42.78	56	13.22	30.90
T_4	10.78	1.816	0.549	19.57	36.64	7.50	44.14	56	11.86	26.87
T_5	10.50	1.719	0.434	18.04	41.58	7.50	49.08	56	6.92	14.09
T_6	10.92	1.727	0.535	18.85	35.23	7.50	42.73	56	13.27	31.05
T_7	11.29	1.644	0.531	18.56	34.95	7.50	42.45	56	13.55	31.92

CHAPTER - V

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

Cockerels are the immature male birds of the poultry species. Cockerel meat and its products have much importance in fast food stall because it is used widely in tandoory chicken, chicken curry and chicken fry and other different dishes. In broiler production high technical skill, expansive feed and medicine are required, which is restraint for our farmers, whereas cockerel rearing need no such requirement. The demand of cockerel is increasing day by day because it gives high price in market as compared to broiler. Cockerels are ready for sale in 5 to 6 week. Although its feed conversion ratio is low but shows high performance index.

Share of feed cost is 60-65% of total input in cockerel rearing. Proper attention on feed is of prime importance in cockerel rearing. Prepared feed available in the market mainly consist of animal protein in the form of fish meal which is costly as well as availability is also difficult sometimes. Moreover it may be contaminated with bacteria, fungus salts and sands etc.

To overcome these problems vegetable protein may be used as protein supplement. Full fat Soya (FFS) is one of the best source of protein in comparision to other vegetable proteins. Also it is comparable to fish meal although little deficient in methionine. Ground nut cake (GNC) is deficient in methionine, lysine and tryptophan also. Soyabean meal based diet supplemented with adequate quantity of lysine and methionine successfully replaces the fish meal protein in broiler ration. The use of full fat Soya in replacing fish meal in broiler ration had been proved successful with a little

supplementation of methionine. Studies on replacement of FFS in cockerel ration is limited.

Thus in order to study the nutritional potentiality of FFS as replacer of fish meal, a feeding and balance trial involving 210 cockerel chicks of commercial Hubbard BV_{300} strain for a period of 6 weeks was conducted. The rations were formulated as per standard recommendation (NRC, 1984) and were fed to chicks for 0-6 weeks. The dietary treatment consisted of control diet (T_1) based on SBM having 10% fish meal. The other experimental diets (T_2 to T_5) were prepared in such a way that 25%, 50%, 75% and 100% of fish meal replaced by FFS, where as two other diets (T_6 & T_7) were as T_5 but supplemented with 5g methionine per kg FFS and 5g Na_2SO_4 per kg FFS, respectively. All the experimental diets were isonitrogenous and isocaloric .

THE FOLLOWING RESULTS AND CONCLUSIONS WERE DRAWN :

BODY WEIGHT GAIN :

The body weight gain during 0-6 weeks ranged from 402.63 to 576.03 g and was significantly ($P<0.05$) influenced by different dietary treatments. 25% replacement group (T_2) showed highest body weight gain and was significantly ($P<0.05$) different from control as well as other different dietary treatments. Chicks fed all vegetable protein diet SBM and FFS (T_5) showed significantly ($P<0.05$) lower weight gain than control (T_1). However, supplementation of 100% replacement diet with methionine or sulphate (T_6 & T_7) gave comparabe body weight gain with that of control diet (T_1).

Feed Consumption :

The feed consumption from 0-6 weeks ranged from 1644 to 1816.7 g and was significantly ($P<0.05$) influenced by different dietary treatments. Chicks fed diet in which 75% of fish meal replaced by FFS (T_4) showed significantly ($P<0.05$) higher feed intakes than other different dietary treatment. 100% fish meal replaced by FFS and supplemented with Na_2SO_4 group (T_7) showed significantly ($P<0.05$) lower feed intake in comparison to control (T_1) and other different dietary treatments.

