Influence of Multienzyme (Polyzyme) Supplementation to Normal and High Fibre Commercial Diets on the Performance of Broilers

THESIS

SUBMITTED TO THE

RAJENDRA AGRICULTURAL UNIVERSITY

(BIHAR)

(FACULTY OF VETERINARY SCIENCE)

PUSA (SAMASTIPUR)

In partial fulfilment of the requirements

FOR THE DEGREE OF

Master of Veterinary Science

IN

ANIMAL NUTRITION

By

Surj Bansh Thakur

(Registration No.- M/AN/42/1997-98)

DEPARTMENT OF ANIMAL NUTRITION

BIHAR VETERINARY COLLEGE

PATNA

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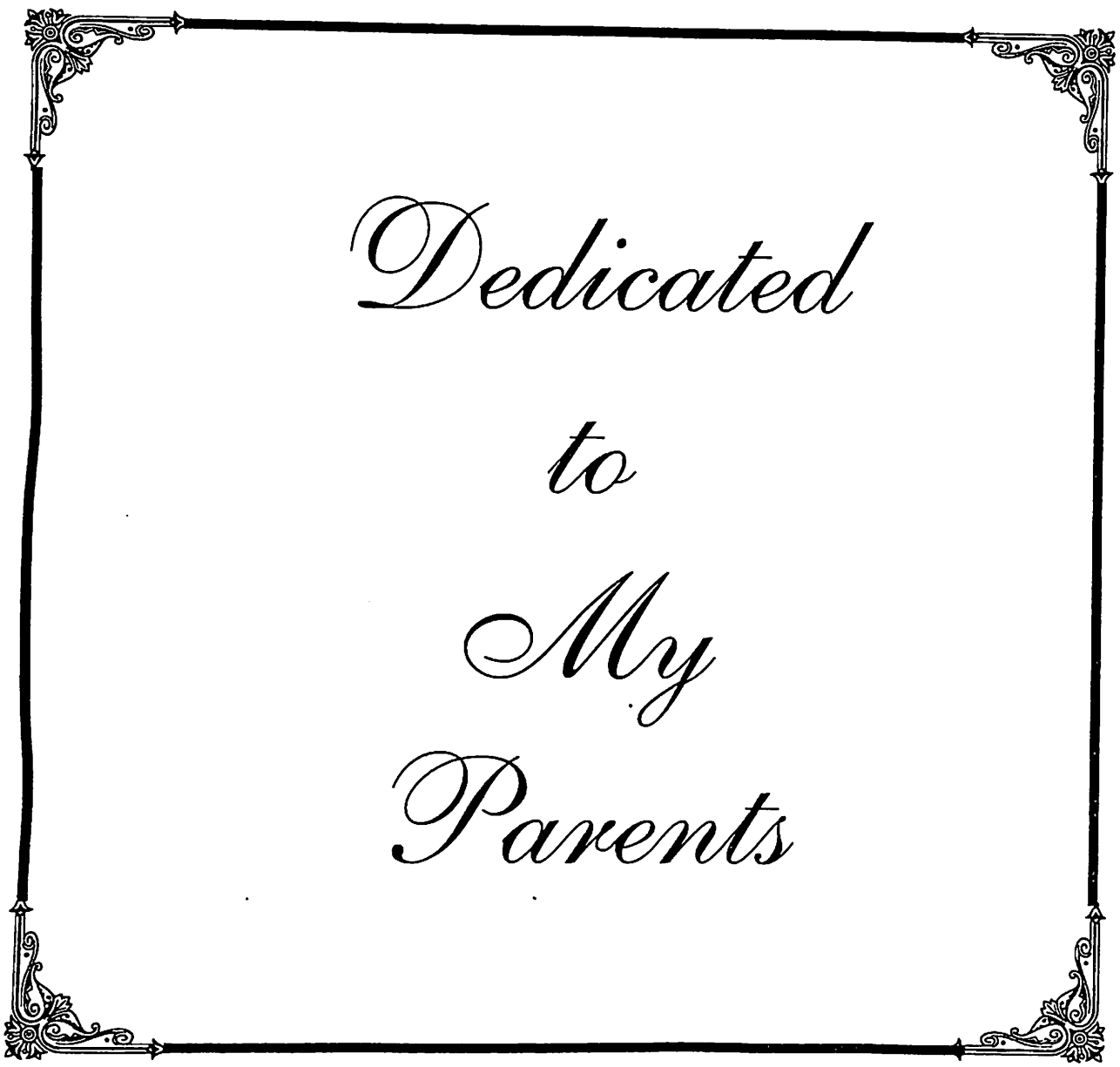
Dedicated
to
My
Parents

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CERTIFICATE - I

This is to certify that the thesis entitled " **INFLUENCE OF MULTIENZYME (POLYZYME) SUPPLEMENTATION TO NORMAL AND HIGH FIBRE COMMERCIAL DIETS ON THE PERFORMANCE OF BROILERS**" submitted in partial fulfilment of the requirements for the degree 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 carried out by **DR. SURJ BANSH THAKUR** under my supervision and guidance. No part of the thesis has been submitted for any other Degree or Diploma.

It is further certified that such help or information received during the course of this investigation and preparation of the thesis have been duly acknowledged.

6/6/2000

Endorsed:

A. Prasad. 6-6-2000

(Chairman/ Head of the Department)

(MD. NOORUDDIN)

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CERTIFICATE - II

We, the undersigned members of the Advisory Committee of **DR. SURJ BANSH THAKUR**, 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 **"INFLUENCE OF MULTIENZYME (POLYZYME) SUPPLE-NTATION TO NORMAL AND HIGH FIBRE COMMERCIAL DIETS ON THE PERFORMANCE OF BROILERS"** may be submitted by **DR. SURJ BANSH THAKUR** in partial fulfilment of the requirements for the degree.

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ACKNOWLEDGEMENTS

With recondite previlage, I express my deep sense of gratitude to my venerable major advisor DR. MD. NOORUDDIN, B. Sc., B. V. Sc. & A. H., M. V. Sc., Ph. D., Associate Professor, Department of Animal Nutrition, Bihar Veterinary College, Patna, for his erudite suggestions, meticulous guidance, constructive councel and unreversed help which served as a constant source of inspiration throughout the period of my research work.

I acknowledge with thanks to the members of my advisory committee, Dr. Ayodhya Prasad, M. V. Sc., Ph. D., Associate Professor & Head, Department of Animal Nutrition, Dr. J. N. Singh, M. V. Sc., Ph. D., Associate Professor & Head, Departments of Veterinary Biochemistry and Livestock Products Technology, Dr. K. G. Mandal, M. V. Sc., Ph. D., Assistant Professor, Department of Animal Breeding & Genetics and Dr. S. S. Singh, M. V. Sc., Ph. D., Associate Professor & Head, Livestock Production & Management for their valuable suggestions, moral support and incessant encouragement during the course of my research work.

I am immensely grateful to my Nominee of Dean, P. G. Studies, RAU, Bihar, Dr. B. K. Singh, R. D., ARI Mithapur, Patna, for his whole hearted support and valuable suggestions during the present investigation.

I am extremely thankful to Dr. M. K. Singh, Dean & Principal, Bihar Veterinary College, Patna for providing facilities during the tenure of this investigation.

Heartiest gratefulness is extended to Late (Dr.) R. R. P. Sinha, Ex- Dean cum Principal and University Professor & Chairman, Department of Animal Nutrition, Bihar Veterinary College, Patna and Late (Dr.) Md. Murtuza, Ex- Associate Professor & Head, Department of Veterinary Biochemistry, for their timely co-operation and constant encouragement during my M. V. Sc. Programme.

I feel extremely happy to express my sincere appreciation to Dr. A. K. Singh, Ex- Associate Professor, Department of Animal Nutrition and Dr. S. B. Verma, Associate Professor, Department of Animal Breeding & Genetics, for their valuable suggestions, constructive criticism and magnanimous help during the course of this study.

I acknowledge with thanks the receipt of financial assistance in the form of fellowship provided by Rajendra Agricultural University, Bihar, Pusa (Samastipur) and for providing all other necessary facilities available to carry out this work.

I am greatly thankful to M/S ZEUS BIOTECH PRIVATE LIMITED, MYSORE for generous supply of free sample of POLYZYME for the experiment.

I am highly obliged to Dr. Naresh Kumar Sinha, General Manager and Dr. Ujjwal Kumar, Veterinary Officer, Central poultry farm, Patna, for their immense help and company during the field work of this study.

My sincere thanks are also due to the members of non-teaching faculty of Animal Nutrition Department for the help and co-operation rendered by them.

I am also thankful to other non-teaching staffs of Bihar Veterinary College, Patna, for their painstaking help.

I am equally grateful to campus Librarian Dr. B. N. Mishra and other library staffs for extending library facilities.

My thanks are also due to all technical and non-technical staffs of M/S I. T. C. Computer, Raja Bazar Patna-14, for their ever available assistance and for final shaping of this thesis.

I would like to place on record my sincere thanks to Dr. Gunanand Pd. Singh, Dr. Uday Kumar, Dr. Pramod Kumar, Dr. Manoj Kumar, Dr. Anup Kr. Agrawal, Dr. Bipin Kumar, Dr. Sukhdeo Mukhiya, Dr. Shahid Parwez, Dr. S. Al. Manowar, Dr. Sanjeev Kumar and all other Colleagues and research scholars, Bihar Veterinary College, Patna, for their love, affection, moral support

and indispensable help during the entire period of my research work.

I express my indebtedness to dear Amit (Lalu), my nephew, for his unwavering help, inenarrable co-operation and incessant encouragement offered time to time during the present M. V. Sc. study programme.

I express special gratitude from core of my heart to my newly married wife, Mrs. Sudha, for her indefatigable patience, imperturbable understanding and endurance in last stage of my thesis preparation, which proved to be a constant source of inspiration.

I have no words to pay regards to my elder brothers, Shri Raghubansh Thakur and Shri Deobansh Thakur and sisters-in-law, who had to toil to bring me upto this stage. The depth of love and affection of my all other family members towards me, enabled to complete this research work in time.

The author takes pleasure in expressing his sincere gratitude to all who have helped to make this dissertation possible.

And finally, I shall never forget to acknowledge the super power "GOD", without which, no work is possible.

B.V.C., PATNA.
DATED 06/06/ 2000.

Surj Bansh Thakur
(SURJ BANSH THAKUR)

LIST OF ABBREVIATIONS

ANF	:	Anti nutritional factors
AOAC	:	Association of Official Analytical Chemists
^0C	:	Degree Celcius
Ca	:	Calcium
CP	:	Crude protein
DM	:	Dry matter
DORB	:	Deoiled rice bran
EE	:	Ether extract
Ext. SFC	:	Extracted sunflower cake
FCR	:	Feed Conversion ratio
F_0E_0	:	Commercial broiler diet with no supplementation of multienzyme
F_0E_1	:	Commercial broiler diet with 0.05% supplementation of multienzyme.
F_0E_2	:	Commercial broiler diet with 0.10% supplementation of multienzyme.
F_1E_0	:	Commercial broiler diet with 10% substitution by mixture of DORB and Ext. SFC unsupplemented with multienzyme.
F_1E_1	:	Commercial broiler diet with 10% substitution by mixture of DORB and Ext. SFC supplemented with 0.05% multienzyme.
F_1E_2	:	Commercial broiler diet with 10% substitution by mixture of DORB and Ext. SFC supplemented with 0.10% multienzyme.
F_2E_0	:	Commercial broiler diet with 20% substitution by mixture of DORB and Ext. SFC unsupplemented with multienzyme.
F_2E_1	:	Commercial broiler diet with 20% substitution by mixture of DORB and Ext. SFC supplemented with 0.05% multienzyme.
F_2E_2	:	Commercial broiler diet with 20% substitution by mixture of DORB and Ext. SFC supplemented with 0.10% multienzyme.
F_3E_0	:	Commercial broiler diet with 30%

		substitution by mixture of DORB and Ext. SFC unsupplemented with multienzyme.
F_3E_1	:	Commercial broiler diet with 30% substitution by mixture of DORB and Ext. SFC supplemented with 0.05% multienzyme.
F_3E_2	:	Commercial broiler diet with 30% substitution by mixture of DORB and Ext. SFC supplemented with 0.10% multienzyme.
g	:	Gram
GE	:	Gross energy
Kcal	:	Kilo Calories
Kcal/g	:	Kilo Calories per gram
Kcal/Kg	:	Kilo Calories per kilogram
Kg	:	Kilogram
ME	:	Metabolisable energy
nm	:	Nanometer
NSP	:	Non starch polysaccharides
%	:	Percent
P	:	Phosphorus
PI	:	Performance index
TDN	:	Total digestible nutrients
U/gm	:	Units per gram

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INTRODUCTION

INTRODUCTION

The enormous growth of broiler industry in recent times calls for a large quantity of feed with the right proportion of nutrients in order to take as much advantage as possible of the greater genetic potentialities of broiler. To make this enterprises on cost-effective economic footing, formulation of rations for broiler is the greatest concern as feeding cost alone constitute about 70% of the total cost of production. Concurrently, the increasing demand of certain food grains for human commonly used as conventional feed ingredients in broiler ration affected its availability and cost. The restricted availability and soaring price of such feed ingredients led the broiler industry under severe strain.

Therefore to meet the present requirement of feed, it became necessary to improve feed resources by incorporation of non-conventional feed stuffs in compounded rations. But large scale use of alternate feeds and agroindustrial by-product in poultry feed is limited because of the presence of certain antinutritional factors (ANF), which can not be degraded in the digestive tract by the host mechanism alone and adversely affect the performance of birds. Most of the ANF's are NSP comprising of hexosans and pentosans which are nearly indigestible by monogastric animals and birds. In addition to these substances which belong to NSP, there are also higher concentration of specific indigestible oligosaccharides present mainly in vegetable protein sources. The concentration of NSP - fractions and other anti-nutritional factors in feed stuffs varies quite considerably. Under certain conditions, there is suboptimal nutrient

utilisation due to insufficient endogenous enzyme production e.g.. proteases, amylases and galactosidases. This is particularly true in the case of young animals as well as in the birds under stress conditions. Presence of these ANF's in compounded feed of poultry may have negative effects such as they are poorly digestible and hence dilute the metabolisable energy and nutritive contents in the feed. They may also produce cage effects by entrapping other nutrients and increases the intestinal viscosity which hinders the intestinal absorption of nutrients thereby producing a negative effect on consistency of the faeces and even symptom of diarrhoea.

About 2/3rd of the total phosphorus contained in plant based feeds are in the unavailable form phytate. The availability of phytate phosphorus from phytic acid is limited and excreted as waste. In addition, it combines with Ca, Zn, Cu, Mn, Fe, Mg, Chromium and certain aminoacids and reduces the availability of these nutrients and minerals due to complex formation. Thus to meet the phosphorus requirement in bird, inorganic phosphorus is required which increases the cost of feed. Moreover the excretion of phytate causes a serious environmental pollution.

In order to increase production in birds with the existing feed position, use of various growth promoters like antibiotics, flavouring agents, growth hormones were in vogue. However, due to increased awareness among consumers with respect to residues of these growth promoters in the end product, it become mandatory to find some safer methods for enhancing production. Enzyme supplementation in poultry rations opened new vistas in this direction and with

biotechnological innovation at present various commercially prepared enzymes are available at affordable price in the market. The purpose of supplementing feed enzymes in the rations is to supplement quantitatively the endogenous digestive enzymes of host and breakdown of those components which cannot be digested by monogastric animals into absorbable nutrients. In addition, it lowers the gastrointestinal viscosity, reduces nutrients entrapment by breakdown of cell- wall structure and releases other nutrients bound to NSP or phytate. The reduction of digesta viscosity results in a decrease stickiness as well as a higher dry matter content of the faeces. This effect reduces the environmental pollution. Besides the affects already mentioned, enzymes have a positive effect on growth performance and beneficial feed utilisation as well as meeting the carcass characteristics demanded by the market.

The main economic advantages of adding enzyme are on both reducing feed production cost and on production cost of poultry. Thus more cost effective compound feed can be produced by using feed enzymes. Incorporation of phytase enzyme in poultry ration increases the availability of phosphorus and other minerals. It has been observed that the addition of 500 units of active microbial phytase to the diet can effectively replace 1.15 g phosphorus from dicalcium phosphate and 1 g from monocalcium phosphate.

A lot of commercial enzymes are available in the market but multienzyme preparation containing phytase as well as other enzymes for breaking down NSP fractions and supplementing inadequate amount of endogenous enzyme have gained much

importance.

Thus, a large number of grains, grain by-products and vegetable protein supplements containing higher amount of fibres and various other NSP and other antinutritional factors (ANF) can be improved with the use of multienzyme preparation.

In view of the above facts, the proposed work was designed to supplement normal and constituted high fibre commercial diets at two levels of multienzyme with the following objectives :

(1) To assess the nutritional quality of commercial broiler diets by analysing its crude protein, crude fibre and other proximate principles.

(2) To develop high fibrous diets by incorporating high fibre cereal by products (Deoiled rice bran) and vegetable protein supplement source (Extracted sunflower cake) in standard commercial diets.

(3) To study the influence of multienzyme supplementation at different levels of crude fibre in commercial diets on the performance of broilers.

(4) To establish the effective level of multienzyme supplementation on the utilisation of various dietary nutrients (protein, phosphorus and crude fibre) of commercial diets for optimum performance in broilers.

(5) To determine the extent of reduction of moisture contents in droppings of broilers fed multienzyme supplemented diets.

(6) To study the effect of various dietary treatments on carcass traits of broilers.

(7) To determine the availability of nutrients (energy, protein and phosphorus) by conducting balance trial.

(8) To develop a cost effective economical diet of broilers based on these findings.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Maize is the most commonly used energy feed stuffs in conventional poultry diet. But its production has never been adequate both for human consumption and industrial use. Hence there is severe shortage of it for use in poultry feeds. Similarly the cost of conventionally employed vegetable oil meals/cakes (groundnut cake, soyabean meal) and animal proteins (fish meal, meat meal) are highly prohibitive and their supply is inconsistent. Thus in order to reduce the dependency on these conventional feed ingredients, poultry nutritionist are devicing ways and methods to replace conventional partially or fully with unconventional energy and protein sources in poultry ration with a view to make it economic and nutritionally balanced. However, due to presence of some antinutritive factors in these unconventional feed ingredients their use is limited in broiler rations. One of the most important antinutrivtive factor generally encountered is high fibre content. Since birds have no secretion of proper enzymes to deal with the cell wall fractions constituting cellulose, hemicellulose, Pentosans (NSP) and other antinutritive factors, whose digestion and destruction will be beneficial to chicks to increase the available of nutrients. Among various ways of improving the nutritive value of high fibre containing feed ingredients, the enzyme treatment has been very promising and effective. The use of feed enzyme offers the potential for the non-conventional feeds available to have a more important impact in dietary formulation, which may be a means of improving the usefulness of non-conventional feed ingredients. Besides, improving the availability of nutrients and at the same time reduces the

variability in the nutritive value of feed ingredients, it also improves and induces greater uniformity in bird response and also improves the litter quality, thereby reducing environmental pollution. A number of enzymes either singly or in combinations are available from various commercial sources and all of them giving good responses in broiler chickens. Among the cereals by-products rice bran a by-product of rice milling industry after extraction of oil and extracted sunflower cake though well balanced in amino acids and rich in sulphur containing amino acids are not fully utilised due to high fibre content. Moreover most of feed ingredients of plant origin though being rich in P but its availability is poor as about 2/3rd of the phosphorus of these feed ingredients is bound to a compound phytic acid. In simple stomached animals under most dietary conditions, phytate phosphorus is unavailable to poultry (Nelson, 1967). In addition, phytate phosphorus chelates several important minerals and thereby reduces their availability (Tyagi et al.,1996). So phytase alone or in multienzyme preparation can increase the availability of phosphorus by splitting the bond form of phosphorus. An attempt has therefore been made to review here the relevant literature under the following subheads:-

(1) Chemical composition of deoiled rice bran and extracted sunflower cake.

(2) The importance of digestive enzymes for improving the productive value of feeds.

(3) Effect of enzyme supplementation in diets on performance and nutrient utilisation.

(4) Effect of enzyme supplementation on the availability of phosphorus from poultry rations.

(5) Influence of enzyme supplementation on litter quality.

CHEMICAL COMPOSITION OF DEOILED RICE BRAN AND EXTRACTED SUNFLOWER CAKE.

DEOILED RICE BRAN

Rice bran is a by-product from the milling of rice consisting of the outer bran layer of the kernel with part of the germ. It is a mixture of pericarp, seed coat and some of the aleurone layer. This by-product is much higher in fat content and some what low in fibre than that of wheat by-products. Usually this full fat rice bran, when used in poultry ration, develops rancidity on prolonged storage and thus reduces the feeding value. Now,a days, due to increasing cost of oil, millers are extracting the fat or oil from the rice bran and this product is known as deoiled rice bran. Though due to extraction of oil, the energy content of this feed stuff has been reduced considerably even then it is used as a cheap energy source in poultry rations replacing maize and other costly cereals. Different workers have found out different ME-value of deoiled rice bran and the range is 840 Kcal to 2980 Kcal/kg. This great differences between ME -values of different deoiled rice bran samples may be attributed to the variety of paddy rice, the efficiency of dehusking prior to milling, the method of milling itself and also due to the adulteration with rice husk. The proximate composition of deoiled rice bran has been studied and the average range values as indicated in several reports are given in

table1.

Usually, deoiled rice bran can be used efficiently in layer's ration to partially replace maize and other cereals, but the inclusion of deoiled rice bran in broiler ration is not advocated due to low energy content. The high fibre and phytate contents of deoiled rice bran may affect the digestibility and nutrient utilisation. Broilers grow at a faster rate and demands more dietary energy. So,when deoiled rice bran included in broiler's ration,the desired weight could not be achieved. Rice bran contains approximately 20-25% NSP, half of which is cellulose (Saunders, 1986). Use of enzymes and other growth promoters may increase the availability of energy to the birds. Researches are conducted in this direction to utilise the cheaper energy source by enzyme supplementation.

Devi (1996) fed a corn based diet containing 24% deoiled rice bran to chicks supplemented with multienzyme containing phytase. She found an improvement in feed efficiency in chicks in comparison to unsupplemented, evenwith lower levels of deoiled rice bran in the ration.

Martin (1995) demonstrated that supplementation of duck diets with microbial phytase allowed rice bran to be used at high levels (up to 60%) without detrimental effects. A reduction in phosphorus excretion by 9.6% and a significant decreased excretion of minerals like Mn, Cu, Zn were also noted.

Table 1. The chemical composition of deoiled rice bran

CP	*EE*	*CF*	*Total Ash*	*Ca*	*P*	*ME (Kcal/kg)*	*Reference*
10-20%	0.4-1.8%	9.0-19.6%	11.3-18.0%	0.26-0.45%	1.02-2.5%	----------	Bhanja et. al.(1992)
14.0	1.0	17.0	---	0.14	0.24(Available)	2200	Dev (1975)
16.91	1.4	14.02	17.31	3.38	1.82	---	Kathaperumel et. al. (1978)
14.0	0.4	16.0	11.3	---	---	2200	Ichhoponani & Lodhi (1975)
12.90	1.15	19.10	16.25	----	---	---	Gill et. al. (1977)
16.50	1.11	15.54	14.49	0.28	1.68	2200	Purushothaman et. al. (1990)

Table 2. The chemical composition of extracted sunflower cake

29.42	2.62	20.10	---	0.43	1.12	---	Determined
43.0	2.80	14.0	---	0.4	0.3(Available)	1760	Nesheim et. al. (1979)
30.0	---	30.0	---	---	---	1000	Chopra (1997)
35.31	0.14	20.10	7.93	0.24	1.29	65.0 (TDN)	Arora (1997)

EXTRACTED SUNFLOWER CAKE

The by-product of sunflower seed after extraction of oil available as sunflower meal is an important vegetable protein supplement for livestock and poultry. The nutrient composition of sunflower meal varies according to the quality of the seeds (with hull and without hull) and the method used for oil extraction (expeller and solvent extraction- batch and continuous). The expellered meal has comparatively high energy level than solvent extracted meal due to high residual oil content. The quality of meal improves if the seeds are dehulled before oil extraction. Reports are available that dehulled sunflower meal has a protein content of more than 40 % and crude fibre 13% or less. Partial dehulling produces meal of 30-35% protein, where as whole sunflower meal has about 25% crude-protein. The crude fibre content of partially dehulled or hulled sunflower meal may exceed 20%, which becomes a major limiting factor in its utilisation in poultry and swine feeds being high in methionine content. Due to high fibre content, only high quality dehulled sunflower meal is usually recommended in broiler diets. Since, at present this commodity is usually available as solvent extracted hulled meal containing high fibre, it is expected that enzyme supplementation may produce beneficial effect in its utilisation. The chemical composition as determined in this laboratory and reported by other workers are given in table 2.

THE IMPORTANCE OF DIGESTIVE ENZYMES FOR IMPROVING THE PRODUCTIVE VALUE OF FEEDS

The quality of poultry ration is dependent upon the feed

ingredients used to formulate the compounded ration. In India, feed ingredients commonly used to formulate the compounded poultry ration are of agroindustrial origin. Due to advancement of technology, a variation in the chemical composition of these feed ingredients has been observed, specially with respect to fibre level which has an energy diluent effect on the diet. The crude fibre is less digestible and tends to reduce the digestibility and ME-value of ration (Sikka, 1993). It has been estimated that a unit increase in crude fibre decreases 78 and 94 kcal /kg energy respectively in the ration of layer and chicks (Ichhponani, 1996). The nitrogen digestibility of oil cakes was found to be inversely related with the fibre level (Lodhi et al., 1976). Besides fibre, various NSP also constitute important antinutritional factor in poultry diets. NSP as a part of carbohydrate in cereals, affects the metabolisable energy of cereals negatively. It is generally accepted that the antinutritional effects are related to high viscosity in chymes in gastrointestinal tract of chickens caused by these NSP. NSP are found in large quantity in cell wall of plant origin feed stuff consisting of cellulose, pectin, hemicellulose, small amount of glycoprotein and lignin. Insoluble fibre tends to increase transit time and to form an insulating coat on the digestible nutrients, thus reducing the nutrients supply. Soluble fibre slow down the transit rate but their gelling, ion-exchange and absorbing characteristics retarded digestion and absorption (Krogdahl, 1986). Increased NSP level in poultry diet leads to watery and sticky droppings due to increased viscosity of gut lumen contents and by acting as physical barrier to endogenous enzymes.

Studies conducted with chicken have established that the productive value of most of the feed ingredients is limited by their dietary fibre content. Further studies have also established that some potentially digestible starch and protein escapes degradation in small intestine of poultry and swine (Graham et al., 1988, Pettersson and Aman, 1989; Low and Longland, 1990). Under the present feed situation, where the prices of feed ingredients are increasing continuously, it is important to utilise the feed resources optimally. Out of various ways to achieve improved feed utilisation and the ability of the birds to access all the potential nutrients in the diet with an ideal balance of nutrients from the digestive tracts, the addition of enzymes which have stimulating effect on the digestive mechanism or inhibiting unwanted microbial growth in the digestive tract is desirable. The possibility of using dietary enzyme supplement to improve the nutritional value of poultry feeds was raised by the report of Jensen et al. (1957), who found that chick performance on a barley based diet could be improved by a crude dietary amylase supplement. However, commercial applications didn't metarlised until the 1980 S, when problems were identified with the feeding quality of wheat (Mollah et al., 1983), in which low ME wheats were efficiently utilized by the supplementation of enzymes. Commercial feed enzymes are usually produced from naturally occurring fungi, yeast and bacteria. They are being grown on sugar and starch hydrolysate substrates and the enzyme produced are extracted and separated from the sources microbes. They are then established before being prepared as free flowing powder or liquid for mixing into feeds. All commercial feed

enzymes contain a range of enzyme activities and cannot be completely characterised. Therefore, response in the animal can reflect the action of enzymes other than the predominant enzyme in the mixture. Their main use in poultry diet has been to destroy antinutritional substances in feed and to increase the availability of dietary nutrients through complementing the activities of endogenous digestive enzymes of the birds. A number of these products are available from various commercial sources ranging from single enzyme to complex multienzyme and all give similar response in broiler chickens (Annison, 1993). The overall effects of feed enzyme is to improve and at the same time to reduce the variability in the nutritive value of feed ingredients in the diet, to improve and induce greater uniformity in bird response, to improve litter quality and to reduce environmental pollution. The use of feed enzymes offers the potential and greatest impact for non-conventional feeds available to be incorporated in dietary formulation thereby improving the usefulness of non-conventional feed ingredients. Moreover the use of enzyme in poultry diets can reduce the dependency on the storage polysaccharides mainly cereal starch and will increase the use of structural carbohydrates. Elevated levels of NSP increased the activity of fermentative microorganism in the small intestine in a detrimental manner (Choct et al., 1996). Enzyme supplementation largely eliminated the fermentation in the small intestine and improved nutrient digestibility and well being of the birds.

The use of enzyme may bring the energy level of different feed ingredients to comparable level, which will bear an increased precision in least cost feed formulation. Enzyme also allow a wide

Table 3. Improvements of feed value by different enzymes

Ingredients in feed mixture	Additive	Growth	Feed efficiency	Reference
Barley	enzyme supplement	+	+	Classen et. al., 1988
Hulled or hulless Barley	b - glucanase	+	+	
Oat groat	b - glucanase	+	+	Edney et. al., 1989
Wheat	b - glucanase	-	-	
Barley/ Maize	a - amylase and protease	+	-	Ezdakov, 1976
Rye	Cellulase	+	+	Friesen et. al., 1991
Wheat, Barley Oat, Rye	Cellulase	+	+	Friesen et. al., 1992
Pearled Barley	Clarase 300	+	+	Fry et. al., 1958
Barley	b - glucanase	+	+	Gohl et. al., 1978
Barley	Fungal enzyme	+	+	Haskell et. al., 1960
Barley	a - amylase	+	+	Herstad and McNab, 1975
Barley	b - glucanase	+	+	Hesselman et. al., 1981
Pearled Barley	Clarase 300	+	+	Jensen et. al., 1957
Maize	Proteolytic enzyme (bacterial)	+	+	kasbaoui and Gullaune, 1976
Barley	b - glucanase	+	+	Mannion, 1981
Barley	a - amylase (diastase)	+	+	Moss et. al., 1977
Wheat bran (Corn-Soyabean diet)	Cellulase	-	+	Nahm & carlson, 1985
Maize	a - amylase	+	+	Parkany- Gyarfas and Toth, 1978
Wheat, Rye & Triticale	Pentosanase	+	+	Pettersson & Aman, 1988
Wheat & Rye	Enzyme Supplement	+	+	Pettersson & Aman, 1989
Barley, wheat & Rye	b - glucanase arabinoxylanase	+	+	Pettersson et. al., 1991
Corn-Soyabean diet	Cellulase	+	+	Reese et. al., 1983
	Gluconase	(improvement no consistent)		
	Xylanase			
	Pectinase			
	Dextranase			
	Amylase			
	Protease			
Barley (better quality)	Cellulase	-	-	Rexen, 1981
	Pectinase			
	Amylase			
Barley	b - glucanase	+	+	White et. al., 1983
Pearied Barley	Amylolytic and Proteolytic enzyme	+	+	Willingham et. al., 1959

range of ingredients to be used in a diet with a desired out come. This gives the producer a great deal of flexibility to formulate a nutritionally balanced least cost diet. Over formulation of poultry diets to increase the availability of certain critical nutrients led to the excretion of unutilised nutrients and ultimately become a source of pollution. Also the chemical structure (cellulose and NSP) location within the feed stuffs and interaction with antinutritive factors are all likely to decrease digestive efficiency and hence increase the excretion of potential pollutants.

A survey of reports in the literature for improvement of feed by enzyme supplementation and biomass has been presented in table 3.

EFFECT OF ENZYME SUPPLEMENTATION IN POULTRY DIETS ON PERFORMANCE AND NUTRIENT UTILISATION.

The potential for feed enzyme has been recognised for years and indeed various enzyme preparations has been used in monogastric diets to increase productivity. The early work focused on the hydrolysis of specific substrates to increase the availability of these substances in their simple constituents (Fry et al., 1957b; Moran et al., 1969). For example, various preparation of amylase were used in an attempt to overcome poor performance of chicks fed barley diets by increasing the availability of starch (Hastings, 1946; Fry et al., 1957a). Cellulases and protease were also used for similar purposes.

Within the past five years, the use of enzymes has become wide

spread in the feed industry with many companies producing a wide variety of enzyme products at low cost. The enzymes currently on the market consisted of several enzymes to utilise non-starch polysaccharides as well as other fibre constituents, protein and phytate phosphorus. The antinutritive effect of NSP was manifested by poor digestibility of energy and nutrients followed by watery and sticky droppings. Reduction of the moisture content and volume of the excreta was often noted when glycanases were added to poultry diets. Supplementation of low AME wheat diets with a xylanase product, improved the overall dry matter digestibility by 17% and reduced the excreta output by 43% (Choct et al., 1995).

The nutritive value of cereal grains of poultry varies greatly, for instance, the variability of wheat AME for poultry can be as large as 4MJ/kgDM (Sibbald and slinger, 1962; Rogel et al., 1987). The use of glycanases can largely overcome this problem and bring the AME of different wheat to a comparable level (Choct et al., 1995).

Some of the oil cakes such as sunflower cakes can not be fed as a sole protein source due to the presence of high level of NSP and oligosaccharides. These NSP are more complex in structure than those in cereals containing a mixture of colloidal polysaccharides called pectic substances. Annison et al. (1995) demonstrated that some current commercial enzyme had a significant effect on these NSP invivo and if these NSP are efficiently utilised as an energy source their nutritive value for poultry will be increased by 50%.

Conflicting reports are available on the response by chicks with enzyme supplementation to barley based diets. Some group of

workers noticed a favourable response of enzyme supplementation (Jensen et al., 1957; Fry et al., 1958; Willingham et al., 1959; Haskell et al., 1960; Herstad and McNab, 1975; Moss et al., 1977; Gohl et al., 1978; Hesselman et al., 1981; Mannion, 1981; White et al., 1983; Classen et al., 1988; Rotter et al., 1990; Wyatt et al., 1991; Bustany, 1996) While other group of workers observed a slight or no improvement on the performance by enzyme supplementation (Henning, 1972, Rexen, 1981). This they attributed that the quality of barley was the probable cause of variable responses in broilers.

Identifications of antinutritive factor present in barley were made and this was found to be β -glucan. In an early experiment, supplementation of barley based diets of high and low viscosity with β -glucanase resulted in increased feed consumption, live weight and improved feed conversion (Hesselman and Aman, 1986). They noticed that the birds receiving diets supplemented with β -glucanase degraded about 67% of the β - glucans in the small intestine. Edney et al. (1989) Carried out an experiment with broiler chicks fed diets containing wheat, hulled barley, hulless barley or oat groats supplemented with a crude enzyme product containing endo-β-glucanase activity. Enzyme addition improved growth fed on hulled-barley, hulless barley or oat-groat diets ($P<0.01$). Where as no improvement was evident for chicks fed on wheat. In a later experiment, it was conceded that the increased level of NSP in wheat was mainly arabinoxylan (Choct and Annison, 1990; Annison, 1991). Supplementation of wheat-based diets with commercial glycanases (arabinoxylanases, pentosanases, xylanases) . Choct et al (1995) demonstrated an increment in the AME by 24% and the

FCE by 25% in 3-4 weeks old broiler chickens.

Pettersson et al. (1990) studied the effect of Glucanase GP 500® and Novozyme-343® supplementation having β -glucanase and arabinoxylanase activities on diets based on barley, wheat and rye. They obtained improved growth rate, food intake and food conversion efficiency in chicks.

Most cereal grains and their by products contain large amounts of arabinoxylan and cellulose as the main NSP. But utilisation of arabinaxylan as an energy source by monogastrics is doubtful. Since the 5-carbon sugars are not efficiently utilised in either pigs or poultry (Schutte, 1991). However, a large bulk of the NSP Consisting of polymers of 6-carbon sugars if supplemented with enzyme can be used efficiently as an energy source. Cellulose can be completely broken down to glucose by cellulase which is a complex of enzymes containing exoglucanase and endoglucanase plus cellobiase, which is β (1-4) glucosidase. Some of the workers have reported that for the complete hydrolysis of insoluble cellulose, a synergistic action between cell well components is required. Minerals associated with cell walls are largely solubilised by cellulase (Bremmer, 1970, Ryu and Mandels, 1980). Studies undertaken to evaluate the effects of cellulase from Trichoderma viride on nutrient utilisation by broilers fed diet containing high level of wheat bran revealed a significant effect on reducing feed consumption and apparent effect in improving feed to gain ratio. Also, cellulase supplementation significantly improved the digestibility of cell-wall components. Calcium, phosphorus, iron, zinc and copper associated with cell walls

were solubilised by cellulase and were made available for absorption (Nahm and Carlson, 1985).

Netke (1990) studied the effect of enzyme supplementation (Multiple enzyme preparation) in low and high energy diets of broilers. The results revealed that weight gain, efficiency of feed utilisation and overall performance of broilers fed low energy diets supplemented with enzyme were comparable with the birds kept on high energy diets having no added enzymes .

In another study, Nagalakshmi and Devegowda (1991) investigated the performance of broilers as influenced by the supplementation of multienzyme (mainly cellulase) preparation to low, moderate and high fibre diets. Chicks fed high fibre diets supplemented with enzymes showed significant improvement in body weight and feed conversion ratio. Similarly, Kadam and Rajmane (1990) and Rajmane (1992) obtained significant improvement in the performance of broilers when diet containing maize, groundnut cake, soyabean meal and rice polish was supplemented with a commercial enzyme preparation having the activities of enzymes viz; protease, amylase, cellulase, lipase and pectinase.

Bhatt et al. (1991) added various levels (0, 20, 25 & 30 g/100 kg) of NovozymeSP -243 containing cellulase and hemicellulase activity in conventional broiler diet. Chicks fed 20g/100kg showed significantly highest weight gain and feed efficiency than other experimental groups. They further noticed that the stimulating response of enzyme supplementation was more during early stages

of growth. However, Arora et al. (1991) obtained significant improvement in weight gain and lower feed conversion ratio in a finisher diet supplemented with 0.75% Novozyme Sp- 243.

Pettersson and Aman (1991) fed diets based on bran and inner endosperm from oat with and without fibre degrading enzyme supplementation to day old broiler chicks. Improvement in weight gain and feed efficiency was observed in group fed oat bran diet supplemented with enzyme than the group fed inner endosperm diet. In a subsequent experiment, Pettersson and Aman (1992) observed significant improvement in live weight gain, feed intake and feed conversion efficiency in chicken fed diets based on extracted oat bran with enzyme supplementation.

Friesen et al. (1992) also demonstrated that the nutritive value of cereal grains such as wheat, barley, oat and rye could be improved by the addition of crude fungal extracts, which when fed to young chicks reflecting an increased weight gain and feed conversion efficiency. Diets based on wheat and barley supplemented with Roxazyme-G @ 100mg/kg, Brenes et al. (1993) obtained improved weight gain by 13% and feed to gain ratio by 10% in broiler chicken in 42 days experimental period. Enzyme supplementation improved the nutritive value of poor quality feed ingredients (Devegowda and Nagalakhsmi, 1992, Flores et al., 1994). Besides NSP, other antinutritive factors such as tannins bind protein, affects the performance of chicks and lower the nutritive value of poor quality feed ingredients, but the deleterious effect of tannin can be minimised by supplementation of enzyme preparation containing

protease (Pillai et al. , 1995). Other workers also suggested that the digestive losses could be compensated by supplementation of enzymes having activities of cellulase (Anandkumar, 1993) and amylase (Arvind et. al., 1994) in broiler ration with high tannin content.

Swain et al. (1996) conducted an experiment with broilers fed low and high fibre diets having autoclaved or unautoclaved rice bran, wheat bran and sunflower cake supplemented with digestive enzymes having activities of amylase, protease, lipase, cellulase and pectinase. Addition of 1.0 and 1.5 g multienzyme in high fibre diet supported significantly higher growth and better feed efficiency than unsuppleamented diet, even when it was autoclaved. They further obtained an increased in ME-content and reduction in retention of fat in enzyme supplemented diet.

Increased fibre levels in poultry ration with the incorporation of high fibre feed ingredients depressed the body weight, feed conversion efficiency (Rajeshwara Rao, 1994), while Tyagi and singh (1996) obtained inconsistent result in respect to body weight gain and feed conversion efficiency on experimental rations containing 4.5 to 9.0% fibre levels. However, supplementation of enzymes improved body weight and feed conversion efficiency of broilers.

Arunbabu and Devegowda (1997) conducted a feeding trial of 8 weeks duration in male broiler chicks to study the effect of supplementation of a multienzyme (Nutrizyme) to diets containing crude fibre levels 5, 7.5, 10 and 12.5%. Increased fibre level significantly depressed the body weight and feed conversion

efficiency. Addition of enzymes increased body weight gain upto 10% fibre level, while feed conversion efficiency improved significantly with enzyme supplementation in 5% and not in other dietary fibre levels, which they attributed due to inadequacy of the enzyme supplemented in proportion to the amount of substrate.

In a similar experiment, Suresh and Devegowda (1996) supplemented experimental rations containing various levels of fibres (5.5, 6.5 and 7.5%) with multienzyme at three levels (0, 0.75 and 1.5 Kg/ton of feed). A higher level of enzyme supplementation (1.5 Kg/ton) resulted in significant ($P<0.05$) improvement in body weight in group fed diets containing 5.5 and 6.5 % crude fibre and feed efficiency in group fed diets containing 5.5 and 7.5% crude fibre.

Scott et al. (1977) investigated the response of enzyme supplementation on wheat based diet to broiler chicks and obtained 6.2 and 7.5% higher body weight gains, 5.3 and 7.7% better feed efficiency, an increased AME value by 23.3 and 11.1% and nitrogen retention by 18.1% and 8.7% during starting and finishing phases of growth respectively. Such improvements in performance of broiler chickens fed wheat based diets supplemented with enzyme were also observed by several workers (Schutte et al., 1990; Hadden, 1992; Bedford and Classen, 1992; Marquardt et al., 1994; Veldman and Vahl, 1994; Hadorn and Wiedmer, 1996; Steenfeldt et al., 1998).

Purushothaman and Natanam (1998) replaced maize of Control diet with little millet at 30 and 40% levels weight to weight basis with or without supplementation of multienzyme (Ventri Gold

containing hemicellulase, cellulase, glucanase, xylanase, pectinase, amylase, protease and lipase) @ 500g / ton feed. Beneficial effects in terms of body weight gain and feed efficiency was seen in both replaced and control diet. However, in balance study, enzyme addition did not influence ME of the diet, balance of nitrogen and calcium but the phosphorus balance was improved.

EFFECT OF ENZYME SUPPLEMENTATION ON THE AVAILABILITY OF PHOSPHORUS FROM POULTRY RATIONS.

Up to about 85% of phosphorus content in feed stuffs of vegetable origin, is present as phytic acid in the form of phytate (myoinositol hexaphosphate). Under most dietary conditions the phytate phosphorus is poorly utilised by monogastrics including poultry due to lack of endogenous phytase enzyme necessary for hydrolysing it and consequently, excreted via the faeces. Due to this the birds need for phosphorus, has to be met through supplementing diet with inorganic phosphorus source such as defluorinated phosphate or the dicalcium phosphate. The traditional practice of adding inorganic phosphorus in poultry ration adds to the cost of feeding besides constraints in finding the right kind of stuff for regular use. Presently in India, about 5.3 million tonnes of compounded poultry feed is being manufactured annually. Considering the minimum level of 1% addition of inorganic source of phosphorus in diet, about 53.000 tonnes of dicalcium phosphate worth Rs. 71.5 crore is required. Further the phytate phosphorus possesses strong chelating properties there by markedly reducing

the bioavailability of several multi-valent cations mainly the Ca^{2+}, Mn^{2+}, Zn^{2+}, Fe^{2+}, and Fe^{3+} by forming insoluble phytate-metal complexes. Moreover, the phytate also affect protein digestibility through formation of indigestible protein-phytate complex and also strongly inhibits the activity of amylases (Tyagi et al., 1996)

Tyagi et al. (1998) analysed various samples of cereals, cereal by products and oil cakes/ meals. The phytate phosphorus content ranged from 0.09 to 0.27% in cereals and millets, from 0.48 to 1.49% in cereal by products and from 0.45 to 0.76% among oil seed cakes /meals. Thus cereal by-products contained highest amount of phytate phosphorus followed by oil seed meals and cereals and millets.

Microbial phytase supplementation in diet of broilers markedly improved their performance, particularly the growth rate and feed intake and increased the availability of phytate phosphorus (Nelson et al. 1971).

Several reports indicated that supplementation of diet of monogastric animals with exogenous phytase enzyme of fungal origin increased the apparent digestibility of plant phosphorus (Nasi,1990; Simons et al., 1990; Beers and Jongbloed, 1992; Cole and Khan, 1994), calcium (Halle et al., 1996; Huyghebaert, 1996), magnesium (Pallauf et al., 1992) and even iron and zinc (Gebert and Wenk, 1995).