Feed Conversion Ratio (FCR) :

The feed conversion ratio during 0-6 weeks ranged from 3.11 to 4.27 and was significantly ($P<0.05$) influenced by different dietary treatments. Chicks fed diet in which 25% of fish meal replaced by FFS (T_2) showed significantly ($P<0.05$) lower FCR in comparison to other different dietary treatments. 100% replacement of fish meal by FFS diet (T_5) showed significantly ($P<0.05$) higher FCR in comparison to other different dietary treatments. 25% replacement group showed significantly ($P<0.05$) lowest FCR value, thereby showing highest efficiency of feed utilization in comparison to other different dietary treatments.

Performance Index (PI) :

Performance index during 0-6 weeks ranged from 94.28 to 185.46 was and significantly ($P<0.05$) influenced by different dietary treatments. The chicks fed diet in which 25% and 100% replacement of fish meal by FFS showed significantly ($P<0.05$) highest and lowest P.I., respectively than control (T_1) in comparison to other dietary treatments.

Thus 25% fish meal replaced by FFS showed significantly ($P<0.05$) highest body weight gain, feed conversion ration, performance index and lowest FCR value in comparison to other different dietary treatment.

Carcass traits :

Dressing and evisceration percentage :

Dressing and evisceration percentage were ranged from 55.37 (67.7) to 56.45 (69.45) and 52.14 (62.33) to 53.51 (64.64) percent, respectively and were significantly ($P<0.05$) influenced by different dietary treatments.

Results indicated that those groups, which had higher, body weights reflected higher dressing percentage. The trend of eviscerated percentage was nearly, same as observed in dressing percentage.

Meat and bone ratio :

The meat and bone ratio was ranging from 3.85 to 4.22 and was not significantly ($P<0.05$) influenced by different dietary treatment. The highest meat bone ratio was observed in 25% replacement of fish meal by FFS based ration (T_2) and lowest in 100% replacement of fish meal by FFS based ration (T_5).

Weights of different body organs :

The weight of head expressed as percentage of preslaughter weight was significantly ($P<0.05$) influenced by different dietary treatments. Whereas giblet and Neck expressed as percentage of preslaughter weight were not significantly ($P<0.05$) influenced by different dietary treatments.

Head percentage ranged from 8.78 (2.32) to 9.78 (2.87) these were significantly ($P<0.05$) influenced by different dietary treatments.

Giblet percentage ranged from 14.67 (6.41) to 14.87 (6.58) and was not significantly ($P<0.05$) influenced by different dietary treatments. 75% replacement of fish meal by FFS based ration (T_4) showed lowest percentage in comparison to other different dietary treatments, whereas methionine supplemented ration i.e. (T_6) showed highest giblet percentage in comparison to other different dietary treatments.

Neck percentage was ranging from 11.92 (4.26) to 12.23 (4.48) and was not significantly ($P<0.05$) influenced by different dietary treatments. 100% replacement group (T_5) showed lowest neck percentage whereas 75% replacement group (T_4) showed highest neck percentage value in comparison to other different dietary treatments.

CARCASS COMPOSITION :

Chemical composition of carcass like moisture, protein and ether extract percentage of thigh muscle ranged from 52.97(63.74) to 53.78 (65.06), 27.42 (21.20) to 28.09 (22.16) and 17.62 (9.17) to 19.26 (10.88) percent, respectively whereas that of breast muscle was ranged from 53.07 (63.81) to 53.99 (65.42), 27.87 (21.85) to 28.53 (22.82) and 11.71 (4.12) to 13.68 (5.59) percent, respectively. Chemical composition of carcass was significantly ($P<0.05$) influenced by different dietary treatments. Chicks fed all vegetable protein diet based on SBM and FFS had higher percentage of moisture in comparison to control and other experimental treatments in both types of muscles, while 25 percent replacement group showed lowest moisture percentage. An inverse relationship was observed in protein percent

of both types of muscles, the group which had lower moisture percent reflected higher percentage of protein. The ether extract percent of thigh muscles in chicks fed all vegetable protein diet based on SBM & FFS reflected higher either extract percentage than other groups. However, a reverse trend in ether extract was observed in breast muscle in which the percentage was lower in comparison to other groups. In general, thigh muscle had higher ether extract percentage and lower protein and moisture percentage than breast muscle in all dietary treatments.