Addition of microbial phytase significantly increased the phytate degradation and phosphorus absorption at the range of 22-52% (Vanderklis and Versteeg, 1991).

Higher daily weight gain (Cantor and Perney, 1992) and higher nitrogen retention (Christensen et al., 1996) in broiler chickens with phytase supplementation in diet was also recorded.

Dungelhoef (1994) observed that supplementation of microbial phytase increased phosphorus availability from 18% to 56% in maize, from 62% to 74% in wheat and from 52% to 67% in triticale.

Martin (1995) demonstrated that rice bran in the ration of duck could be used upto 60% with microbial phytase supplementation . Reduction of phosphorus excretion by 9.6% and other minerals was also noted.

Results of Jensen et al. (1996) suggested that the levels of calcium and phosphorus could be reduced by supplementing increased level of phytase in a broiler's ration with an improved weight gain, feed intake and feed conversion efficiency.

Christensen et al. (1996) also obtained an improved utilisation of both phytate and calcium naturally present in feed components with phytase supplementation and an improved nitrogen retention reflecting better overall performance in broiler chickens.

Results of Vetesi et al., (1998) indicated that inorganic phosphorus (Dicalcium phosphate) level could be reduced upto 50% in broiler chicken diets with the addition of phytase enzyme without any measurable changes in the production traits (daily weight gain, feed conversion ratio, ash content and mechanical stability of tibia). They obtained comparable body weight gain and improved feed

conversion rate by 5.6% with a decreased out put of phosphorus and calcium by 21% and 11% respectively.

In addition to decreasing or eliminating the need for inorganic phosphorus supplementation in poultry ration, supplementation of poultry feeds with microbial phytase reduces the environmental pollution. Majority of the phytic phosphorus present in cereal feed ingredients passed into the faeces in nondigested form and causes an increased environmental load (Khan, 1995).

INFLUENCE OF ENZYME SUPPLEMENTATION ON LITTER QUALITY

Among various factors, inclusion of feed ingredients containing high level of fibres, other NSP fractions and some other antinutritive factors lead to watery and sticky droppings. Wet excreta is a big problem in poultry industry and may cause many managemental problems. Besides environmental pollution, wet droppings may also cause increased gas production (i.e. ammonia) and fly and rodent population in the shed. This can affect the well being of the bird by way of increased stress and poor air quality. Damp litter also increased the likelihood of twisted leg and breast blisters in broilers. Reduction of the moisture content and the volume of the excreta is often noted with the supplementation of enzymes in poultry diet containing various antinutritive factors. A reduction in the excretion of nitrogen and organic phosphorus can be obtained through the use of phytase enzyme in poultry diet (Choct, 1996).

High levels of β-glucans in barley increased digesta viscosity

and consequently decreased the absorption of nitrogen and carbohydrate (Burnett, 1966; Hesselman and Aman, 1986). A reduction in sticky droppings of the chicks fed barley containing diets by supplementation of amylase enzyme has been well documented (Allred et al., 1957; Arscott et al., 1957; Fry et al., 1957 a,b; Jensen et al., 1957; Arscott and Rose, 1960; Thomas et al., 1960; Rose and Arscott, 1962).

β - glucanase supplementation of barley based diet in chicks reduced the frequency of sticky droppings due to reduction in digesta viscosity were also reported by several workers (Jensen et al., 1957; Fry et al., 1958; Moran and McGinnis, 1965; Moran et al., 1969; Herstad and McNab, 1975; Hesselman et al., 1981; Hesselman and Aman, 1986; Elwinger and Saterby, 1987; Edney et al., 1989; Pettersson and Aman, 1989; Bustany, 1996; Gowda et al., 1996; Narendranath and Shrivastava, 1996).

Willingham et al. (1959) obtained a significant reduction in moisture content from 74.8% to 60.3% in the faeces of the chicks fed barley diets supplemented with fungal amylase than that of unsupplemented diet.

Gohl et al. (1978) obtained a substantial increase in the dry matter content of the excreta of the chicks receiving barley supplemented with β - glucanase resulting a reduction in wet and sticky droppings through decreased viscosity of the intestinal contents. They found an increase in DM content of the excreta from 17.0% to 22.5%.

Benabdeljelil (1996,1997) obtained a gradual decrease in litter quality and significant increase in litter moisture content as the barley level was increased in corn based broiler ration. With supplementation of cellulolytic enzymes (Avizyme SX^{211}), an increased dry matter content in excreta and a marked reduction in sticky droppings and intestinal viscosity were noted.

Evenwith low fibre ration based on maize (Han and Yu, 1996) and maize & wheat based ration (Rajeshwara Rao and Devegowda, 1996) supplementation of enzyme decreased the viscosity of the intestinal contents and reduced the moisture content of droppings in broiler chickens. In a similar experiment, Satyamoorthy and Menachery (1996) showed that feed enzymes viz. cellulase and protease in layers ration reduced the moisture content of excreta and a decrease in digesta viscosity with a reduction in microbial load on eggs laid. Scheideler and Joroni (1996) also obtained a reduction in faecal output by 3% and intestinal viscosity in high fibre starter and grower diets in WLH pullet with supplementation of pectinase enzyme. Enzyme supplementation decreased the viscosity of intestinal contents and improved the nutrients digestibility and absorption in broiler chicken fed diets containing rye (Patel et al.; 1980, Grootwassink et al., 1989).

Inclusion of endo-β-xylanase (Pentosanase) in rye based diets of broilers had been reported to reduce the incidence of sticky droppings markedly and to improve litter quality (Pettersson and Aman, 1988, 1989; Bedford et al., 1991).

In a later experiment, Pettersson et al. (1990) reported that a

mixture of both β- glucanase and arabinoxylanase was found to be more effective in reducing the incidence of sticky droppings in chicken fed rye based diets. While supplementation of Glucanase GP 5000(R) preparation to a diet based on barely, wheat and rye affected increased absorption of nutrients in the small intestine with marked reduction in sticky droppings.

The problem of wet droppings associated with the feeding of high fibre feed ingredients like oat to broilers was alleviated by incorporation of enzyme preperations rich in β- glucanase activity (Broz and Frigg., 1986; Campbell et al., 1987).

Pattersson and Aman (1992) observed a significantly reduction in the frequency of sticky droppings by about 83% in broiler chicken fed diets based on oat bran and extracted oat bran with enzyme supplementation.

Supplementation of enzyme arabinoxylanase on wheat based diets of broilers had a positive effect on reducing wet litter and digesta viscosity as reported by Hadorn and Wiedmer (1996), Bedford and Morgan (1996); Scott et al. (1997) and Steenfeldt et al. (1998).

Phytate phosphorus, calcium and nitrogen when not properly utilised, passed into the faeces in undigested form may cause watery and sticky droppings in broilers. Christensen et al. (1996) demonstrated that phytase supplementation improved the utilisation of phytate, calcium and nitrogen responsible for watery and sticky droppings in broilers. Choct (1996) narrated that the benefit in the

use of feed enzyme (phytase) was related to environment through reduction of nitrogen and organic phosphorus output. He also observed an increased digesta passage rate and reduced excreta moisture by the use of glycanases in poultry diets.

MATERIALS AND METHODS

MATERIALS AND METHODS

The present investigation was carried out with day old broiler chicks for a period of seven weeks at Central poultry farm, Patna to study the effect of multienzyme (Polyzyme) supplementation to normal and constituted high fibre commercial diets on the performance of broilers. The experimental procedures and analytical techniques followed in the present study are described below.

PROCUREMENT OF DIGESTIVE MULTIENZYME AND ITS COMPOSITION.

A propriety multienzyme (Polyzyme) manufactured by M/S ZEUS BIOTIECH PRIVATE LIMITED, CH-26, 7th Main Saraswathipuram , MYSORE-570009, INDIA was used in this experiment. This multienzyme feed supplement was produced from Trichoderma longibrchiatum Rifai by solid state fermentation, which contained the following mentioned enzymes as declared by the company.

Endo-xylanase	=	2000 U/gm
Beta-glucanase	=	600 U/gm
Pectinase	=	60 U/gm
Amylase	=	1500 U/gm
Cellulase	=	15 U/gm
Protease	=	600 U/gm
Phytase	=	20 U/gm

Table 4. Percentage chemical composition of commercial broiler diets (starter & finisher) and other feed ingredients (ON DM BASIS)

	Commercial broiler diets		Extracted Sunflower Cake	Deoiled rice bran	Mixture of extracted Sunflower Cake & Deoiled rice bran (1:1)
	Starter	Finisher			
CP	22.85	20.28	29.42	16.12	22.63
CF	5.74	4.82	20.10	15.34	17.60
EE	4.26	5.68	2.62	1.14	1.80
Ca	1.35	1.48	0.43	0.31	0.36
P	0.62	0.69	1.12	1.73	1.40
*ME (Kcal/kg)	2800	2900	1760	2200	1980

* ME - Value of (i) Commercial broiler diets (Starter & finisher) from M/S COMPFED RANCHI (1998)

(ii) Extracted Sunflower Cake from Nesheim et al. (1979)

(iii) Deoiled rice bran from Purushothaman et al. (1990)

CONSTITUTION OF HIGH FIBRE DIETS WITH COMMERCIAL BROILER RATIONS (STARTER AND FINISHER) AND HIGH FIBRE FEED INGREDIENTS WITH THEIR ANALYSIS.

The required quantity of commercial broiler diets (starter & finisher) supplied by COMPFED, RANCHI to Central poultry farm Patna, Department of Animal Husbandry, Bihar and high fibre feed ingredients viz; deoiled rice bran & extracted sunflower cake supplied by Cattle feed factory unit, Patna dairy project, B-9, Shrikrishnapuri, Patna-800001 were procured. The representative samples of these commercial broiler diets (starter & finisher) and high fibre feed ingredients (deoiled rice bran & extracted sunflower cake) were analysed for their proximate compositions, calcium and total phosphorus content and their analytical values on dry matter basis are presented in table 4.

PREPARATION OF EXPERIMENTAL RATIONS AND THEIR ANALYSIS.

A mixture of high crude fibre cereal by product (Deoiled rice bran) and high crude fibre vegetable protein source supplement (Extracted sunflower cake) in 1:1 ratio was prepared. Four basal diets were prepared one as such and the other three by increasing the existing crude fibre content of commercial broiler diets (starter & finisher) to nearly 1,2 & 3% by substitution with prepared mixture of deoiled rice bran and extracted sunflower cake at a level of 10, 20 & 30%, replacing commercial broiler diets without disturbing the crude protein content. Each basal diet was either unsupplemented

or supplemented with two levels of multienzyme (polyzyme) viz; 0.05 & 0.10% feed supplement. The outline of the treatments were as follows:-

(a)	Standard commercial broiler diet with no substitution by mixture of deoiled rice bran and extracted sunflower cake.	(i) No multienzyme supplementation - T_1 (ii) Plus 0.05% multi-enzyme supplementation - T_2 (iii) Plus 0.10% multi-enzyme supplementation. - T_3
(b)	Standard commercial broiler diet with nearly 1% more crude fibre by subsituting 10% of mixture of deoiled rice bran & mixture of deoiled rice bran & extracted sunflower cake.	(i) No multienzyme supplementation - T_4 (ii) Plus 0.05% multi-enzyme supplementation - T_5 (iii) Plus 0.10% multi-enzyme supplementation - T_6
(c)	Standard commercial broiler diet with nearly 2% more crude fibre by substituting 20% of mixture of deoiled rice bran & extracted sunflower cake.	(i) No multienzyme supplementation - T_7 (ii) Plus 0.05% multi-enzyme supplementation - T_8 (iii) Plus 0.10% multi-enzyme supplementation - T_9
(d)	standard commercial broiler diet with nearly	(i) No multienzyme supplementation - T_{10}

Table 5. Percentage composition and nutrients content of experimental starter rations

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
Commercial broiler starter ration	100	100	100	90	90	90	80	80	80	70	70	70
Mixture of Extracted sunflower Cake &Deoiled rice bran (1:1)	---	---	---	10	10	10	20	20	20	30	30	30
Polyzyme	---	+	++	---	+	++	---	+	++	---	+	++
CP(Determined)	22.85	22.90	22.94	22.77	22.81	22.86	22.70	22.75	22.79	22.64	22.67	22.71
CF(Determined)	5.74	5.76	5.80	6.86	6.87	6.89	8.02	8.05	8.06	9.20	9.22	9.25
EE(Determined)	4.26	4.24	4.21	3.96	3.95	3.93	3.72	3.70	3.67	3.46	3.42	3.40
Ca(Determined)	1.35	1.37	1.32	1.24	1.23	1.26	1.13	1.15	1.11	1.05	1.06	1.03
P (Determined)	0.62	0.63	0.60	0.68	0.70	0.71	0.77	0.78	0.75	0.84	0.82	0.85
ME(Kcal/kg) (Calculated)	2800	2800	2800	2718	2718	2718	2636	2636	2636	2554	2554	2554

--- = No Supplementation of polyzyme

+ = 50g/100 kg feed supplementation of polyzyme

++= 100 g/100 kg feed supplementation of polyzyme.

Table 6. Percentage composition and nutrients content of experimental finisher rations

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
Commercial broiler finisher ration	100	100	100	90	90	90	80	80	80	70	70	70
Mixture of Extracted sunflower cake &Deoiled rice bran (1:1)	---	---	---	10	10	10	20	20	20	30	30	30
Polyzyme	---	+	++	---	+	++	---	+	++	---	+	++
CP (Determined)	20.28	20.33	20.37	20.42	20.45	20.49	20.66	20.70	20.75	20.87	20.91	20.94
CF (Determined)	4.82	4.84	4.85	6.02	6.04	6.07	7.28	7.29	7.32	8.52	8.55	8.57
EE (Determined)	5.68	5.65	5.64	5.23	5.20	5.18	4.82	4.80	4.77	4.44	4.43	4.40
Ca (Determined)	1.48	1.45	1.50	1.35	1.37	1.34	1.20	1.23	1.25	1.11	1.09	1.15
P (Determined)	0.69	0.67	0.70	0.74	0.76	0.73	0.81	0.79	0.83	0.87	0.90	0.86
ME(Kcal/kg) (Calculated)	2900	2900	2900	2808	2808	2808	2716	2716	2716	2624	2624	2624

--- = No Supplementation of polyzyme

\+ = 50g/100 kg feed supplementation of polyzyme

++= 100 g/100 kg feed supplementation of polyzyme.

3% more crude fibre by substituting 30% of mixture of deoiled rice bran & extracted sunflower cake.	(ii) Plus 0.05% multi-enzyme supplementation	- T_{11}
	(ii) Plus 0.10% multi-enzyme supplementation	-T_{12}

The detailed percent composition of all the experimental rations (starter & finisher) and their proximate compositions, calcium & total phosphorus content on dry matter basis are presented in table 5 & 6.

EXPERIMENTAL TECHNIQUE

250 day old broiler chicks of commercial strain developed by Central poultry farm, Patna, Department of Animal Husbandry, Bihar were procured for the experiment. The chicks were vaccinated against Marek's disease at the time of procurement and against Ranikhet (Newcastle) disease on 2nd day of procurement. The crippled chicks and those with extreme body weight were discarded from the study. On first day, the chicks were given only crushed maize and then given commercial broiler starter diet for three days. On 5th day, these chicks (240) were wing banded, weighed and randomly divided into twelve equal experimental groups of 20 chicks in each group replicated twice so that averages of body weight were similar in all groups. On the day of assigning the treatments, the live weight of chicks were ranged from 42 to 50 gms. On 15th day of procurement, the chicks were vaccinated against Gumboro disease. The chicks were reared on deep litter of dry saw dust. The litter was kept 2.5 inch thick for the first month and 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. Commercial starter & finisher rations were fed to chicks from 0-4 weeks and 4-7 weeks respectively. All mash system of feeding was followed. The broiler chicks were reared under uniform conditions of housing including brooding, feeding, watering, lighting and other managements.

OBSERVATION AND SAMPLING

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

BODY WEIGHT

The chicks were weighed individually at the start of the experiment and subsequently at weekly intervals. The weekly live weight gain was calculated form the difference in body weight attained at the end and at the start of the period in question.

FEED INTAKE

A weekly record of the feeds offered and weigh back was maintained for each group to calculate feed consumption.

FEED CONVERSION RATIO

The feed conversion ratio (FCR) was calculated from the feed consumption and body weight gain to show the feed efficiency by

using the following formula:-

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

PERFORMANCE INDEX

In order to take into account the feed efficiency as well as growth rate, an index was obtained for each experimental diet by dividing the average weight gain by the feed conversion figure (Bird, 1955). It was calculated as follows:-

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

MORTALITY RATE

Regular observations were made to record the occurrence of death in experimental broilers to estimate mortalities relative to experimental groups.

BALANCE STUDY

Balance trials for energy (ME), nitrogen (crude protein) and phosphorus were conducted at two different phases of growth during the experimental period. In each trial, 4 birds from each treatment and 2 from each replicate were randomly selected and transferred to metabolic cages. Preliminary feeding was given for adaptation of broilers to the new system of housing and management.

Polythene sheets of appropriate size were spread over the droppings trays for the collection of mixed excreta after the third day of the preliminary period and at the start of 4^{th} and 7^{th} week of

broiler's age. The chicks were offered a weighed amount of experimental rations at a fixed morning hour everyday during the trial week. The mixed droppings were also quantitatively collected at the end of every 24 hours and pooled to know the total amount of excrement voided for five days. The feeding time and time of collecting excreta, especially on the first and last day were kept the same. Daily feed intake was calculated after deducting weigh back from the feed offered. Representative feed samples were drawn from the bulk, finely ground and stored in polythene bottles for dry matter percentage and chemical analysis. The groupwise aliquots from dropping after thorough mixing with the help of spatula was drawn for dry matter with its follow up analysis and nitrogen estimation, separately. Aliquots for three days were pooled together for nutrient analysis. For nitrogen estimation, samples in duplicates were preserved in 5% sulphuric acid in wide mouthed glass stoppered bottles kept in refrigerator (ISI, 1967). For dry matter estimation, about 10 ml of 2% acetic acid was added for every 50 g of the excreta and dried in an oven at about 80•° C till constant weight was obtained (ISI, 1967). For phosphorus estimation, colorimetric method was adopted with the help of photoelectric colorimeter. The developed blue colour on treating the mineral extract with ammonium molybdate reagent and then reducing with ferrous sulphate reagent was recorded for optical density using red filter (No. 66) at 660-720 nm wavelength (Pathak et al., 1996).

CARCASS STUDY

At the end of 7 weeks, three birds from each dietary treatment

group were randomly selected for slaughter and processing. The birds to be slaughtered were not offered any feed for 24 hours but were given water ad- libitum. Each bird was weighed immediately before slaughter. The difference between live weight and immediately before slaughter was recorded as shrinkage and was calculated as percentage of live weight. The birds were bled by clean incision at the base of ear lobes and allowed to bleed and weighed. The weight loss before slaughter and after slaughter was recorded as blood loss. 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, dried and the weights were recorded which reflected the feather loss. The head was removed by severing the cervical at the base of the occipital bone and the feet and shanks were cut at the tibiotarsal joints, wing tips was removed and dressed weight of the carcass was recorded. Thus the dressed weight consisted of fasted weight minus blood, feather, head, feet and shanks, wing tips keeping the viscera intact. The birds were then eviscerated by removing the crops, gullet, trachea and viscera. The lungs were scrapped off. The giblets (liver, heart and gizzard) were removed from the viscera and the weight of the 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 linning was pulled off and the weight was recorded. The heart was freed from blood clots and adhering vessels. The weight of the carcass alongwith giblet was recorded as eviscerated weight. The dressing percentage and eviscerated percentage were calculated on the basis of preslaughter live weight at 7th week of age.

The neck of three carcasses from each group were removed as closely to the clavicles as possible weight of neck and giblets were recorded separately and were expressed as percentage of preslaughter weight. The ready to cook weight was calculated by substituting the weight of neck and giblets from the eviscerated weight of the carcass. Samples of breast and thigh muscles were taken from carcasses of each group with a scissor and sharp knife. The samples were wrapped in polythene bag and kept in deep freeze for proximate analysis.

For the determination of meat : bone ratio, the carcasses were then cooked in enamelled tray for $1\frac{1}{2}$ hour in an oven at 163°C (Dawson et al., 1957). After every 25 minutes, the carcasses were turned side up so that each carcass 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 carcasses alongwith trays were removed from the oven and individually weighed to obtain the cooked weight of the carcass and the difference between ready to cook weight and cooked weight of carcass referred to cooking loss and was expressed as percentage of ready to cook weight. Edible meat and bones were separated manually. The bones were dried in oven to a constant weight at 80° C. The weight of the dried bones was recorded and was also expressed as percentage of ready to cook weight. This weight of the dried bones was deducted from the ready to cook weight and the difference constituted the weight of raw edible meat (flesh + skin + fat). Weight of cooked edible meat was obtained by substracting the weight of the dried bones from cooked weight of the carcass. The

ratios of raw edible meat to bone and cooked edible meat to bone were calculated as follows :-

$$\text{Ratio of raw edible meat to bone} = \frac{\text{Ready to cook weight - Weight of oven dried bones}}{\text{Weight of oven dried bones}}$$

$$\text{Ratio of cooked edible meat to bone} = \frac{\text{Cooked weight of carcass - Weight of oven dried bones}}{\text{Weight of oven dried bones}}$$

ECONOMICS OF PRODUCTION

The economics of broiler production was calculated on the cost of feed and levels of multienzyme (Polyzyme) supplemented to the feed per kg live weight gain. The economics is thus dependent on the cost of commercial broiler diets (starter and finisher) and multienzyme (Polyzyme) supplements used in the experiment along with the feed efficiency of various treatments. Thus most profitable diets for chicken have been chosen by comparing diets on body weight gains at the end of the experiment to the investment on feed and dietary enzyme supplements.

METHODS OF ANALYSIS

Representative samples of standard commercial broiler diets (starter & finisher), high fibre feed ingredients (deoiled rice bran and extracted sunflower cake), droppings and constituted experimental rations were analysed for their proximate principles according to procedure laid down by AOAC (1990) and for their total phosphorus content using the colorimetric method as outlined by Pathak et al. (1996). While calcium was determined in commercial broiler diets, feed ingredients as well as experimental rations only using the method of McCrudden and Neumann as modified by

Talapatra et al. (1940). The moisture content of breast and thigh muscles was determined by drying 10 g sample in an oven at 100° C for 18 hours. For ether extract and nitrogen (Kjeldahl nitrogen) determination, the samples were grinded in a glass pestle and morter. Representative samples of breast and thigh muscles were taken for determining moisture, nitrogen (crude protein) and ether extract as outlined by AOAC (1990).

The gross energy of each experimental ration and excreta was estimated from the proximate principles by multiplying with the calorific values of their respective nutrients. From gross energy of each ration and excreta, ME was calculated as per the method of Hill and Anderson(1958) as follows :-

$$\text{AME of diet (K. cal/kg)} = \frac{(FI \times GE) - (EW \times GE)}{FI}$$

Where,

AME = Apparent metabolisable energy (Kcal/kg)

FI = Feed intake (g/bird/day)

GE = Gross energy of feed or excreta (Kcal /g)

EW = Weight of dried excreta (g/bird/day)

All the above estimates were done in duplicate.

STATISTICAL ANALYSIS

The data of treatment means with respect to the parameters studied were subjected to statistical analysis by using the analysis of variance (ANOVA) following the procedure of Snedecor and Cochran (1968). Duncan's multiple range test (DMRT) was applied for testing the significance of mean differences (Duncan, 1955).

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

BODY WEIGHT GAIN

The average weekly body weight gain of dietary treatments are given in table 7. The treatment means of body weight gain during different experimental periods and their analysis of variance are presented in table 8 & 9 and appendix table 1 respectively.

0-4 WEEKS

The body weight gain during this phase of growth significantly 2($P<0.05$) influenced by diet and level of enzyme supplementation but was not influenced by the interaction of level of enzyme and diets. The average body weight gain ranged from 365 to 510 g. As the level of fibre in the control (Commercial diet) was increased by substitution with the mixture of extracted sunflower cake and deoiled rice bran, a gradual decline in body weight gain was observed. Control diets substituted with mixture at 20% and 30% (F_2E_0 and F_3E_0) reflected significantly ($P<0.05$) lower body weight gain in comparison to control but at 10% substitution ($F_1 E_0$) though the body weight gain was lower but not significantly ($P<0.05$) different. 10% substituted ration ($F_1 E_0$) was not significantly ($P<0.05$) different from control ration while the former was comparable with 20% substituted ration. The lowest weight gain (365 g) was observed in ration with 30% substitution ($F_3 E_0$) but was comparable with 20%($F_2 E_0$) substituted ration. Effect of increment in fibre level of control diet was clearly noted, in which an increase in fibre level in the ration reflected significantly ($P<0.05$) lower body weight gain

than control, however the value of weight gain at two fibre levels ($F_1 E_0$ and $F_2 E_0$) were comparable.

Improvement in body weight gain in all multienzyme supplemented groups irrespective of fibre level was observed. Control diet at 0.05% level of supplementation ($E_0 E_1$) reflected highest body weight gain (510g) but was comparable with 10% substituted ration at the same level of supplementation (F_1E_1) and also with 0.01% supplemented control and 20% substituted ration. 30% substituted ration at 0.05 and 0.10% supplementation with enzyme ($E_3 E_1$ & $E_3 E_2$) did not differ significantly ($P<0.05$) with control unsupplemented diet (F_0E_0). With respect to level of enzyme, no beneficial effect was observed by increasing the level of enzymes from 0.05 to 0.10% in the dietary treatments during this phase of growth. Chicks fed control ration supplemented with enzyme at 0.10% (E_0E_1) gave similar body weight gain with 10% and 20% substituted diets supplemented with both levels of enzyme. ($F_1 E_1$ $F_1 E_2$ & $F_2 E_1$ & $F_2 E_2$)

4-7 WEEKS

The body weight gains during this phase of growth were significantly ($P<0.05$) affected by diet, level of enzyme and their interactions. During this phase of growth, average body weight gain was ranged from 500 to 700g. A similar effect in body weight gain was observed as the level of fibre was increased in commercial diet substituted with mixture as was observed during starting phase of growth. The lowest weight gain was obtained in 30% substituted ration ($F_3 E_0$) and was significantly ($P<0.05$) lower form control,

10% and 20% substituted rations ($F_0 E_0$, $F_1 E_0$ & $F_2 E_0$) . Chicks fed 10% substituted diet (F_1E_0) were similar in body weight gain with control group ($F_0 E_0$) but was significantly ($P<0.05$) higher than 20% and 30% substituted groups. ($F_2 E_0$ & $F_3 E_2$). Considering the fibre levels in the diet, a gradual increase in fibre level reflected a gradual decrease in body weight gain and the values obtained were significantly ($P<0.05$) different from each other.

Improvement in body weight gain was also observed through enzyme supplementation during this phase of growth. The maximum body weight gain (700 g) was observed in control diet supplemented with enzyme at 0.05% level (F_0E_1) and the value was significantly ($P<0.05$) higher than all supplemented groups. The body weight gain in 30% substituted group supplemented with 0.01% enzyme (F_3E_2) was comparable with 10% and 20% substituted group at the same level of supplementation (F_1E_1&F_2E_1) Similarly, 10% substituted ration with supplementation at 0.05% (F_1E_2) was not significantly different with control ration supplemented with 0.10% enzyme level (F_0E_2). At all enzyme levels, 0.05% supplementation showed significantly ($P<0.05$) higher body weight gain in comparison to 0.10% and unsupplemented diets. The difference in results during starting and finishing phase of growth may be that the enzyme and fibre level being more critical during the later period and supplementation of enzyme showed positive effect in fibre utilisation.

0-7 WEEKS

The body weight gain during this combined phase of growth

was significantly ($P<0.05$) influenced by the diet, enzyme and interactive effects between diet and enzyme. The average body weight gain was ranged from 870 to 1210 g. An increase in fibre level of control diet by substitution with mixture of extracted sunflower cake and deoiled rice bran reflected a decrease in body weight gain accordingly, however control diet with 10% substitution was not significantly ($p<0.05$) different from the control, while at higher level of substitution a significantly ($p<0.05$) decreased body weight gain was noticed. Chicks fed 30% substituted ration (F_3E_0) showed significantly ($P<0.05$) lowest body weight gain in comparison to other groups. The body weight gain of chicks fed either 10% or 20% substituted rations (F_1E_0&F_2E_0) were comparable.

An apparent effect of enzyme supplementation was seen in control as well as in mixture substituted rations. The highest body weight gain (1210 g) was observed in control diet supplemented with 0.05% enzyme (F_0E_1) and was significantly ($p<0.05$) higher than all the groups. Control diet supplemented with 0.10% enzyme (F_0E_2) was comparable with 20% substituted ration at the same level of enzyme (F_2E_2) as well as 10% substituted ration with 0.05% enzyme level (F_1E_1). Similarly, 0.05% enzyme supplemented diet having 10% substitution (F_1E_1) and 20% substitution with mixture (F_1E_1) was comparable. 30% substituted ration with supplementation at 0.05 and 0.10% (F_3E_1& F_3E_2) was not significantly ($p<0.05$) different from the control ration. In general higher level of enzyme did not produce profound effect and was numerically lower in comparison to 0.05% level of supplementation and the values were comparable. Therefore a beneficial effect of supplementation of

enzyme was observed either on the diet without or with increased fibre level content.

Results of body weight gain indicated that the ration in which substitution with a mixture of high fibrous extracted sunflower cake and deoiled rice bran was made to any level gave lower body weight gain. This might be due to decreased metabolisable energy in the substituted ration. A dilution of metabolisable energy by incorporation of high fibrous feed ingredients reflected a decrease in body weight gain was also reported by Rajeshwara Rao (1994). The result of the present investigation also agreed well with the result of Arun Babu and Devegowda (1997) who obtained a gradual but significant depression in body weight gain when the fibre level of the diet were increased in the range of 5,7.5,10 and 12.5%. However, Tyagi and Singh (1996) obtained inconsistent result with respect to body weight gain containing 4.5 to 9.0% fibre level. The data indicated an improvement in body weight gain at both the levels of enzyme supplementation in control as well as high fibre level rations. The improvement in body weight gain of chicks fed control ration supplemented with enzyme suggested a better utilisation of the available nutrients from the NSP fractions and a reduction in the harmful effect of the antinutritive factors of the diet. The better growth rate with enzyme supplementation to conventional diet of chicks was also reported by Kadam and Rajmane (1990), Rajmane (1992) and Purushothaman and Natanam (1998). These workers obtained a significant improvement in the performance of broiler in terms of body weight gain, when conventional diet was supplemented with commercial multienzyme. Beneficial effect was also seen on

Table 7. Treatment means of body weight gain (g/chick) and feed intake (g/chick) in different periods

Treatment No.	Ist week		2nd week		3rd week		4th week		5th week		6th week		7th week	
	Weight gain	Feed intake	Weight gain	Feed intake	Weight gain	Feed intake	Weight gain	Feed intake	Weight gain	Feed intake	Weight gain	Feed intake	Weight gain	Feed intake
T1	54	56.25	92	163.26	130	252.45	171	430.98	184	476.18	228	694.50	196	753.78
T2	65	68.32	102	175.44	149	274.22	194	476.52	230	504.22	252	710.17	218	755.61
T3	60	63.65	104	178.60	144	267.54	182	470.21	214	474.38	236	695.42	210	748.20
T4	52	58.57	87	166.50	122	258.63	164	442.80	185	572.75	218	732.14	212	774.21
T5	58	60.10	96	170.25	143	266.35	178	458.05	202	455.64	242	679.05	211	746.86
T6	59	64.18	100	176.75	138	264.20	173	477.17	189	394.45	225	658.31	216	703.94
T7	47	54.40	81	160.18	115	242.50	157	430.92	178	541.50	214	724.66	208	765.84
T8	57	65.36	93	177.90	137	270.15	173	475.59	192	446.86	229	689.10	209	741.74
T9	59	70.48	99	182.86	139	283.60	183	490.26	208	462.20	220	675.21	212	747.39
T10	40	49.90	73	152.50	106	224.34	146	390.86	140	404.42	192	662.49	173	708.09
T11	45	57.15	86	167.00	123	253.28	161	431.42	186	430.52	218	686.53	201	738.30
T12	48	59.82	84	164.10	126	265.75	172	460.63	198	511.50	223	714.55	209	759.85

growth with the addition of enzyme feed supplement on high fibre mixture substituted diets. The body weight gain of chicks fed high fibre diet supplemented with enzyme was as good as to those birds fed control diet without any enzyme supplementation. That the supplementation of enzyme on the rations with high fibre level by inclusion of low quality feed ingredients or high fibre conventional feed ingredients improved growth rate was also reported by several workers (Netke, 1990; Nagalakshmi and Devegowda, 1991; Swain et al., 1996; Tyagi and Singh, 1996; Suresh and Devegowda, 1996; Arun babu and Devegowda, 1997; Purshothaman and Natanam, 1998). Netke (1990) obtained comparable body weight gain in the birds fed low energy diet supplemented with multienzyme as compared to the birds kept on high energy diet having no added enzyme. Results also agreed well with the result of Nagalakshmi and Devegowda (1991) and Swain et al. (1996), who obtained significantly higher growth rate in high fibre diet supplemented with multienzyme than unsupplemented diets.

FEED CONSUMPTION

The treatment means of weekly feed intake and total feed consumption of chicks during different experimental periods and their analysis of variance are presented in table 7, 8 & 9 and appendix table 2 respectively.

0-4 WEEKS

The feed intake during this phase of growth ranged from 818 to 995 g was significantly ($P<0.05$) affected by dietary treatments.

(T_{10}) showed significantly (P<0.05) lower feed consumption in comparison to control and other substituted diets. No significant (P<0.05) differences in feed consumption was observed in chicks fed either control diet or 10% and 20% substituted diets. Enzyme supplementation in all dietary treatments significantly (P<0.05) improved feed consumption.

Supplementation of enzyme at 0.05 and 0.01% levels gave comparable feed consumption and were significantly (P<0.05) higher than the respective unsupplemented diets. By comparing the effect of 0.05% and 0.10% levels of enzyme supplementation, 10% and 20% substituted diets showed similar result but comparable with 30% substituted diet supplemented at 0.10% level of enzyme.

4-7 WEEKS

The mean feed consumption was significantly (P<0.05) affected by the diet, enzyme and interactive effects between diet and enzyme. The feed consumption during this period ranged from 1707 to 2079 g. Chicks fed 30% substituted diet showed significantly (P<0.05) lower feed consumption in comparison to other unsupplemented diets. However, chicks fed 10% and 20% substituted diets showed significantly (P<0.05) higher feed consumption from control. Enzyme supplementation influenced feed consumption only in substituted high fibre diets. The feed consumption of chicks fed control diet with or without supplementation of enzyme did not differ significantly (P<0.05) . A reduction in feed intake was observed in chicks fed 10% and 20% substituted diets supplemented at both levels of enzyme, while an increased feed consumption was observed

in chicks fed 30% substituted diet supplemented at both the levels of enzyme. 0.05% level of enzyme supplementation in all substituted diets reduced feed intake in chicks as compared to control diet. 0.10% supplementation of enzyme in 20% and 30% substituted diets gave similar feed consumption with control diet supplemented at this level.

0-7 WEEKS

The feed consumption during the entire experimental period ranged from 2593 to 3006 g and was significantly ($P<0.05$) influenced by the diet, enzyme and interactive effects between diet and enzyme. The lowest feed consumption was observed in chicks fed 30% substituted diet and was significantly ($P<0.05$) lower from all other groups. Chicks fed 10% substituted diet showed significantly ($P<0.05$) highest feed consumption than control but was not different form the chicks fed 20% substituted diet. However, the feed consumption of chicks fed 20% substituted diet and control diet were comparable. No clear cut trend of effect of enzyme supplementation was seen among various groups. Feed consumption was found to be increased with 0.05% level of enzyme in control, while there was no difference in 0.10% supplemented and unsupplemented diets. A significant ($P<0.05$) reduction in feed intake was observed in chicks fed 10% substituted diet at both levels of enzyme supplementation, while no effect of enzyme supplementation in feed consumption was seen in 20% substituted diet. However, chicks fed 30% substituted diet with enzyme supplementation showed increased feed consumption. The feed

Table 8: Treatment means of body weight gain (g/chick) and feed consumption (g/chick) during different experimental periods

Treatment No.	Body weight gain			Feed consumption		
	0-4 weeks	4-7 weeks	0-7 weeks	0-4 weeks	4-7 weeks	0-7 weeks
T1	447^{cde} ±5.76	608^{bc} ±5.97	1055^{cd} ±14.69	902.94^{bc} ±13.44	1924.46^{bc} ±23.78	2827.40^{bcd} ±11.63
T2	510^{g} ±11.61	700^{f} ±2.03	1210^{h} ±11.42	994.50^{ef} ±6.13	1970.00^{cd} ±28.07	2964.50^{ef} ±42.47
T3	490^{fg} ±15.72	660^{e} ±6.57	1150^{g} ±14.44	980.00^{ef} ±20.14	1918.00^{bc} ±34.41	2898.00^{def} ±23.06
T4	425^{bcd} ±9.70	615^{c} ±8.47	1040^{bc} ±13.62	926.50^{bcd} ±15.34	2079.10^{e} ±20.34	3005.60^{f} ±66.75
T5	475^{efg} ±15.39	655^{e} ±3.28	1130^{fg} ±4.07	954.75^{de} ±9.04	1881.55^{b} ±9.84	2836.30^{bcde} ±31.73
T6	470^{ef} ±15.18	630^{d} ±3.47	1100^{ef} ±14.31	982.30^{ef} ±10.83	1756.70^{a} ±39.80	2739.00^{b} ±56.26
T7	400^{ab} ±17.37	600^{b} ±2.57	1000^{b} ±18.71	888.00^{b} ±22.46	2032.00^{de} ±42.72	2920.00^{def} ±42.12
T8	460^{def} ±16.82	630^{d} ±2.60	1090^{def} ±15.52	989.00^{ef} ±29.98	1877.70^{b} ±11.36	2866.70^{bcde} ±34.97
T9	480^{efg} ±12.58	640^{d} ±3.58	1120^{fg} ±13.08	1027.20^{f} ±9.62	1884.80^{b} ±16.04	2912.00^{def} ±61.78
T10	365^{a} ±13.29	505^{a} ±2.49	870^{a} ±13.33	817.60^{a} ±24.89	1775.00^{a} ±6.07	2592.60^{a} ±20.06
T11	415^{bc} ±13.46	605^{bc} ±6.29	1020^{bc} ±14.48	908.80^{bcd} ±4.15	1855.35^{b} ±26.69	2764.20^{bc} ±70.58
T12	430^{bcd} ±12.17	630^{d} ±3.09	1060^{cde} ±13.37	950.30^{cde} ±7.32	1985.90^{cd} ±10.73	2936.20^{def} ±19.13
CD(P<0.05)	37.84	12.78	39.66	50.53	77.89	136.45

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

Table 9. Treatment means of body weight gain (g/chick) and feed consumption (g/chick) of chicks fed different fibre and enzyme levels

Fibre and Enzyme level	Body weight gain			Feed consumption		
	0-4 weeks	4-7 weeks	0-7 weeks	0-4 weeks	4-7 weeks	0-7 weeks
F0	482^{c} ±12.76	656^{d} ±16.99	1138^{c} ±29.13	959^{b} ±19.09	1937^{b} ±16.59	2897^{b} ±28.12
F1	457^{b} ±11.68	633^{c} ±7.74	1090^{b} ±17.82	955^{b} ±11.52	1906^{ab} ±60.52	2860^{b} ±54.76
F2	447^{b} ±16.64	623^{b} ±7.68	1070^{b} ±23.83	968^{b} ±28.09	1932^{b} ±34.03	2900^{b} ±23.70
F3	403^{a} ±13.66	580^{a} ±24.22	983^{a} ±37.06	892^{a} ±25.70	1872^{a} ±39.60	2764^{a} ±65.70
CD(P<0.05)	23.38	7.68	24.76	29.17	44.97	78.78
E0	409^{a} ±12.36	582^{a} ±17.04	991^{a} ±28.08	884^{a} ±17.03	1953^{b} ±45.30	2836 ±60.32
E1	465^{b} ±13.91	648^{c} ±13.33	1113^{b} ±26.47	962^{b} ±14.26	1896^{a} ±18.31	2858 ±32.54
E2	468^{b} ±10.02	640^{b} ±4.87	1108^{b} ±13.37	985^{b} ±11.47	1886^{a} ±33.19	2871 ±33.76
CD(P<0.05)	20.25	6.65	21.45	25.26	38.94	NS
CD (F x E) (P<0.05)	NS	13.31	42.90	NS	77.89	136.45

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

F0 = No Substitution of standard commercial broiler diet.
F1 = 10% substitution by DORB and Ext. S. F. Cake.
F2 = 20% substitution by DORB and Ext. S.F. Cake.
F3 = 30% substitution by DORB and Ext S.F. Cake.

E0 = No supplementation of multienzyme.
E1 = 0.05% supplementation of multienzyme.
E2 = 0.10% supplementation of multienzyme.

consumption of chicks fed 10% and 20% substituted diets with 0.05% level of enzyme were comparable with control diet, while 20% and 30% substituted diets with 0.1% level of enzyme were similar with control. At both levels of enzyme supplementation, the feed consumption in 10% and 20% substituted diets were similar but significantly ($P<0.05$) higher than 30% substituted diet.

Results of the feed consumption indicated that the chickens fed unsupplemented high fibre diets had a progressively lower feed intake than those fed the control diet. Often chickens are able to adapt a diet rich in dietary fibre by increasing the volume of their digestive tract, thereby increasing the relative feed intake and consequent weight gain (Hakansson, 1978). In the present case, control diet constituted with the high dietary fibre content could not influence the similar adaptation in chick. Such a decrease in feed intake was also noted by Friesen et al. (1992) and Tyagi and Singh (1996). Pettersson and Aman (1991) while comparing the diets containing oat bran and inner endosperm, obtained a lower feed intake (910g) in chicks fed oat bran than inner endosperm containing diet (1550 g) at 27 day of age. In a later experiment, these workers (1992) also obtained a reduction in feed intake in high fibre extracted oat bran diet than low fibre oat bran diet. The improvement in feed intake by enzyme supplementation in the present case was also reported by several workers (Pettersson and Aman, 1991, 1992; Friesen et al., 1992). Contrary to our findings (Choct et al., 1995; Purushothaman and Natanam, 1998; Steenfeldt et al., 1988) did not obtained improvement in feed intake by enzyme supplementation. Nahm and Carlson (1985) even obtained a reduction in feed intake

on a diet containing high level of wheat bran supplemented with enzyme.

FEED CONVERSION RATIO (FCR)

Results obtained on efficiency of feed utilisation of broilers fed different experimental diets at 0-4 weeks , 4-7 weeks and 0-7 weeks of age are presented in table 10 & 11 and appendix table 3 respectively.

0-4 WEEKS

Efficiency of feed utilisation in terms of FCR ranged from 1.95 to 2.24, was influenced significantly ($P<0.05$) by different levels of enzyme as well as by various diets. Chicks fed control diet significantly produced lower ratio than diets modified to contain high fibre through mixture substitution No differences in ratios were observed among mixture substituted diets (T_4, T_7 and T_{10}). Supplementation of enzyme in control diet had no effect in the efficiency of feed utilisation. Chicks fed 10% substituted diet supplemented with both levels of enzyme showed improved feed efficiency but the ratios were comparable. Similarly chicks fed 20% and 30% substituted diets supplemented with enzyme showed comparable FCR values with respect to unsupplemented diet. Results indicated that no substantial improvement in efficiency of feed utilisation by enzyme supplementation was evident during this phase of growth.