MORTALITY :

No mortality was recorded during entire course of experimental period which might be associated to the better management condition.

ECONOMICS :

The total cost per kg live weight gain was found to be lower in 25% replacement group followed by 50%, 100% but supplemented with methionine and Na_2SO_4, respectively 75% and 100% replacement groups i.e. T_4 and T_5 showed higher total cost per kg live weight gain as compared to control (T_1).

By above finding, it may be concluded that FFS can not completely replace fish meal in cockerel ration, but can replace fish meal to the extent of 75 percent in standard ration and FFS based ration completely replace fish meal requires the supplementation of methionine and Na_2SO_4 for optimum performance.

CONCLUSION

(i) Ration based on only vegetable protein sources i.e. soyabean meal and full fat soyabean (FFS) meal could not maintain the desired performance in cockerel.

(ii) The chicks fed replacing fish meal up to 75 percent by FFS on isonitrogenous and isocaloric diet of cockerels influenced higher body weight gain and feed efficiency than control.

(iii) The chicks fed 25 percent replaced fish meal by FFS based diet showed significantly ($P<0.05$) higher body weight gain and feed efficiency among all group.

(iv) The chicks fed replacing fish meal up to 100 percent by FFS based ration, supplemented either by methionine or by sodium sulphate improved performance of cockerel by compensating probably the deficiency of sulpher containing amino acids.

(v) Processing losses were found to be higher in lighter weight cockerels while heavier cockerels showed higher dressing and eviscerated percentage and higher degree of fleshing in comparison to bone.

(vi) Thigh muscle had higher either extract percentage and lower protein and moisture percentage than breast muscle in all dietary treatments.

(vii) No mortality was observed during entire experimental period in different dietary treatments.

(viii) In view of economics, it may be concluded that FFS can not be completely replaced by fish meal in cockerel ration but can replace fish meal to the extent of 75 percent in standard ration and FFS based ration without fish meal require the supplementation of methionine and sodium sulphate for optimum performance.

(ix) The chicks fed 25 % replaced fish meal by FFS based diet showed inexpensive and economical in comparison to others groups.

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APPENDIX

Appendix table No. 1 : Analysis of variance of *body weight gain* during experimental periods.

		0 – 6 weeks	
Source of variation	d.f.	Mean square	F
Between treatments	6	81265.941	367.43**
Error (within treatments)	203	221.176	

** Significant at P<0.01

Appendix table No. 2 : Analysis of variance of *feed consumption* during experimental periods.

		0 – 6 weeks	
Source of variation	d.f.	Mean square	F
Between treatments	6	9447701.26	17113.32**
Error (within treatments)	14	552.06	

** Significant at P<0.01

Appendix table No. 8 : Composition of mineral mixture, Additives (contained per quintal of feed), B complex oral liquid (Ranbaxy– 5x @ 5 ml per day per 100 birds in drinking water).

(A) Mineral mixture VEST PHARMA	(B) Additives contained (per quintal of feed)	(C) B complex oral liquid (Ranbaxy) – 5x
Poultry –MARK (N.S –92) Moisture max = 3 % Calcium min = 30 % Phosphours min = 9% Manganese min = 0.40% Iodine min = 0.01 % Zinc min = 0.40$ Copper min = 500 ppm Iron min = 2000 ppm Florin mix = 0.05%	Common salt = 300 g Ciprozole – T = 50 g Famitone = 50 g Rancox = 50 g Poultryfuran = 50 g	Each ml contains Vit. B_2 = 2.0mg Vit. B6 = 0.62mg Vit. B12 = 6.25 mcg D. panthenol = 1.25 mg Niacinamide = 37.5 mg *d.l.*- methionine = 5 mg *l* –lysine = 5 mg Choline chloride = 5 mg Excipients = Q.S.