4-7 WEEKS

The efficiency of feed utilisation was significantly ($P<0.05$) influenced by diet, enzyme level and interaction between diet and enzyme. The FCR values during this phase of growth ranged from 2.78 to 3.51. Chicks fed control diet reflected significantly ($P<0.05$) lower FCR than the groups fed high fibre diets. There was no significant ($P<0.05$) difference in FCR values between the groups fed 10% and 20% mixture substituted diets but were significantly ($P<0.05$) lower than 30% substituted diet. Supplementation of enzyme at both the levels (0.05 and 0.10%) improved feed utilisation in control diet with no difference between the levels of enzyme. Similar trend of feed utilisation was observed in 10% , 20% and 30% substituted diets by enzyme supplementation. The FCR value was found to be similar in control and 10% substituted diets supplemented at both the levels of enzyme. However, chicks fed 10% substituted diet with 0.05% level of enzyme gave comparable FCR value with 20% substituted diet at both the levels of enzyme supplementation. The feed efficiency in chicks fed 30% substituted diet at both the levels of enzyme supplementation was not significantly ($P<0.05$) different from control diet without any enzyme supplementation. Among various groups, the lowest feed efficiency with higher FCR value was observed in unsupplemented 30% substituted diet ($F_3 E_0$)

0-7 WEEKS

The feed efficiency during combined phases of growth was significantly ($P<0.05$) influenced by diet, enzyme level and

Table 10. Treatment means of feed conversion ratio (FCR) and performance index (PI) during different experimental periods

Treatment No.	Feed conversion ratio (FCR)			Performance index (PI)		
	0-4 weeks	4-7 weeks	0-7 weeks	0-4 weeks	4-7 weeks	0-7 weeks
T1	2.02^{abc} ±0.029	3.16^{d} ±0.038	2.68^{de} ±0.007	221^{d} ±3.00	192^{c} ±2.00	394^{de} ±2.00
T2	1.95^{a} ±0.009	2.81^{a} ±0.039	2.45^{a} ±0.034	262^{g} ±2.00	249^{g} ±4.00	449^{i} ±7.01
T3	2.00^{ab} ±0.039	2.90^{ab} ±0.051	2.52^{abc} ±0.019	245^{f} ±5.01	228^{f} ±4.00	456^{h} ±4.00
T4	2.18^{de} ±0.035	3.38^{e} ±0.032	2.89^{fg} ±0.063	195^{c} ±3.00	182^{b} ±2.00	360^{bc} ±8.02
T5	2.01^{ab} ±0.017	2.87^{ab} ±0.014	2.51^{abc} ±0.027	236^{ef} ±2.00	228^{f} ±1.00	450^{gh} ±5.01
T6	2.09^{bcd} ±0.021	2.78^{a} ±0.062	2.49^{ab} ±0.050	225^{de} ±2.00	227^{ef} ±5.01	442^{gh} ±9.02
T7	2.22^{e} ±0.055	3.38^{e} ±0.070	2.92^{g} ±0.041	180^{b} ±5.01	178^{b} ±4.00	342^{b} ±5.01
T8	2.15^{de} ±0.064	2.98^{bc} ±0.017	2.63^{cd} ±0.031	214^{d} ±6.01	211^{d} ±1.00	414^{ef} ±5.01
T9	2.14^{cde} ±0.019	2.94^{bc} ±0.024	2.60^{bcd} ±0.054	224^{d} ±2.00	218^{de} ±2.00	431^{fg} ±9.02
T10	2.24^{e} ±0.067	3.51^{f} ±0.009	2.98^{g} ±0.022	163^{a} ±5.01	144^{a} ±1.00	292^{a} ±2.00
T11	2.19^{de} ±0.009	3.06^{cd} ±0.043	2.71^{de} ±0.068	189^{bc} ±1.00	198^{c} ±3.00	376^{cd} ±10.02
T12	2.21^{de} ±0.015	3.15^{d} ±0.014	2.77^{ef} ±0.017	195^{c} ±2.00	200^{c} ±1.00	383^{d} ±3.00
CD(P<0.05)	0.12	0.12	0.13	10.89	8.80	19.55

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

Table 11. Treatment means of feed conversion ratio and performance index of chicks fed different fibre and enzyme levels

Fibre and Enzyme level	Feed conversion ratio (FCR)			Performance index (PI)		
	0-4 weeks	4-7 weeks	0-7 weeks	0-4 weeks	4-7 weeks	0-7 weeks
F0	1.99^{a} ±2.09	2.96 ^{a} ±0.069	2.55^{a} ±0.044	243^{d} ±7.69	223^{d} ±10.64	448^{d} ±18.56
F1	2.09^{b} ±0.033	3.01 ^{a} ±0.120	2.63^{b} ±0.085	219^{c} ±7.82	212^{c} ±9.70	417^{c} ±18.50
F2	2.17^{c} ±0.028	3.10 ^{b} ±0.091	2.72^{c} ±0.067	206^{b} ±8.68	202^{b} ±7.89	396^{b} ±17.50
F3	2.21^{c} ±0.091	3.24 ^{c} ±0.088	2.82^{d} ±0.055	182^{a} ±6.37	181^{a} ±11.63	350^{a} ±18.69
CD(P<0.05)	0.07	0.07	0.07	6.29	5.08	11.28
E0	2.17^{b} ±0.038	3.36 ^{b} ±0.050	2.87^{b} ±0.045	190^{a} ±8.20	174^{a} ±6.89	347^{a} ±14.05
E1	2.08^{a} ±0.039	2.93 ^{a} ±0.038	2.58^{a} ±0.042	225^{b} ±10.27	222^{b} ±7.29	434^{b} ±16.71
E2	2.11^{ab} ±0.031	2.94 ^{a} ±0.053	2.60^{a} ±0.044	222^{b} ±6.83	218^{b} ±4.44	428^{b} ±10.69
CD(P<0.05)	0.06	0.06	0.06	5.44	4.40	9.77
CD (F x E) (P<0.05)	NS	0.12	NS	10.89	8.80	19.55

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

F0 = No Substitution of standard commercial broiler diet.
F1 = 10% substitution by DORB and Ext. S. F. Cake.
F2 = 20% substitution by DORB and Ext. S.F. Cake.
F3 = 30% substitution by DORB and Ext S.F. Cake.

E0 = No supplementation of multienzyme.
E1 = 0.05% supplementation of multienzyme.
E2 = 0.10% supplementation of multienzyme.

interaction between diet and enzyme. With a gradual increase in fibre level by substitution with mixture of deoiled rice bran and extracted sunflower cake, a gradual decline in feed efficiency was observed. Chicks fed control diet reflected significantly ($P<0.05$) lower FCR value than substituted diet. However, the FCR values in all unsupplemented substituted diets were not significantly ($P<0.05$) different. Chicks fed control diet supplemented with enzyme at both the levels showed significantly ($P<0.05$) higher feed efficiency than unsupplemented control diet. Similar trend in efficiency of feed utilisation were observed in all substituted diets with enzyme supplementation. No beneficial effect of increasing the level of enzyme from 0.05% to 0.10% was observed in FCR value in control and other substituted diet. Similarly, the feed efficiency in control diet with 0.10% level of supplementation was similar with 10% and 20% substituted diets at the same level of supplementation but was significantly ($P<0.05$) higher than 30% substituted diet at the same level of enzyme. 20% and 30% substituted diets at both the levels of enzyme supplementation reflected better efficiency in feed utilisation as compared to unsupplemented control diet.

PERFORMANCE INDEX (PI)

The index for comparing the performance of different groups during different experimental periods and their analysis of variance are presented in table 10 & 11 and appendix table 4 respectively.

0-4 WEEKS

During this phase of growth, a gradual decline in PI- value was

observed as the fibre level of control diet was increased by substituting mixture of high fibre feed ingredients. The PI values were found to be significantly ($P<0.05$) different in control as well as in different substituted diets without supplementation. Improvement in PI-values were observed at both the levels of enzyme supplementation but 0.05% supplemented diet reflected significantly ($P<0.05$) higher PI-value than 0.10% supplemented diet. Levels of enzyme improved PI-values in all substituted diets and no beneficial effect was seen in PI-values by increasing the level of enzyme from 0.05 to 0.10% The highest PI value (262) was obtained in control diet supplemented with 0.05% level of enzyme and the lowest (163) in 30% unsupplemented diet (F_3 E_0). Among substituted diets, 20% substituted diet at both the levels of enzyme supplementation gave similar PI-values in comparison to control unsupplemented diet.

4-7 WEEKS

The PI-value ranging from 144 to 249 during this phase of growth was significantly ($P<0.05$) affected by diet, level of enzyme and the interaction between diet and level of enzyme. Chicks fed control diet reflected significantly ($P<0.05$) higher PI-value than all levels of substituted diets. However, the PI-values in 10% and 20% substituted diets were similar but significantly ($P<0.05$) higher than 30% substituted diet. Supplementation of enzyme improved PI-values in both control and substituted diets. Control diet supplemented with 0.05% feed enzyme gave significantly ($P<0.05$) higher PI-value than 0.10% of supplementation. Among all substituted diets, supplementation of enzyme at both the levels

showed similar PI-value. Chicks fed 30% substituted diet at both the levels of enzyme supplementation gave similar PI-values as compared to control unsupplemented diet.

0 - 7 WEEKS

The PI-values during this combined phase of growth showed similar trend as was observed during finishing phase of growth. The PI- values ranging from 292 to 494 were significantly ($P<0.05$) affected by diet, enzyme and interaction between diet and enzyme. A significant ($P<0.05$) improvement in PI-value was observed when control diet was supplemented with enzyme and the same trend of improvement in PI-values in all substituted diets at both the levels of enzyme supplementation was noted. The highest PI-value was obtained in control diet supplemented with 0.05% enzyme followed by 0.10% supplemented control and 0.05% and 0.10% enzyme supplemented substituted diets.

The present results indicated that there was no beneficial effect of increasing the level of enzyme on the performance of broilers and 0.05% level seems to be adequate.

Results of the present study also indicated that as the level of fibre was increased in the diet, a gradual decrease in feed efficiency was noticed. This effects were more marked in finishing phase of growth than starting phase. No improvement in feed efficiency during early stages of growth in high vs low fibre diet was also reported by Swain et al. (1996) and Arora et al. (1991). Though Tyagi and Singh (1996) indicated from their results that FCR was

not affected significantly by dietary fibre level and only a marginal increase in FCR value was noticed by increasing fibre level. Lowered efficiency of feed utilisation in high fibre diets than low fibre diets was also reported by Pettersson et al. (1991), Rajeshwara Rao (1994) and Arun babu and Devegowda (1997). The inclusion of enzyme feed supplement at 0.05 and 0.10% levels improved feed conversion efficiency significantly ($P<0.05$). However, addition of 50g enzyme feed supplement per 100kg feed resulted in better feed efficiency and performance index in comparison to other dietary treatment without or with 100g enzyme feed supplement per 100kg feed. Enzyme supplementation improved feed efficiency in low fibre and high fibre diets as obtained in the present investigation was also indicated in the results of several workers (Pettersson and Aman, 1991,1992; Suresh and Devegowda, 1996; Prushothaman and Natanam, 1998).

From the results of feed conversion ratio, it can be concluded that a diet containing about 5 to 6% crude fibre, when increased to about 9% by inclusion of high fibre feed ingredients, could be utilised efficiently through enzyme supplementation at a level of 50g/100kg feed. The performance index obtained in the present study also corroborate the above findings.

CARCASS TRAITS

The data on carcass traits with respect to different parameters and their analysis of variance are given in table 12 to 18 and appendix table 5 to 9 respectively.

PROCESSING LOSSES

The shrinkage percentage expressed as percentage of live weight ranged from 3.10 to 3.45 and was significantly ($P<0.05$) influenced by diet, enzyme and their interactions. Chicks fed control diet had comparable shrinkage percentage with 30% substituted diet and 10% substituted diet, while the latter group had similar shrinkage percentage with 20% substituted diet. Enzyme supplementation in control diet did not affect the shrinkage percentage though a numerically reduction in shrinkage percentage was observed. The same effect in shrinkage percentage was seen in 10% substituted diet. No clear cut trend in shrinkage percentages was noticed in different dietary treatments. However, in general heavier birds showed lower shrinkage percentages.

The blood loss percentage and feather loss percentage expressed as percentage of preslaughter weight were significantly influenced by the dietary treatments. Blood loss percentages in chicks fed control diet and 10% substituted diet did not differ significantly ($P<0.05$) but were different from 20% substituted diet without any enzyme supplementation. The blood loss percentages in chicks fed 20% and 30% substituted diets without enzyme supplementation were comparable. Enzyme supplementation of all diets showed an increased blood loss percentages except 30% substituted diet with 0.05% level of enzyme. Results indicate that the blood loss percentage was found to be more in birds with higher live weight. The feather loss percentage ranging from 4.91 to 6.07 were similar in control (T1), 10% substituted diet and 30% substituted diet. The

Table 12. Treatment means of carcass traits of broilers at the end of experimental period

Treatment No.	As % of live weight			As % of preslaughter weight			
	Live weight	Preslaughter weight	Shrinkage %	Slaughtered weight	Blood loss %	Defeathered Weight	Feather loss %
T1	1173^{cde} ±20.28	1136^{cde} ±18.85	3.21^{abc} ±0.07	1083 ±17.40	4.60^{cde} ±0.05	1026 ±15.95	5.05^{abc} ±0.04
T2	1303^{f} ±14.53	1262^{f} ±14.31	3.15^{abc} ±0.04	1189 ±12.98	5.78^{g} ±0.07	1113 ±11.79	6.07^{g} ±0.16
T3	1239^{ef} ±26.86	1201^{ef} ±25.98	3.12^{ab} ±0.01	1136 ±21.31	5.34^{fg} ±0.28	1072 ±17.90	5.35^{cdef} ±0.18
T4	1130^{bcd} ±30.14	1093^{bcd} ±28.48	3.24^{bcd} ±0.03	1047 ±25.71	4.17^{bc} ±0.11	997 ±24.31	4.66^{a} ±0.04
T5	1236^{ef} ±29.48	1188^{e} ±28.35	3.10^{a} ±0.03	1129 ±25.71	4.96^{ef} ±0.11	1062 ±23.63	5.64^{ef} ±0.04
T6	1203^{de} ±24.34	1165^{e} ±23.46	3.19^{abc} ±0.01	1109 ±19.77	4.80^{de} ±0.30	1051 ±15.92	4.91^{ab} ±0.23
T7	1093^{b} ±35.28	1057^{b} ±33.71	3.35^{de} ±0.06	1019 ±29.87	3.55^{a} ±0.25	964 ±28.11	5.20^{bcd} ±0.21
T8	1197^{de} ±14.25	1155^{de} ±13.78	3.45^{e} ±0.04	1101 ±12.25	4.67^{cde} ±0.07	1035 ±10.41	5.74^{fg} ±0.09
T9	1215^{e} ±24.01	1177^{e} ±23.17	3.16^{abc} ±0.02	1118 ±19.01	4.98^{ef} ±0.25	1056 ±17.70	5.30^{bcde} ±0.05
T10	960^{a} ±28.32	930^{a} ±27.17	3.12^{ab} ±0.03	894 ±24.85	3.83^{ab} ±0.14	847 ±22.52	5.05^{abc} ±0.14
T11	1108^{bc} ±29.36	1072^{bc} ±28.39	3.25^{cd} ±0.02	1026 ±27.41	4.30^{bcd} ±0.03	961 ±25.62	6.07^{g} ±0.10
T12	1182^{cde} ±17.78	1145^{de} ±16.97	3.16^{abc} ±0.03	1093 ±14.57	4.51^{cde} ±0.14	1030 ±12.35	5.47^{def} ±0.13
CD(P<0.05)	74.03	70.98	0.12	---	0.52	---	0.40

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

Table 13. Treatment means of carcass traits of broilers fed different levels of fibre and enzyme at the end of experimental period

Fibre and Enzyme level	Live weight	Preslaughter Weight	As % of live weight Shrinkage %	As % of preslaughter weight Blood loss %	Feather loss %
F0	1239^{c} ±21.54	1200^{c} ±20.91	3.16^{a} ±0.03	5.24^{c} ±0.19	5.49^{b} ±0.17
F1	1186^{b} ±20.18	1149^{b} ±19.59	3.18^{a} ±0.03	4.64^{b} ±0.16	5.07^{a} ±0.16
F2	1168^{b} ±22.96	1130^{b} ±22.29	3.32^{b} ±0.05	4.40^{ab} ±0.24	5.41^{b} ±0.11
F3	1083^{a} ±35.11	1049^{a} ±33.89	3.18^{a} ±0.02	4.21^{a} ±0.12	5.53^{b} ±0.16
CD(P<0.05)	42.74	40.98	0.07	0.30	0.23
E0	1089^{a} ±27.08	1054^{a} ±26.01	3.23^{b} ±0.03	4.04^{a} ±0.14	4.99^{a} ±0.08
E1	1208^{b} ±23.31	1169^{b} ±22.73	3.24^{b} ±0.04	4.93^{b} ±0.17	5.88^{c} ±0.07
E2	1210^{b} ±11.80	1172^{b} ±11.42	3.16^{a} ±0.01	4.91^{b} ±0.14	5.26^{b} ±0.09
CD(P<0.05)	37.01	35.49	0.06	0.26	0.20
CD (F x E) (P<0.05)	NS	NS	0.12	NS	NS

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

F0 = No Substitution of standard commercial broiler diet.
F1 = 10% substitution by DORB and Ext. S. F. Cake.
F2 = 20% substitution by DORB and Ext. S.F. Cake.
F3 = 30% substitution by DORB and Ext S.F. Cake.

E0 = No supplementation of multienzyme.
E1 = 0.05% supplementation of multienzyme.
E2 = 0.10% supplementation of multienzyme.

feather loss percentages were found to be more in control and substituted diets supplemented at 0.05% level of enzyme. The interaction between level of enzyme and fibre level was found to be non significant ($P<0.05$).

DRESSING AND EVISCERATED PERCENTAGES

The dressing percentage was significantly ($P<0.05$) influenced by the dietary treatments and ranged from 77.64 to 80.82. The dressing percentage of chicks fed either control or substituted diets without enzyme supplementation showed comparatively lower percentages than enzyme supplemented diets. 10% and 30% substituted diets with or without enzyme supplementation reflected similar dressing percentages, while the dressing percentages in 10% , 20% and 30% substituted diets at both the levels of enzyme were similar.

The eviscerated percentage ranging from 69.21 to 71.30 was significantly ($P<0.05$) influenced by the dietary treatments. 0.05% level of enzyme supplementation in control diet improved significantly ($P<0.05$) the eviscerated percentage but no improvement was observed by 0.10% level of enzyme on the same diet. 0.05 and 0.10% levels of enzyme in 10, 20 and 30% substituted diets gave similar eviscerated percentages in comparison to their respective unsupplemented diets. The interaction between fibre level and enzyme level was not statistically significant ($P<0.05$).

Results indicated that supplementation of enzyme with low and high fibre diets increased the eviscerated percentage which may be

of broilers at the end of experimental period

Treatment No.	As % of preslaughter weight					
	Dressed weight	Dressing %	Eviscerated weight	Eviscerated %	Ready to cook weight	Cooked weight of carcass
T1	893 ±17.40	78.65^{ab} ±0.23	794 ±15.95	69.91^{abc} ±0.34	724 ±13.13	556 ±10.97
T2	1019 ±13.74	80.74^{fg} ±0.17	900 ±5.77	71.30^{f} ±0.36	818 ±3.93	636 ±2.08
T3	948 ±25.22	78.97^{bcd} ±0.41	845 ±22.91	70.36^{bcde} ±0.40	772 ±20.40	598 ±17.35
T4	869 ±24.50	79.51^{bcdef} ±0.17	767 ±16.67	70.14^{bcd} ±0.34	702 ±12.68	538 ±9.67
T5	954 ±19.37	80.29^{efg} ±0.52	842 ±22.05	70.84^{def} ±0.17	771 ±19.29	597 ±17.01
T6	942 ±21.62	80.82^{g} ±0.23	828 ±17.40	71.10^{ef} ±0.22	755 ±13.87	583 ±12.72
T7	838 ±19.22	79.39^{bcde} ±0.71	738 ±26.82	69.86^{ab} ±0.35	677 ±23.30	514 ±19.62
T8	897 ±9.07	77.64^{a} ±0.39	800 ±10.49	69.21^{a} ±0.08	730 ±8.57	561 ±6.81
T9	927 ±24.21	78.73^{abc} ±0.50	821 ±22.18	69.72^{ab} ±0.51	746 ±19.04	572 ±15.90
T10	743 ±26.03	79.93^{cdefg} ±0.46	652 ±21.11	70.16^{bcd} ±0.22	596 ±19.08	445 ±16.22
T11	860 ±18.93	80.27^{efg} ±0.47	755 ±23.63	70.43^{bcdef} ±0.38	689 ±20.60	523 ±17.58
T12	917 ±8.97	80.16^{defg} ±0.41	811 ±13.37	70.82^{cdef} ±0.12	741 ±11.61	568 ±10.09
CD(P<0.05)	---	1.23	---	0.92	---	---

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

due to higher body weight gain and better utilisation of feed in the chicks. Such reports that the chicks with higher body weight had higher dressing and eviscerated percentages were also given by Raina (1974) and Pandey (1992). However, Sunaria (1977) reported no significant effect on dressing or eviscerated percentage, though the live weight was significantly reduced by the dietary treatments.

BONE PERCENTAGE, MEAT AND BONE RATIO AND COOKING LOSS PERCENTAGE

Weight of bone, cooking loss, ratio of raw edible meat to bone and ratio of cooked edible meat to bone expressed as percentage of ready to cook weight and their analysis of variance are presented in table 15 & 16 and appendix table 7 respectively.

The bone percentage ranging from 16.23 to 19.87 was significantly ($P<0.05$) influenced by diet, level of enzyme and interaction between diet and enzyme level. As the level of fibre in the diet was increased, a corresponding increase in bone percentages were noted. The highest bone percentage was obtained in group fed 30% substituted diet without enzyme supplementation and was significantly($P<0.05$) higher from all other groups. Supplementation of enzyme at both the levels significantly ($P<0.05$) decreased the bone percentage with their corresponding unsupplemented diet. Effects of level of enzyme were similar in different dietary treatments.

The ratios of raw edible meat to bone and cooked edible meat to bone were significantly ($P<0.05$) influenced by different dietary

...carcass traits of broilers at the end of experimental period

Treatment No.	As % of ready to cook weight						
	Cooking loss %	Bone weight	Bone %	Weight of raw edible meat	Weight of cooked edible meat	Ratio of raw edible meat to bone	Ratio of cooked edible meat to bone
T1	23.17^{bc} ±0.13	128 ±0.88	17.74^{de} ±0.20	595 ±12.25	428 ±10.09	4.64^{cde} ±0.06	3.33^{cd} ±0.06
T2	22.22^{a} ±0.12	133 ±0.67	16.23^{a} ±0.06	685 ±3.51	503 ±1.67	5.16^{h} ±0.02	3.80^{g} ±0.02
T3	22.55^{ab} ±0.20	131 ±1.53	16.99^{b} ±0.26	641 ±18.88	467 ±15.82	4.89^{g} ±0.09	3.56^{f} ±0.08
T4	23.37^{c} ±0.06	127 ±1.33	18.15^{ef} ±0.14	574 ±11.35	410 ±8.33	4.51^{bcd} ±0.04	3.22^{bc} ±0.03
T5	22.58^{ab} ±0.28	130 ±1.15	16.87^{ab} ±0.28	641 ±18.15	467 ±15.87	4.93^{g} ±0.10	3.59^{f} ±0.09
T6	22.78^{abc} ±0.26	129 ±0.67	17.05^{bc} ±0.24	627 ±13.28	455 ±12.13	4.87^{fg} ±0.08	3.53^{ef} ±0.08
T7	24.05^{d} ±0.28	126 ±1.86	18.69^{f} ±0.36	551 ±21.46	388 ±17.78	4.35^{b} ±0.11	3.07^{b} ±0.10
T8	23.12^{bc} ±0.03	129 ±0.67	17.64^{cde} ±0.12	601 ±7.94	432 ±6.43	4.67^{def} ±0.04	3.36^{cde} ±0.03
T9	23.29^{c} ±0.18	130 ±1.67	17.39^{bcd} ±0.22	616 ±17.37	443 ±14.24	4.75^{efg} ±0.07	3.41^{cdef} ±0.06
T10	25.41^{e} ±0.34	118 ±2.60	19.87^{g} ±0.20	478 ±16.48	326 ±13.62	4.03^{a} ±0.05	2.76^{a} ±0.05
T11	24.11^{d} ±0.29	127 ±1.76	18.40^{f} ±0.29	562 ±18.84	396 ±15.81	4.44^{bc} ±0.09	3.13^{b} ±0.08
T12	23.36^{c} ±0.18	128 ±1.45	17.23^{bcd} ±0.08	614 ±10.17	441 ±8.65	4.81^{efg} ±0.03	3.45^{def} ±0.03
CD(P<0.05)	0.63	---	0.64	---	---	0.20	0.19

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

...carcass traits of broilers at the end of experimental period

Treatment No.	As % of ready to cook weight						
	Cooking loss %	Bone weight	Bone %	Weight of raw edible meat	Weight of cooked edible meat	Ratio of raw edible meat to bone	Ratio of cooked edible meat to bone
T1	23.17^{bc} ±0.13	128 ±0.88	17.74^{de} ±0.20	595 ±12.25	428 ±10.09	4.64^{cde} ±0.06	3.33^{cd} ±0.06
T2	22.22^{a} ±0.12	133 ±0.67	16.23^{a} ±0.06	685 ±3.51	503 ±1.67	5.16^{h} ±0.02	3.80^{g} ±0.02
T3	22.55^{ab} ±0.20	131 ±1.53	16.99^{b} ±0.26	641 ±18.88	467 ±15.82	4.89^{g} ±0.09	3.56^{f} ±0.08
T4	23.37^{c} ±0.06	127 ±1.33	18.15^{ef} ±0.14	574 ±11.35	410 ±8.33	4.51^{bcd} ±0.04	3.22^{bc} ±0.03
T5	22.58^{ab} ±0.28	130 ±1.15	16.87^{ab} ±0.28	641 ±18.15	467 ±15.87	4.93^{g} ±0.10	3.59^{f} ±0.09
T6	22.78^{abc} ±0.26	129 ±0.67	17.05^{bc} ±0.24	627 ±13.28	455 ±12.13	4.87^{fg} ±0.08	3.53^{ef} ±0.08
T7	24.05^{d} ±0.28	126 ±1.86	18.69^{f} ±0.36	551 ±21.46	388 ±17.78	4.35^{b} ±0.11	3.07^{b} ±0.10
T8	23.12^{bc} ±0.03	129 ±0.67	17.64^{cde} ±0.12	601 ±7.94	432 ±6.43	4.67^{def} ±0.04	3.36^{cde} ±0.03
T9	23.29^{c} ±0.18	130 ±1.67	17.39^{bcd} ±0.22	616 ±17.37	443 ±14.24	4.75^{efg} ±0.07	3.41^{cdef} ±0.06
T10	25.41^{e} ±0.34	118 ±2.60	19.87^{g} ±0.20	478 ±16.48	326 ±13.62	4.03^{a} ±0.05	2.76^{a} ±0.05
T11	24.11^{d} ±0.29	127 ±1.76	18.40^{f} ±0.29	562 ±18.84	396 ±15.81	4.44^{bc} ±0.09	3.13^{b} ±0.08
T12	23.36^{c} ±0.18	128 ±1.45	17.23^{bcd} ±0.08	614 ±10.17	441 ±8.65	4.81^{efg} ±0.03	3.45^{def} ±0.03
CD(P<0.05)	0.63	---	0.64	---	---	0.20	0.19

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

experi mental period

Fibre and Enzyme level	As % of preslaughter weight		As % of ready to cook weight			
	Dressing %	Eviscerated %	Cooking loss %	Bone %	Ratio of raw edible meat to bone	Ratio of cooked edible meat to bone
F0	79.45^{b} ±0.36	70.52^{b} ±0.27	22.65^{a} ±0.16	16.98^{a} ±0.24	4.90^{d} ±0.08	3.56^{c} ±0.07
F1	80.21^{c} ±0.26	70.69^{b} ±0.19	22.91^{a} ±0.16	17.35^{a} ±0.23	4.77^{c} ±0.08	3.45^{c} ±0.07
F2	78.59^{a} ±0.38	69.60^{a} ±0.20	23.48^{b} ±0.17	17.91^{b} ±0.24	4.59^{b} ±0.07	3.28^{b} ±0.06
F3	80.12^{bc} ±0.23	70.47^{b} ±0.16	24.30^{c} ±0.33	18.50^{c} ±0.40	4.43^{a} ±0.12	3.11^{a} ±0.10
CD(P<0.05)	0.71	0.53	0.37	0.37	0.12	0.11
E0	79.37 ±0.24	70.01 ±0.14	24.00^{b} ±0.28	18.61^{b} ±0.26	4.38^{a} ±0.07	3.09^{a} ±0.07
E1	79.74 ±0.41	70.45 ±0.26	23.01^{a} ±0.23	17.28^{a} ±0.26	4.80^{b} ±0.09	3.47^{b} ±0.08
E2	79.67 ±0.31	70.50 ±0.21	23.00^{a} ±0.16	17.16^{a} ±0.10	4.83^{b} ±0.03	3.49^{b} ±0.03
CD(P<0.05)	NS	NS	0.32	0.32	0.10	0.09
CD (F x E) (P<0.05)	1.23	NS	0.63	0.64	0.20	0.19

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

F0 = No Substitution of standard commercial broiler diet.
F1 = 10% substitution by DORB and Ext. S. F. Cake.
F2 = 20% substitution by DORB and Ext. S.F. Cake.
F3 = 30% substitution by DORB and Ext S.F. Cake.

E0 = No supplementation of multienzyme.
E1 = 0.05% supplementation of multienzyme.
E2 = 0.10% supplementation of multienzyme.

treatments and the interaction between the enzyme level and fibre level. A gradual decrease in ratio of meat to bone was observed as the fibre level of control diet was increased. The lowest ratio in both the cases (4.03 and 2.76) was obtained in 30% substituted diet without enzyme supplementation. Enzyme supplementation in all diets improved ratios, however 0.05% level of enzyme supplementation of control and substituted diets showed comparatively better ratios than 0.10% supplemented diets.

The cooking loss percentages were also influenced significantly ($P<0.05$) by different dietary treatments. Cooking loss percentage was found to be significantly ($P<0.05$) more in 20% and 30% substituted diets than control and 10% substituted diets. Enzyme supplementation at both the levels decreased cooking loss percentage in comparison to respective unsupplemented diets. Effects of level of enzyme in cooking loss percentages were similar.

Results indicated that the heavier birds had high degree of fleshing in comparison to bone due to the fact that the muscles in comparison to bone have high content of protein showing its efficient utilisation through enzyme supplementation. The lower ratios in high fibre diets without enzyme supplementation might be due to improper utilisation of nutrients reflecting lower body weight. That bone percentage increased with the lower body size and decreased with the higher body size was also reported by Dawson et al. (1957). Results also suggest a lower cooking losses in enzyme supplemented diets and such results are in agreement with Harms et al. (1957) who observed that the birds with higher body weight had a greater

percentage of drippings and significantly lowered cooking losses due to evaporation.

WEIGHTS OF DIFFERENT BODY ORGANS

The weight of different organs (liver, gizzard and heart as well as neck) expressed as percentage of preslaughter weight and their analysis of variance are given in table 17 & 18 and appendix table 8 & 9 respectively. This value was based on the average weight of the organs collected from three chicks of each treatment group.

LIVER WEIGHT

The dietary treatments and the interaction of the level of enzyme and dietary fibre significantly ($P<0.05$) affected the liver weight expressed as percentage of preslaughter weight and it ranged from 2.08 to 2.35%. Highest weight of liver observed in chicks fed 20% mixture substituted diet (T_9) and was not significantly ($P<0.05$) different from T_1, T_2, T_4, T_6 and T_{11}. The lowest weight of liver was obtained in 20% substituted unsupplemented diet (T_7) and was comparable with T_3, T_4, T_5, T_8, T_{10}, T_{11}, and T_{12}. No regular trend in the weight of liver was found at different fibre level and enzyme supplemental level of the diet.

GIZZARD WEIGHT AND HEART WEIGHT

The weight of gizzard as percentage of preslaughter weight ranged from 1.37 to 1.65 was significantly ($P<0.05$) influenced by the dietary treatments and the interaction between fibre level and enzyme level. Chicks fed high fibre 30% mixture substituted diet

without enzyme supplementation, produced heavier gizzard in comparison to other diets. The increased weight of gizzard on high fibre nutrient deficient diet has also been reported by Hakansson (1978). The weight of the gizzard in other dietary treatments did not reflect a uniform trend. Dietary fibre and enzyme level did not affected significantly ($P<0.05$) heart% in different dietary treatments. However, the weight of heart as percentage of preslaughter weight was within the normal range.

GIBLET YIELD

The giblet yield expressed as percentage of preslaughter weight was significantly ($P<0.05$) influenced by the dietary treatments and the interaction of the level of enzyme and level of fibre, which ranged from 4.07 to 4.49. The pattern of giblet percentage was similar as was observed in liver and gizzard percentage. The giblet percentage was found to be lowest in chicks fed 10% substituted diet with 0.05% level of enzyme and the highest percentage in control diet supplemented with enzyme at same level.

NECK AND NECK + GIBLET PERCENTAGES

The neck percentage ranging from 1.67 to 2.03 was significantly ($P<0.05$) affected by the dietary treatments. As the fibre level of control diet was increased at any substituted level a comparatively but significantly ($P<0.05$) lower percentage in neck was obtained than control diet. Supplementation of enzyme at both levels in either control or substituted diet increased significantly ($P<0.05$) the neck percentages. Neck + Giblet percentage of the chicks of different

period

Treatment No.	As % of preslaughter weight					
	Liver %	Gizzard %	Heart %	Giblet %	Neck %	Neck + Giblet %
T1	2.23^{bcd} ±0.04	1.55^{cdef} ±0.04	0.56 ±0.02	4.34^{abcd} ±0.10	1.85^{bcd} ±0.06	6.19 ±0.16
T2	2.27^{cd} ±0.03	1.64^{ef} ±0.04	0.58 ±0.02	4.49^{d} ±0.08	2.03^{e} ±0.03	6.52 ±0.12
T3	2.08^{a} ±0.03	1.55^{cdef} ±0.04	0.53 ±0.02	4.16^{ab} ±0.04	1.91^{de} ±0.04	6.08 ±0.08
T4	2.22^{abcd} ±0.08	1.40^{ab} ±0.09	0.58 ±0.02	4.20^{abc} ±0.17	1.74^{abc} ±0.05	5.93 ±0.21
T5	2.16^{abc} ±0.05	1.37^{a} ±0.03	0.53 ±0.02	4.07^{a} ±0.06	1.88^{d} ±0.06	5.94 ±0.11
T6	2.32^{d} ±0.06	1.51^{bcd}, ±0.03	0.57 ±0.05	4.40^{bcd} ±0.12	1.86^{cd} ±0.06	6.26 ±0.18
T7	2.08^{a} ±0.05	1.45^{abc} ±0.04	0.60 ±0.02	4.13^{ab} ±0.09	1.67^{a} ±0.06	5.79 ±0.15
T8	2.13^{abc} ±0.03	1.59^{def} ±0.01	0.55 ±0.02	4.27^{abcd} ±0.07	1.79^{abcd} ±0.04	6.06 ±0.10
T9	2.35^{d} ±0.06	1.56^{cdef} ±0.05	0.54 ±0.02	4.47^{cd} ±0.10	1.87^{cd} ±0.05	6.34 ±0.14
T10	2.12^{ab} ±0.03	1.65^{f} ±0.04	0.57 ±0.02	4.34^{abcd} ±0.03	1.72^{ab} ±0.01	6.06 ±0.04
T11	2.21^{abcd} ±0.05	1.52^{bcde} ±0.04	0.59 ±0.02	4.32^{abcd} ±0.11	1.83^{bcd} ±0.02	6.15 ±0.12
T12	2.10^{ab} ±0.02	1.48^{abcd} ±0.03	0.55 ±0.03	4.13^{ab} ±0.04	1.92^{de} ±0.02	6.06 ±0.06
CD(P<0.05)	0.14	0.12	NS	0.27	0.13	NS

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

Table 18. Treatment means of percent weight of differefnt body/organ cuts of broilers fed different levels of fibre and enzyme at the end of experimental period

Fibre and Enzyme level	As % of preslaughter weight					
	Liver %	Gizzard %	Heart %	Giblet %	Neck %	Neck+Giblet %
F0	2.20 ±0.03	1.58[b] ±0.02	0.55 ±0.01	4.33 ±0.06	1.93[b] ±0.04	6.26 ±0.09
F1	2.23 ±0.04	1.43[a] ±0.02	0.56 ±0.02	4.22 ±0.08	1.82[a] ±0.04	6.04 ±0.10
F2	2.19 ±0.05	1.53[b] ±0.03	0.56 ±0.01	4.29 ±0.07	1.77[a] ±0.04	6.06 ±0.10
F3	2.14 ±0.09	1.55[b] ±0.03	0.57 ±0.01	4.26 ±0.05	1.83[a] ±0.03	6.09 ±0.04
CD(P<0.05)	NS	0.07	NS	NS	0.08	NS
E0	2.16 ±0.03	1.51 ±0.04	0.58 ±0.01	4.25 ±0.05	1.75[a] ±0.03	5.99 ±0.08
E1	2.19 ±0.02	1.53 ±0.03	0.56 ±0.01	4.29 ±0.06	1.88[b] ±0.03	6.17 ±0.08
E2	2.21 ±0.04	1.53 ±0.02	0.55 ±0.01	4.29 ±0.06	1.89[b] ±0.02	6.18 ±0.06
CD(P<0.05)	NS	NS	NS	NS	0.07	NS
CD (F x E) (P<0.05)	0.14	0.12	NS	0.27	NS	NS

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

F0 = No Substitution of standard commercial broiler diet.
F1 = 10% substitution by DORB and Ext. S. F. Cake.
F2 = 20% substitution by DORB and Ext. S.F. Cake.
F3 = 30% substitution by DORB and Ext S.F. Cake.

E0 = No supplementation of multienzyme.
E1 = 0.05% supplementation of multienzyme.
E2 = 0.10% supplementation of multienzyme.

groups were similar and was not affected by the dietary treatments.

The increased weight of some of the organs on high fibre unsupplemented diet might be due to stimulated development of gastrointestinal system (Hakansson, 1978).

CARCASS COMPOSITION

Data pertaining to chemical composition of thigh and breast muscles in terms of moisture%, protein% and ether extract% and their analysis of variance are given in table 19 & 20 and appendix table 10 & 11 respectively.

MOISTURE PERCENTAGE

The moisture percentage of thigh and breast muscles ranging from 70.54 to 73.27 and 71.33 to 74.53 respectively were significantly ($P<0.05$) influenced by the different dietary treatments. Chicks fed substituted diets without enzyme supplementation had significantly ($P<0.05$) higher percentages of moisture in comparison to control unsupplemented diet in both type of muscles. Supplementation of enzyme at both the levels of control and substituted diets significantly ($P<0.05$) reduced the moisture content in both type of muscles in chicks. In general, high moisture content was observed in breast muscle than thigh muscle.

PROTEIN PERCENTAGE

The protein percentage of thigh and breast muscles on wet basis varied from 20.04 to 22.26 and 21.36 to 23.91 respectively. A

Means of the chemical composition of thigh and breast muscle of the birds at the end of experimental period

Treatment No.	Thigh muscle			Breast muscle		
	Moisture %	Protein %	Ether extract %	Moisture %	Protein %	Ether extract %
T1	71.20^{b} ±0.23	20.77^{cd} ±0.13	5.84^{f} ±0.11	72.12^{b} ±0.14	22.10^{cd} ±0.18	3.13^{de} ±0.06
T2	70.67^{a} ±0.20	20.15^{ab} ±0.17	5.90^{f} ±0.10	71.52^{a} ±0.11	21.52^{ab} ±0.07	3.21^{e} ±0.10
T3	70.54^{a} ±0.15	20.04^{a} ±0.15	5.98^{f} ±0.09	71.33^{a} ±0.28	21.36^{a} ±0.11	3.29^{e} ±0.17
T4	71.93^{c} ±0.19	21.08^{d} ±0.13	5.38^{de} ±0.14	72.89^{c} ±0.20	22.50^{de} ±0.17	2.65^{c} ±0.09
T5	71.37^{b} ±0.23	20.58^{bc} ±0.15	5.45^{e} ±0.09	72.24^{b} ±0.11	21.93^{bc} ±0.19	2.77^{c} ±0.04
T6	71.28^{b} ±0.22	20.50^{bc} ±0.14	5.52^{e} ±0.11	72.17^{b} ±0.18	21.84^{bc} ±0.09	2.84^{cd} ±0.11
T7	72.50^{d} ±0.13	21.65^{f} ±0.14	4.94^{bc} ±0.16	73.67^{d} ±0.16	23.25^{f} ±0.10	2.17^{b} ±0.14
T8	71.98^{c} ±0.04	21.17^{de} ±0.12	5.05^{c} ±0.11	72.97^{c} ±0.16	22.62^{e} ±0.12	2.26^{b} ±0.09
T9	71.95^{c} ±0.13	21.12^{de} ±0.15	5.11^{cd} ±0.04	72.93^{c} ±0.17	22.46^{de} ±0.09	2.32^{b} ±0.10
T10	73.27^{e} ±0.10	22.26^{g} ±0.11	4.48^{a} ±0.07	74.53^{e} ±0.10	23.91^{g} ±0.12	1.63^{a} ±0.08
T11	72.71^{d} ±0.18	21.76^{f} ±0.11	4.58^{a} ±0.13	73.82^{d} ±0.19	23.31^{f} ±0.26	1.72^{a} ±0.12
T12	72.62^{d} ±0.09	21.56^{ef} ±0.30	4.65^{ab} ±0.09	73.76^{d} ±0.14	23.19^{f} ±0.19	1.81^{a} ±0.10
CD(P<0.05)	0.49	0.45	0.31	0.49	0.44	0.31

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

Table 20. Treatment means of the chemical composition of thigh and breast muscle of the birds fed different fibre and enzyme levels at the end of experimental period

Fibre and Enzyme level	Thigh muscle			Breast muscle		
	Moisture %	Protein %	Ether extract %	Moisture %	Protein %	Ether extract %
F0	70.80[a] ±0.14	20.32[a] ±0.14	5.91[d] ±0.05	71.66[a] ±0.15	21.66[a] ±0.13	3.21[d] ±0.06
F1	71.53[b] ±0.15	20.72[b] ±0.11	5.45[c] ±0.06	72.43[b] ±0.14	22.09[b] ±0.13	2.75[c] ±0.05
F2	72.14[c] ±0.11	21.31[c] ±0.11	5.03[b] ±0.06	73.19[c] ±0.14	22.78[c] ±0.13	2.25[b] ±0.06
F3	72.87[d] ±0.12	21.86[d] ±0.14	4.57[a] ±0.06	74.04[d] ±0.14	23.47[d] ±0.15	1.72[a] ±0.06
CD(P<0.05)	0.28	0.26	0.18	0.28	0.25	0.18
E0	72.22[b] ±0.24	21.44[b] ±0.18	5.16 ±0.16	73.30[b] ±0.28	22.94[b] ±0.22	2.40 ±0.17
E1	71.68[a] ±0.24	20.91[a] ±0.19	5.25 ±0.15	72.64[a] ±0.26	22.35[a] ±0.22	2.49 ±0.17
E2	71.60[a] ±0.24	20.81[a] ±0.19	5.32 ±0.15	72.55[a] ±0.28	22.21[a] ±0.21	2.57 ±0.18
CD(P<0.05)	0.25	0.22	NS	0.24	0.22	NS
CD (F x E) (P<0.05)	NS	NS	NS	NS	NS	NS

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

F0 = No Substitution of standard commercial broiler diet.

F1 = 10% substitution by DORB and Ext. S. F. Cake.

F2 = 20% substitution by DORB and Ext. S.F. Cake.

F3 = 30% substitution by DORB and Ext S.F. Cake.

E0 = No supplementation of multienzyme.

E1 = 0.05% supplementation of multienzyme.

E2 = 0.10% supplementation of multienzyme.

significant ($P<0.05$) increase in protein percentages in both type of muscles were obtained, when the fibre content of control diet was increased by substitution of the mixture. Enzyme supplementation at both levels in different diets significantly ($P<0.05$) reduced the protein percentages in both type of muscles.

Results indicated a positive relationship between moisture percentage and protein percentage in both type of muscles reflecting similar trend.

ETHER EXTRACT PERCENTAGE

The ether extract contents of thigh and breast muscles on wet basis ranged from 4.48 to 5.98 and 1.63 to 3.29 respectively. A gradual reduction in ether extract percentage of thigh muscle was obtained as the level of dietary fibre was increased, while ether extract percentage in breast muscle though reduced significantly ($P<0.05$) from control did not show the similar trend as observed in thigh muscle. A numerical increase in ether extract percentages in both type of muscles were observed in rations supplemented with enzyme at both levels. In general, the thigh muscle had higher ether extract percentage than breast muscle.

Results of the chemical composition indicated that a significant ($P<0.05$) effect in carcass composition was noted with the type of diet and enzyme supplementation as was evident in moisture and protein percentages in both type of muscles. Unsupplemented high fibre diets had a significantly ($P<0.05$) higher moisture and crude protein contents and lower ether extract content in comparison to

control diet. In general, the fat content, in muscle was increased as a result of the enzyme supplementation, where as water content & crude protein decreased. Chemical composition of thigh and breast muscles estimated by Raina (1974) indicated that with low fibre diet, an increase in ether extract content and a decrease in moisture content resulted. Pettersson and Aman (1991) studied the effect of dietary fibre in broiler diets based on oat bran and inner endosperm from oats with or without enzyme supplementation and obtained a significantly higher carcass water content and crude protein content and lower crude fat content in chickens fed unsupplemented oat bran diet than inner endosperm diet. A decrease in water content and crude protein content and an increase in crude fat content were obtained by enzyme supplementation.

METABOLISABLE ENERGY (ME) CONTENTS OF VARIOUS EXPERIMENTAL DIETS AND PERCENT GROSS ENERGY (GE) METABOLISED AS INFLUENCED BY ENZYME SUPPLEMENTATION.

The data on the GE contents of experimental diets and excreta collected during metabolic trial of both the phases of growth (starting & finishing) have been presented in table 21 and 22 respectively. The data pertaining to ME-contents of starter and finisher rations of various dietary treatments and percent GE metabolised and their analysis of variance are given in table 23 & 26 and appendix table 12 respectively.

The ME-values of starter and finisher rations ranged from 2527 to 2883 and 2592 at 2981 Kcal/kg of feed respectively. While

Table 21. Gross energy and metabolisable energy in experimental diets and excreta collected during metabolic trial at the end of starting period (4th week)

Treatment No.	Feed intake (g/bird/day)	Gross energy of feed(kcal/g)	Faeces voided (g/bird/day)	Gross energy of faeces (kcal/g)	Total gross energy of diets (Kcal)	Total gross energy of faeces (kcal)	Metabolisable energy (kcal/g)
T1	62.10	4.230	25.57	3.546	262.68	90.67	2.770
T2	69.07	4.239	26.12	3.598	292.79	93.98	2.878
T3	67.65	4.218	25.02	3.610	285.35	90.32	2.883
T4	64.26	4.259	27.80	3.657	273.68	101.66	2.677
T5	66.50	4.268	26.20	3.725	283.82	97.60	2.800
T6	70.16	4.270	27.34	3.737	299.58	102.17	2.814
T7	62.57	4.347	29.10	3.764	271.99	109.53	2.596
T8	68.97	4.385	29.16	3.794	302.43	110.63	2.781
T9	71.15	4.379	29.75	3.808	311.57	133.29	2.787
T10	59.84	4.396	29.39	3.806	263.06	111.86	2.527
T11	62.92	4.432	27.63	3.840	278.86	106.10	2.746
T12	65.74	4.423	28.35	3.857	290.77	109.35	2.760

Table 22. Gross energy and metabolisable energy in experimental diets and excreta collected during metabolic trial at the end of finishing period (7th week)

Treatment No.	Feed intake (g/bird/day)	Gross energy of feed(kcal/g)	Faeces voided (g/bird/day)	Gross energy of faeces (kcal/g)	Total gross energy of diets (Kcal)	Total gross energy of faeces (kcal)	Metabolisable energy (kcal/g)
T1	108.45	4.180	40.42	3.478	453.32	140.58	2.884
T2	109.68	4.206	37.93	3.542	461.31	134.35	2.981
T3	107.57	4.194	35.81	3.564	451.15	127.63	3.008
T4	111.60	4.232	45.34	3.593	472.29	162.91	2.772
T5	107.89	4.254	39.20	3.647	458.96	142.96	2.929
T6	101.47	4.261	35.95	3.678	432.36	132.22	2.958
T7	110.40	4.308	48.87	3.708	475.60	181.21	2.667
T8	106.96	4.337	41.16	3.750	463.89	154.35	2.894
T9	107.85	4.345	40.78	3.779	468.61	154.11	2.916
T10	102.15	4.378	48.23	3.783	447.21	182.45	2.592
T11	106.53	4.395	42.75	3.825	468.20	163.52	2.860
T12	109.65	4.389	43.40	3.832	481.25	166.21	2.872

comparing these values with calculated ME of the diets used in this experiment, it was observed that in all the starter and finisher experimental rations, the determined values were less than the calculated values. This finding is an agreement with the reports of Pandey (1992), Raina (1974) and Saxena (1975). However, Sunaria (1977) reported to the contrary. The data indicated that the ME contents of diets were progressively decreased as the level of fibre was increased by substitution of the mixture of high fibre ingredients. Such reduction of energy by increasing fibre level in the diet was also reported by several workers (Friesen et al., 1991, 1992; Sikka, 1993; Ichhponani, 1996; Swain et al.,1996). Supplementation of enzyme feed supplement at both the levels caused significant ($P<0.05$) improvement of ME-value. As the level of enzyme feed supplement was raised from 0% to 0.10%, there was a significantly ($P<0.05$) but progressive increase in the ME content.

The percent increase in ME content due to enzyme supplementation was more pronounced in higher substituted diet than the lower substituted or control diet and have been summarised below :

Diet	Level of enzyme feed supplementent	Percent increase in ME-Value	
		At 4th week	At 7th week
I. Standard commercial broiler diet with no substitution by mixture of DORB and Ext. S.F.C. (Control)	(i) 0.05%	3.90	3.36
	(ii) 0.10%	4.08	4.30

II. Standard commercial broiler diet with 10% substitution by mixture of DORB and Ext. S.F.C.	(i) 0.05%	4.59	5.66
	(ii) 0.10%	5.12	6.75
III. Standard commercial broiler diet with 20% substitution by mixture of DORB and Ext. S.F.C.	(i) 0.05%	7.13	8.51
	(ii) 0.10%	7.36	9.34
IV. Standard commercial broiler diet with 30% substitution by mixture of DORB and Ext. S.F.C.	(i) 0.05%	8.67	10.34
	(ii) 0.10%	9.22	10.80

Such an increase in ME-value due to enzyme supplementation agreed well with the findings of the several workers (Friesen et al., 1991, 1992; Choct et al., 1995; Swain et al., 1996; Scott et al., 1997).

PERCENT GROSS ENERGY METABOLISED

AT 4TH WEEK

The percent GE metabolised at 4th week of age differed significantly ($P<0.05$) by diet, enzyme level and the diet x enzyme. A significant ($P<0.05$) but progressive decrease in percent GE metabolised was observed as the level of fibre was increased in control diet by substitution with 10%, 20% and 30% mixture without enzyme supplementation. Enzyme supplemented groups metabolised GE more efficiently in comparison to their respective unsupplemented diet. Level of enzyme particularly at higher level (0.10%) showed significantly ($P<0.05$) better percentage of GE

periods

Treatment No.	At 4th week			At 7th week		
	Gross energy of feed (Kcal/kg)	Metabolisable energy of feed (Kcal/kg)	%Gross energy metabolised	Gross energy of feed (Kcal/kg)	Metabolisable energy of feed (Kcal/kg)	% Gross energy metabolised
T1	4230	2770	$65.48^{f} \pm 0.13$	4180	2884	$69.00^{e} \pm 0.16$
T2	4239	2878	$67.89^{g} \pm 0.26$	4206	2981	$70.87^{f} \pm 0.14$
T3	4218	2883	$68.35^{g} \pm 0.16$	4194	3008	$71.72^{g} \pm 0.32$
T4	4259	2677	$62.86^{d} \pm 0.12$	4232	2772	$65.50^{c} \pm 0.25$
T5	4268	2800	$65.60^{f} \pm 0.10$	4254	2929	$68.85^{e} \pm 0.10$
T6	4270	2814	$65.90^{f} \pm 0.09$	4261	2958	$69.42^{e} \pm 0.12$
T7	4347	2596	$59.72^{b} \pm 0.10$	4308	2667	$61.91^{b} \pm 0.21$
T8	4385	2781	$63.42^{e} \pm 0.13$	4337	2894	$66.73^{d} \pm 0.13$
T9	4379	2787	$63.64^{e} \pm 0.20$	4345	2916	$67.11^{d} \pm 0.18$
T10	4396	2527	$57.48^{a} \pm 0.11$	4378	2592	$59.21^{a} \pm 0.21$
T11	4432	2746	$61.96^{c} \pm 0.13$	4395	2860	$65.07^{c} \pm 0.12$
T12	4423	2760	$62.40^{cd} \pm 0.19$	4389	2872	$65.44^{c} \pm 0.22$
CD(P<0.05)	---	---	0.47	---	---	0.59

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

metabolised.

AT 7TH WEEK

At 7th week of age, the percent GE metabolised showed the similar trend. Higher level of fibre decreased the percent GE metabolised and the chicks fed 30% substituted diet showed the lowest value and was significantly ($P<0.05$) lower than other values. Supplementation of dietary enzyme improved the percent GE metabolised in a similar way as was observed during 4th week.

Improvement in percent GE metabolised by enzyme supplementation might be due to increased availability of nutrients from fibre and other NSP fractions as well as increased amount of available phosphorus. Enzyme supplementation could bring the uniformity between different feed ingredients of variable nutrients composition was also reported by Sibbald and Slinger (1962) and Rogel et al.(1987).

RETENTION OF NUTRIENTS

PERCENT NITROGEN RETENTION

The nitrogen retention percentages of both the phases of growth (starting & finishing) and their analysis of variance are presented in table 24 & 26 and appendix table 13 respectively. Statistical analysis of the data revealed significant ($P<0.05$) effects of different levels of enzyme feed supplement, diet and enzyme x diet interaction on percent nitrogen retention in broilers during both the phases of growth. Percent nitrogen retention of unsupplemented 30%

periods

Treatment No.	At 4th week				At 7th week			
	Nitrogen intake (g/bird/day)	Nitrogen outgo (g/bird/day)	Nitrogen retained (g/bird/day)	% Nitrogen retention	Nitrogen intake (g/bird/day)	Nitrogen outgo (g/bird/day)	Nitrogen retained (g/bird/day)	% Nitrogen retention
T1	2.270	1.033	1.237	$54.49^{ef} \pm 0.12$	3.519	1.755	1.764	$50.12^{e} \pm 0.12$
T2	2.531	1.014	1.517	$59.94^{j} \pm 0.24$	3.568	1.556	2.012	$56.39^{i} \pm 0.19$
T3	2.483	1.009	1.474	$59.36^{i} \pm 0.09$	3.506	1.548	1.958	$55.85^{h} \pm 0.15$
T4	2.341	1.141	1.200	$51.26^{c} \pm 0.26$	3.646	1.941	1.705	$46.76^{c} \pm 0.11$
T5	2.427	1.086	1.341	$55.25^{gh} \pm 0.18$	3.530	1.727	1.803	$51.08^{fg} \pm 0.08$
T6	2.566	1.136	1.430	$55.73^{h} \pm 0.11$	3.327	1.615	1.712	$51.46^{g} \pm 0.23$
T7	2.273	1.186	1.087	$47.82^{b} \pm 0.12$	3.649	2.070	1.579	$43.27^{b} \pm 0.14$
T8	2.511	1.135	1.376	$54.80^{fg} \pm 0.20$	3.543	1.747	1.796	$50.69^{f} \pm 0.10$
T9	2.594	1.166	1.428	$55.05^{g} \pm 0.09$	3.581	1.759	1.822	$50.88^{f} \pm 0.15$
T10	2.168	1.201	0.967	$44.60^{a} \pm 0.26$	3.411	1.986	1.425	$41.78^{a} \pm 0.11$
T11	2.282	1.052	1.230	$53.90^{d} \pm 0.15$	3.564	1.795	1.769	$49.64^{d} \pm 0.24$
T12	2.389	1.097	1.292	$54.08^{de} \pm 0.17$	3.674	1.840	1.834	$49.92^{de} \pm 0.12$
CD(P<0.05)	---	---	------	0.54	---	---	-----	0.47

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

substituted diet was found to be significantly ($P<0.05$) lower than other enzyme supplemented or unsupplemented diets. A gradual increase in fibre content of the control diet by substitution showed a gradual decrease in percent nitrogen retention. Enzyme supplementation at both the levels improved significantly ($P<0.05$) the percent nitrogen retention, though the values were not consistent. Data further indicated that percent nitrogen retention at both the levels of enzyme supplementation were similar but significantly ($P<0.05$) higher than unsupplemented diet.

In the present study, significantly ($P<0.05$) higher nitrogen retention percentages were observed for low fibre diet as compared to high fibre diet. Reduction in percent nitrogen retention in high fibre diets as observed in this study was in agreement with the observations reported by Lodhi et al. (1976) and Friesen et al. (1991, 1992). Significant ($P<0.05$) improvement in percent nitrogen retention due to enzyme supplementation to all dietary treatments observed in this study were also reported by several workers (Hesselman and Aman, 1986; Friesen et al., 1991, 1992; Choct, 1996; Christensen et al., 1996; Scott et al., 1997). However, with better quality of feed ingredients such as barley & millets used in chick ration, no beneficial effect of supplementation of enzyme in nitrogen retention was seen (Rexen, 1981; Purushothaman and Natanam, 1998).

PERCENT PHOSPHORUS RETENTION

The data on phosphorus retention percentages at 4th and 7th weeks of ages of broilers and their analysis of variance are presented

Table 25. Treatment means for percent phosphorus retention at the end of starting (4th week) and finishing (7thweek) periods

Treatment No.	At 4th week				At 7th week			
	phosphorus intake (g/bird/day)	phosphorus outgo (g/bird/day)	phosphorus retained (g/bird/day)	% phosphorus retentioin	phosphorus intake (g/bird/day)	phosphorus outgo (g/bird/day)	phosphorus retained (g/bird/day)	% phosphorus retentioin
T1	0.385	0.156	0.229	$59.48^{ef} \pm 0.18$	0.748	0.339	0.409	$54.68^{de} \pm 0.17$
T2	0.435	0.150	0.285	$65.52^{j} \pm 0.12$	0.735	0.286	0.449	$61.09^{h} \pm 0.09$
T3	0.406	0.142	0.264	$65.02^{i} \pm 0.27$	0.753	0.296	0.457	$60.69^{h} \pm 0.19$
T4	0.437	0.193	0.244	$55.84^{c} \pm 0.09$	0.826	0.401	0.425	$51.45^{c} \pm 0.15$
T5	0.466	0.186	0.280	$60.09^{gh} \pm 0.11$	0.820	0.366	0.454	$55.37^{fg} \pm 0.13$
T6	0.498	0.197	0.301	$60.44^{h} \pm 0.12$	0.741	0.328	0.413	$55.74^{g} \pm 0.11$
T7	0.482	0.231	0.251	$52.07^{b} \pm 0.17$	0.894	0.472	0.422	$47.20^{b} \pm 0.25$
T8	0.538	0.217	0.321	$59.67^{efg} \pm 0.11$	0.845	0.381	0.464	$54.91^{ef} \pm 0.11$
T9	0.534	0.214	0.320	$59.93^{fg} \pm 0.13$	0.895	0.400	0.495	$55.31^{fg} \pm 0.16$
T10	0.503	0.258	0.245	$48.71^{a} \pm 0.15$	0.889	0.493	0.396	$44.54^{a} \pm 0.14$
T11	0.516	0.212	0.304	$58.91^{d} \pm 0.23$	0.959	0.439	0.520	$54.22^{d} \pm 0.10$
T12	0.559	0.228	0.331	$59.21^{de} \pm 0.14$	0.943	0.430	0.513	$54.40^{d} \pm 0.13$
CD (P<0.05)	---	---	------	0.49	---	---	-----	0.46

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

Table 26. Treatment means for percent gross energy metabolised, percent nitrogen retention and percent phosphorus retention in broilers fed different levels of fibre and enzyme at the end of starting (4th week) and finishing (7th week) periods

Fibre and Enzyme level	% Gross energy metabolised		% Nitrogen retention		% Phosphorus retention	
	At 4th week	At 7th week	At 4th week	At 7th week	At 4th week	At 7th week
F0	67.24^{d} ±0.57	70.53^{d} ±0.52	57.12^{d} ±1.10	54.12^{d} ±1.27	63.34^{d} ±1.23	58.82^{d} ±1.31
F1	64.79^{c} ±0.61	67.92^{c} ±0.78	54.08^{c} ±0.90	49.77^{c} ±0.96	58.79^{c} ±0.94	54.19^{c} ±0.87
F2	62.26^{b} ±0.81	65.25^{b} ±1.06	52.56^{b} ±1.50	48.28^{b} ±1.59	57.22^{b} ±1.63	52.47^{b} ±1.67
F3	60.61^{a} ±1.00	63.24^{a} ±1.28	50.86^{a} ±1.98	47.11^{a} ±1.69	55.61^{a} ±2.18	51.05^{a} ±2.06
CD(P<0.05)	0.27	0.34	0.31	0.27	0.28	0.27
E0	61.39^{a} ±1.15	63.91^{a} ±1.40	49.54^{a} ±1.40	45.48^{a} ±1.22	54.03^{a} ±1.53	49.47^{a} ±1.47
E1	64.72^{b} ±0.85	67.88^{b} ±0.83	55.97^{b} ±0.89	51.95^{b} ±0.99	61.05^{b} ±0.99	56.40^{b} ±1.04
E2	65.07^{c} ±0.86	68.42^{c} ±0.90	56.06^{b} ±0.76	52.03^{b} ±0.86	61.15^{b} ±0.86	56.54^{b} ±0.93
CD(P<0.05)	0.23	0.29	0.27	0.24	0.25	0.23
CD (F x E) (P<0.05)	0.47	0.59	0.54	0.47	0.49	0.46

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

F0 = No Substitution of standard commercial broiler diet.
F1 = 10% substitution by DORB and Ext. S. F. Cake.
F2 = 20% substitution by DORB and Ext. S.F. Cake.
F3 = 30% substitution by DORB and Ext S.F. Cake.

E0 = No supplementation of multienzyme.
E1 = 0.05% supplementation of multienzyme.
E2 = 0.10% supplementation of multienzyme.

in table 25 & 26 and appendix table 14 respectively. The percent phosphorus retention ranging form 48.71 to 65.52 and 44.54 to 61.09 during 4th and 7th weeks respectively were significantly ($P<0.05$) influenced by diet, level of enzyme and diet x enzyme interaction in broilers. Level of fibre in the diet affected significantly ($P<0.05$) the percent phosphorus retention. High fibre diet had lower percentage of retention than low fibre diets. A close association of phosphorus with cell walls usually decreased the availability of phosphorus to the chicks and this might be the probable reason for gradual decrease in phosphorus retention percentage as the fibre level of diet was increased. Such association of phosphorus with the cell wall and a decrease in availability of phosphorus was also reported by Bremmer (1970) and Ryu and Mandels (1980). Nahm and Carlson (1985) indicated that phosphorus associated with cell wall were solubilized by cellulase and more phosphorus were made available for absorption. Supplementation of dietary multienzyme containing cellulase & phytase significantly ($P<0.05$) improved the percent phosphorus retention in all supplemented diets. Levels of enzyme (0.05 and 0.10%) used in the present study, though significantly ($P<0.05$) improved the percent phosphorus retention but were comparable, suggesting that the microbial phytase present in multienzyme preparation seems to be adequate in maintaining the availability of phosphorus. Microbial phytase supplementation improved the retention of phosphorus in broiler chickens, agreed well with the results of Nelson et al. (1971), Simons et al. (1990), Broz et al. (1994) and Sebastian et al. (1996).

MOISTURE CONTENTS OF DROPPINGS AS INFLUENCED BY FIBRE LEVEL AND ENZYME SUPPLEMENTATION.

The treatment means of the moisture percentage of droppings of the birds at 4th and 7th weeks and their analysis of variance are presented in table 27 & 28 and appendix table 15 respectively.

AT 4TH WEEK

The moisture percentage of excreta of chicks of various groups during starting phase of growth was significantly ($P<0.05$) influenced by fibre and enzyme levels and fibre x enzyme interaction, which ranged from 77.05 to 83.3. A significant ($P<0.05$) gradual increase in excreta moisture content of chicks was observed as the fibre levels of control diet was increased by substitution with 10%, 20% and 30% mixture of DORB and Ext. S.F.C. The highest moisture content of excreta (83.3%) was seen in 30% substituted diet (F_3 E_0). Supplementation of enzyme at both the levels significantly ($P<0.05$) reduced the moisture content of excreta with their respective diet. However, both the levels of enzyme had similar effect in reducing the moisture content of excreta though percentage of reduction in moisture content was found to be numerically more in 0.10% level of enzyme supplementation. Result further indicated that enzyme supplementation in all substituted diets showed a reduction in moisture content at par with the control enzyme unsupplemented diet (F_0E_0).

AT 7TH WEEK

During 7th weeks of age, the percent moisture content of excreta ranging from 72.96 to 79.35 was also significantly ($P<0.05$) influenced by diet, level of enzyme and diet x enzyme interaction. Data of the result indicated almost similar pattern as was observed during 4th weeks. Comparing the starting phase and finishing phase of growth, a lower level of moisture percentage in the excreta of chicks was found at 7th week than at 4th week. The difference between periods was due to high fibre content of the starter diet than the finisher diet. Data pertaining to percent increment in moisture content of excreta due to increasing fibre level and percent reduction in moisture content of excreta due to enzyme supplementation at the end of both the phase of growth are summarised below.

et	Percent increment in moisture conte-nt of excreta due to increasing fibre level		Level of enzyme feed supplement	Percent reduction in moisture con-tent of excreta due to enzyme supplementa-tion	
	At 4th week	At 7th week		At 4th week	At 7th week
tandard commercial oiler diet with no ubstitution by the ixture of DORB and xt. S.F.C.(Control)			(i) 0.05% (ii) 0.10%	2.96 3.20	3.07 3.36
Standard commercial oiler diet with 10% bstitution by the	1.63	1.72	(i) 0.05% (ii) 0.10%	2.04 2.41	2.17 3.13

mixture of DORB and Ext. S.F.C.					
III. Standard commercial broiler diet with 20% substitution by the mixture of DORB and Ext. S.F.C.	3.02	3.42	(i) 0.05% (ii) 0.10%	3.20 3.50	3.56 3.87
IV. Standard commercial broiler diet with 30% substitution by the mixture of DORB and Ext. S.F.C.	4.65	5.10	(i) 0.05% (ii) 0.10%	4.26 4.62	4.63 5.08

Result indicated that a high fibre diet caused an increase in the moisture content of excreta as compared to low fibre control diets. Our result is an agreement with the result of Benabdeljelil (1996, 1997), who obtained a significant increase in litter moisture content as the fibre level was increased through substitution by barley in corn based broiler ration. A significant ($P<0.05$) reduction in moisture content of excreta at 4th and 7th weeks by enzyme supplementation as obtained in the present study have also been reported by several workers. Willingham et al., (1959) obtained a significant reduction in moisture content from 74.8% to 60.3% in the faeces of chicks fed barley diet supplemented with enzyme. A reduction in wet and sticky droppings through decreased viscosity of the intestinal contents by supplementation of enzyme in high fibre diet has also been reported by several workers (Gohl et al., 1978; Broz and Frigg, 1986; Campbell et al., 1987; Grootwassink et al., 1989; Hadorn and Wiedmer, 1996; Bedford and Morgan, 1996; Scott et al., 1997; Steenfeldt et al., 1998).

Chicks fed control diet supplemented with enzyme caused a reduction in moisture content of droppings as obtained in the present

droppings of the birds at the end of starting (4th week) and finishing (7th week) periods

Treatment No.	At 4th week	At 7th week
T1	79.60^{bc} ± 0.17	75.50^{bc} ± 0.18
T2	77.24^{a} ±0.31	73.18^{a} ± 0.21
T3	77.05^{a} ± 0.19	72.96^{a} ± 0.38
T4	80.90^{d} ± 0.43	76.80^{d} ± 0.18
T5	79.25^{bc} ± 0.21	75.13^{bc} ± 0.36
T6	78.95^{b} ± 0.14	74.84^{b} ± 0.13
T7	82.00^{e} ± 0.33	78.08^{e} ± 0.10
T8	79.38^{bc} ± 0.19	75.30^{bc} ± 0.23
T9	79.13^{bc} ± 0.09	75.06^{bc} ± 0.22
T10	83.30^{f} ± 0.22	79.35^{f} ± 0.20
T11	79.75^{c} ± 0.37	75.68^{c} ± 0.08
T12	79.45^{bc} ± 0.22	75.32^{bc} ± 0.14
CD (P<0.05)	0.75	0.64

Means bearing a common superscript in a column donot differ significantly (P<0.05).

Table 28. Treatment means of percent moisture content of droppings of the birds fed different fibre and enzyme levels at the end of starting (4th week) and finishing (7th week) periods

Fibre and Enzyme level	At 4th week	At 7th week
F0	77.96^{a} ± 0.43	73.88^{a} ± 0.43
F1	79.70^{b} ± 0.34	75.59^{b} ± 0.33
F2	80.17^{c} ± 0.47	76.15^{c} ± 0.49
F3	80.83^{d} ± 0.63	76.78^{d} ± 0.65
CD (P<0.05)	0.43	0.37
E0	81.45^{b} ± 0.43	77.43^{b} ± 0.44
E1	78.91^{a} ± 0.32	74.82^{a} ± 0.31
E2	78.65^{a} ± 0.29	74.55^{a} ± 0.30
CD (P<0.05)	0.38	0.32
CD (F x E) (P<0.05)	0.75	0.64

Means bearing a common superscript in a column donot differ significantly (P<0.05).

F0 = No substitution of standard commercial broiler diets.
F1 = 10% substitution by DORB and Ext. S. F. Cake.
F2 = 20% substitution by DORB and Ext. S.F. Cake.
F3 = 30% substitution by DORB and Ext S.F. Cake.

E0 = No supplementation of multienzyme.
E1 = 0.05% supplementation of multienzyme.
E2 = 0.10% supplementation of multienzyme.

study corroborated the findings of Han and Yu (1996) and Rajeshwara Rao and Devegowda (1996), whose rations based on maize & wheat respectively decreased the viscosity of the intestinal contents and reduced the moisture content of droppings in broiler chickens. The presence of phytase in multienzyme preparation used in the present experiment may be responsible for reducing watery and sticky droppings also indicated by Christensen et al. (1996), who demonstrated that unutilised phytase phosphorus in undigested form require more water for its excretion thereby causing watery and sticky droppings in broilers. Pettersson and Aman (1992) observed a significant reduction in frequency of sticky droppings by about 83% in broiler chickens in enzyme supplemented oat bran and extracted oat bran diets.

MORTALITY

Mortality during different weeks are given in table - 29. Out of a total of 240 chicks used for the study, 16 died during the course of entire experimental period. Thus mortality was 6.67% of the total. From the table, it is evident that during the first week, 11 chicks died. Thus the total mortality during the first week was 4.58%. The number of mortality occurred was found to be more in high fibre unsupplemented diets than control. Highest mortality occurred in first week was due to environmental factors such as cold season and sudden shut down of electric supply during odd hour of night. During the second week, a total of 3 chicks died, raising the total mortality to 5.83%. No mortality was observed during third week. During 4th week, 2 chicks died, raising the total 6.67% and there after, no mortality was observed during the rest of the experimental period.

Table 29. Mortality in different weeks

Age/Week	Treatment identifications												Birds left over	Total mortality %
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12		
1	1	---	---	2	---	---	2	1	1	2	1	1	229	4.58
2	1	---	---	---	1	1	---	---	---	---	---	---	226	5.83
3	---	---	---	---	---	---	---	---	---	---	---	---	226	5.83
4	---	1	1	---	---	---	---	---	---	---	---	---	224	6.67
5	---	---	---	---	---	---	---	---	---	---	---	---	224	6.67
6	---	---	---	---	---	---	---	---	---	---	---	---	224	6.67
7	---	---	---	---	---	---	---	---	---	---	---	---	224	6.67
Total	2	1	1	2	1	1	2	1	1	2	1	1	224	-----
% mortality	0.83	0.42	0.42	0.83	0.42	0.42	0.83	0.42	0.42	0.83	0.42	0.42	----	6.67

Result indicated that higher mortality was observed in unsupplemented than enzyme supplemented diets. The higher mortality in enzyme unsupplemented diets is difficult to explain.

ECONOMICS

Cost per kg live weight was calculated on the basis of feed cost and the cost of survived chicks from 0-7 weeks. Actual cost of feed was calculated on the basis of the rate of commercial diet supplied by COMPFED, Ranchi, which was the same for starter and finisher rations and the high fibre feed ingredients (DORB and Ext S.F.C.) plus the cost of supplemented enzyme. The cost of both type of rations ranged from Rs. 7.10 to 9.75. The variability in the cost of rations used in different treatments was mainly due to different levels of substitution of high fibre feed ingredients in control diet as well as in the level of enzyme supplementation. A reduction in cost of ration was evident, as the level of substitution by high fibre feed ingredients was increased in control ration. Higher level of enzyme supplementation caused an increase in the cost of ration, which were about Rs. 0.55 to Rs. 1.10 per kg for 0.05% and 0.10% level of enzyme supplementation respectively. The cost of feed per kg live weight was found to be lower in 0.05% enzyme supplemented group of all dietary treatments and the lowest cost was found to be in 30% substituted diet. Considering the cost of enzyme in relation to increase in body weight it was found that the chicks fed substituted diet at 0.05% level of enzyme supplementation, gave more economical gain. The increase cost of rations due to enzyme supplementation was compensated by increase in body weight and recorded more margin of profit.

...s as influenced by various dietary treatments

T.No.	Cost/kg starter ration (Rs)	Cost of starter ration cons-umed (Rs)	Cost/kg finisher ration (Rs)	Cost of finisher ration cons-umed (Rs)	Total feed cost (Rs)	Cost of survived chicks (Rs)	Total cost (Rs)	Average live weight of chicks (g)	Average live weight gain of chicks (g)	Total cost/kg live weight (Rs)	Cost of feed/kg live weight gain (Rs)
T1	8.65	7.81	8.65	16.65	24.46	8.89	33.35	1101	1055	30.29	23.18
T2	9.20	9.15	9.20	18.12	27.27	8.42	35.69	1255	1210	28.44	22.54
T3	9.75	9.56	9.75	18.70	28.26	8.42	36.68	1197	1150	30.64	24.57
T4	8.13	7.53	8.13	16.90	24.43	8.89	33.32	1085	1040	30.71	23.49
T5	8.68	8.29	8.68	16.33	24.62	8.42	33.04	1176	1130	28.10	21.79
T6	9.23	9.07	9.23	16.21	25.28	8.42	33.70	1148	1100	29.36	22.98
T7	7.61	6.76	7.61	15.46	22.22	8.89	31.11	1047	1000	29.71	22.22
T8	8.16	8.07	8.16	15.32	23.39	8.42	31.81	1136	1090	28.00	21.46
T9	8.71	8.95	8.71	16.42	25.37	8.42	33.79	1165	1120	29.00	22.65
T10	7.10	5.80	7.10	12.60	18.40	8.89	27.29	917	870	29.76	21.15
T11	7.65	6.95	7.65	14.19	21.14	8.42	29.56	1068	1020	27.68	20.73
T12	8.20	7.79	8.20	16.28	24.07	8.42	32.49	1106	1060	29.38	22.71

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

In order to minimize the cost of production, feed ingredients of agroindustrial origin are invariably used in broiler rations. Incorporation of these agroindustrial by-products leads to variation in the chemical composition particularly with respect to fibre level which has an energy diluent effect on the diet. Also conventional feed ingredients contain some factors which can not be degraded in the digestive system of monogastric animals and are thus antinutritional. The incorporation of such feeds containing incriminating factors in poultry rations may cause stress to the birds thereby affecting their production adversely. The adverse effect on production to some extent can be overcome by the use of feed enzymes in broiler rations. With the use of feed enzymes, the nutritive value of poultry diet can be improved through better utilisation of NSP as energy source and elimination of specific antinutritive factors. The benefits of using enzymes in poultry diets include not only enhanced bird performance and feed conversion but also less environmental problem due to reduced excretion of excreta. Also some exogeneous enzyme such as microbial phytase not only reduces the need of inorganic phosphorus by increasing its availability but also serves to reduce the need for some other minerals in the diet. The objective of the present study is to access the fibre status of commercial diet and effect of addition of feed enzymes in commercial diet and in constituted high fibre commercial diet.

For this, a biological experiment involving 240 day old broiler chicks of commercial strain was conducted to study the response of

broilers reared on twelve experimental diets. The design of the experiment was 4 x 3 factorial arrangements (4 diets and 3 levels of enzyme feed supplements). High fibre feed ingredients viz. deoiled rice bran and extracted sunflower cake were procured and were analysed for their proximate composition and minerals. Four basal diets consisting of one commercial diet and three high fibre diets with the substitution of 10%, 20% and 30% mixture of Ext. S.F.C. and DORB in 1:1 ratio were formulated. Each basal diet was supplemented without or with multienzyme @ 50 g and 100g/100 kg diet. The activities of multienzyme feed supplement with respect to different enzymes per gram were endoxylanase - 2000 units, beta-glucanase- 600units, pectinase - 60 units, amylase - 1500 units, cellulase - 15 units, protease - 600 units and phytase - 20 units. The duration of experiment was upto 7 weeks of age, spreading into 0-4 weeks as starting phase and 4-7 weeks as finishing phase of growth. The supplemental level of enzymes were similar for both the phases of growth. A balance trial of 5 days duration consisting of 2 days of preliminary period and 3 days of collection period was conducted to find out the effect of various treatment on ME content of diet and retention of energy, nitrogen and phosphorus in broilers. Parameters relating to performance and carcass characteristics were recorded.

The following results and conclusion drawn were as follows :-

BODY WEIGHT GAIN.

The average body weight gain during 0-4 weeks ranged from 365 to 510 g. There was a significant ($P<0.05$) decrease in body weight gain, when the level of fibre in commercial diet was increased

through substitution of high fibre feed ingredients mixture beyond 10%. Body weight gain in 30% substituted diet was numerically lower but not significantly ($P<0.05$) different from 20% substituted diet. Addition of feed enzyme irrespective of fibre level of diets improved body weight gain. Not much beneficial effect was seen by increasing the level of enzyme from 0.05% to 0.10%.

The body weight gain during 4-7 weeks of growth ranged from 505 to 700 g. Effect on body weight gain by increasing the fibre level of diet, was the same as was observed in starting phase of growth. Enzyme supplementation produced significantly ($P<0.05$) higher body weight gain with respect to each unsupplemented diet. Rations supplemented with 0.05% enzyme showed significantly ($P<0.05$) higher body weight gain in comparison to 0.10% and unsupplemented diet.

The body weight gain during the entire experimental period was significantly ($P<0.05$) influenced by dietary treatments and ranged from 870 to 1210g. Increase in fibre level by substitution with mixture of ext. SFC and DORB decreased body weight gain with no apparent effect upto 10% substitution. Enzyme supplementation influenced both control and substituted diets and reflected significantly ($P<0.05$) higher body weight gain. However, higher level of enzyme (0.10%) could not produced a substantial increase in body weight gain. Body weight gain of chicks fed 20% and 30% substituted diets supplemented with enzyme were as good as control without enzyme supplementation.

From the results, it can be concluded that this commercial diet

require the supplementation of enzyme at a level of at least 0.05% and the chicks can tolerate the commercial diet upto 30% substitution of high fibre ingredients with enzyme supplementation at this level.

FEED CONSUMPTION

The feed consumption during 0-4 weeks ranged form 818 to 995 g was significantly ($P<0.05$) affected by dietary treatments. There was no differences in feed consumption, when the commercial diet was substituted upto 20% of mixture. Chicks fed 30% substituted diet showed decreased feed consumption. Enzyme supplementation in all basal diets showed significantly ($P<0.05$) higher feed consumption. Level of enzyme had similar effect in control and upto 20% substituted diet but feed consumption was found to be more in 30% substituted diet at 0.10% level of enzyme.

The feed consumption during 4-7 weeks ranging from 1707 to 2079 g was significantly ($P<0.05$) affected by dietary treatments. Chicks fed 30% substituted diet showed significantly ($P<0.05$) lower feed consumption while 10% and 20% substituted diets showed higher feed consumption from control. No effect of supplementation of enzyme in control diet was seen in feed consumption. A reduction in feed intake was observed in 10% and 20% substituted diets supplemented with enzyme while an increased feed consumption was noted in 30% substituted diet supplemented with enzyme.

The feed consumption during entire experimental periods ranged form 2593 to 3006 g and was significantly ($P<0.05$) influenced by dietary treatments. A significantly ($P<0.05$) lowered feed

consumption was observed in chicks fed 30% substituted diet in comparison to other diets in which feed consumption were not significantly ($P<0.05$) different. No definite trend of effect of enzyme supplementation was seen among various groups. A significant ($P<0.05$) reduction of feed intake was observed in chicks fed 10% substituted diet with enzyme supplementation while no effect was seen in 20% substituted diet but an increased feed consumption in 30% substituted diet.

Results of feed consumption indicated that the chickens fed unsupplemented high fibre diet had comparatively lower feed intake than control diet. Enzyme supplementation showed an improvement in feed intake but was not consistent.

FEED CONVERSION RATIO (FCR)

Efficiency of feed utilisation in terms of FCR during 0-4 weeks ranging form 1.95 to 2.24, was significantly ($P<0.05$) influenced by dietary treatments. Low fibre control diet had lower ratio in comparison to high fibre diet. No apparent difference in ratios were obtained by increasing the fibre level of commercial diet. Supplementation of enzyme in control diet and 20% and 30% substituted diets showed comparable FCR-value with respect to unsupplemented diet, except in 10% substituted diet which reflected improved feed efficiency by enzyme supplementation.

The FCR values during 4-7 weeks ranging from 2.78 to 3.51, was significantly ($P<0.05$) influenced by dietary treatments. Low fibre control diet showed lower FCR value than high fibre diet.

Among high fibre diets, 10% and 20% substituted diets showed comparable but significantly ($P<0.05$) lower FCR value than 30% substituted diet. Supplementation of enzyme improved feed efficiency in control and high fibre substituted diets. The feed efficiency in chicks fed 30% substituted diet with enzyme supplementation was as good as control diet without enzyme supplementation.

During combined phases of growth, FCR value of different dietary treatments ranging from 2.45 to 2.98, was significantly ($P<0.05$) influenced by diet, enzyme level and interaction between diet and enzyme. A gradual decline in feed efficiency was observed with a gradual increase in fibre level of commercial diet. The FCR-values in all substituted diets were comparable. Supplementation of enzyme at both the levels showed significantly ($P<0.05$) higher feed efficiency than unsupplemented control and all substituted diets. No beneficial effect of increasing the level of enzyme from 0.05% to 0.10% was observed in feed utilisation by chicks.

PERFORMANCE INDEX (PI)

The performance index during 0-4 weeks showed a gradual decline as fibre level of control diet was increased. Improvement in PI-value was noticed at both levels of enzyme supplementation but 0.05% supplementation reflected significantly ($P<0.05$) higher PI-value than all unsupplemented diets.

Chicks fed control diet during finishing phase of growth reflected significantly ($P<0.05$) higher PI-value than all substituted

diets. However, PI-values in 10% and 20% substituted diets were similar but significantly ($P<0.05$) higher than 30% substituted diet. Supplementation of enzyme improved PI-value in both control and substituted diets, with no marked difference in improvement by increasing the level of enzyme.

A similar trend in PI-was reflected during combined phase of growth. A significant ($P<0.05$) improvement in PI-value was observed when control and substituted diets were supplemented by enzyme. The highest PI-value was obtained in control diet supplemented with 0.05% level of enzyme followed by 0.05 and 0.10% enzyme supplemented substituted diets.

Results indicated that as the level of fibre was increased in the diet, a gradual decrease in feed efficiency was noticed and this effect was more marked in finishing phase of growth than starting phase. Addition of 50g enzymes feed supplement per 100kg feed resulted in better feed efficiency and performance index in comparison to diet without or with 100g enzyme feed supplement per 100 kg feed.

CARCASS TRAITS

The shrinkage% expressed as percentage of live weight though significantly ($P<0.05$) affected by dietary treatments but did not show a definite trend either by increasing the level of fibre of control diet or by enzyme supplementation. In general, heavier birds had lower shrinkage% .

The blood loss% and feather loss% was significantly ($P<0.05$)

influenced by dietary treatments. The blood loss% was found to be significantly ($P<0.05$) more in control and 10% substituted diets than 20% and 30% substituted diets. Enzyme supplementation increased blood loss% in all diets except 20% substituted diet supplemented with 0.05% enzyme. Feather loss percentages ranging from 4.91 to 6.07 was not affected much by increasing the fibre level in diet, while enzyme supplementation at 0.05% level reflected more feather loss%.

The dressing % was significantly ($P<0.05$) influenced by dietary treatments and ranged from 77.64 to 80.82. Chicks fed either control or substituted diet without enzyme supplementation showed comparatively lower% than enzyme supplemented diet. Similarly, the eviscerated % ranging from 69.21 to 71.30 was also influenced by dietary treatments. The trend of eviscerated percentages was nearly some as observed in dressing%.

BONE PERCENTAGE, MEAT AND BONE RATIO AND COOKING LOSS PERCENTAGE.

The bone % ranging from 16.23 to 19.87, was significantly ($P<0.05$) influenced by dietary treatments. Increased fibre level of the diet showed an increase in bone%, while supplementation of enzyme decreased the bone% with their corresponding unsupplemented diet. The ratios of raw edible meat to bone and cooked edible meat to bone were significantly ($P<0.05$) influenced by different dietary treatments. A gradual decrease in ratio of meat to bone was observed, as the fibre level of control diet was increased. Enzyme supplementation at 0.05% level improved the ratios. The

cooking loss% was found to be significantly ($P<0.05$) more in high fibre diet, while supplementation of enzyme decreased the cooking loss%.

The weight of liver, gizzard, giblet and neck expressed as percentage of preslaughter weight were significantly ($P<0.05$) affected by dietary treatments. No regular trend in the weight of liver and gizzard was found either by increasing the fibre level of diet or by enzyme supplementation. However, chicks fed high fibre 30% substituted diet without enzyme supplementation produced heavier gizzard in comparison to other diets. Dietary fibre and enzyme level did not influenced significantly ($P<0.05$) heart %. Supplementation of enzyme in control diet improved the giblet% but the effect was not seen in substituted diets supplemented with enzyme. Increased fibre level of control diet showed lower % in neck, while neck + giblet % of different groups were similar.

CARCASS COMPOSITION

Dietary treatments significantly ($P<0.05$) affected the chemical composition of thigh and breast muscles. High fibre unsupplemented diet showed significantly ($P<0.05$) higher percentage of moisture, while supplementation of enzyme reduced the moisture content of both type of muscles. A significant increase in protein % in both type of muscles was noticed as the fibre level of diet was increased. Enzyme supplementation significantly ($P<0.05$) reduced the protein percentage in both type of muscles. A gradual reduction in ether extract % of thigh muscle was obtained as the level of dietary fibre was increased but the ether extract in breast muscle did not show

the same trend. In general, thigh muscle had higher ether extract % and lower protein and moisture % than breast muscle in all dietary treatments.

METABOLISABLE ENERGY (ME) CONTENT OF VARIOUS EXPERIMENTAL DIETS AND PERCENT GROSS ENERGY (GE) METABOLISED AS INFLUENCED BY ENZYME SUPPLEMENTATION.

As the level of fibre was increased, a gradual decline in ME content of diet was noticed, Supplementation of enzyme produced a significant increase in ME- value. Higher level of enzyme affected more in increasing the ME-value of diet. The % GE metabolised decreased as the level of fibre was increased. Enzyme supplementation at higher level (0.10%) showed significantly ($P<0.05$) better % of GE metabolised during 4th week. Similar trend of % GE metabolised was obtained at 7th week of age. High fibre level decreased, while supplementation of enzyme improved the % GE metabolised of diet.

RETENTION OF NUTRIENTS

The percent nitrogen retention of unsupplemented 30% substituted diet was found to be significantly ($P<0.05$) lower than all other diets. A gradual decrease in percent nitrogen retention was obtained, as the level of fibre content in control diet was increased during both the phases of growth. Enzyme supplementation of both levels improved significantly ($P<0.05$) the percent nitrogen retention.

The percent phosphorus retention ranging from 48.71 to 65.52 and 44.54 to 61.09 during 4th and 7th weeks respectively were significantly ($P<0.05$) influenced by dietary treatments. Level of fibre in the diet affected the percent phosphorus retention in a negative way. Supplementation of dietary multienzyme significantly ($P<0.05$) improved the percent phosphorus retention with no marked beneficial effect by increasing the level of enzyme from 0.05% to 0.10%.

MOISTURE CONTENT OF DROPPINGS AS INFLUENCED BY FIBRE LEVEL AND ENZYME SUPPLEMENTATION.

The moisture percentage of droppings at 4th and 7th weeks of age was significantly ($P<0.05$) influenced by fibre and enzyme level and their interaction. A significant ($P<0.05$) increase in excreta moisture content was observed as the fibre level of control diet was increased. Supplementation of enzyme at both levels significantly ($P<0.05$) reduced the moisture content of excreta during both the phases of growth. A lower level of moisture percentage in the excreta of chicks was found at 7th week than at 4th week. Supplementation of higher level of enzyme showed comparatively more reduction in moisture content of excreta of their respective unsupplemented diet.

MORTALITY

Out of total mortality (6.67%), the mortality during the Ist week itself was 4.58%. During 2nd week and 4th week, 3 chicks and 2 chicks died respectively and thereafter no mortality was observed. Enzyme supplemented diet showed lower mortality percentage than

unsupplemented diet.

ECONOMICS

The cost per kg live weight gain was found to be lower in 0.05% enzyme supplemented group of all dietary treatments. Considering the cost of enzyme in relation to increase in body weight, chicks fed substituted diet at 0.05% level of enzyme supplementation gave more economical gain. The increased cost of rations due to enzyme supplementation was compensated by increase in live weight and recorded more margin of profit.

CONCLUSION

(1) Inclusion of mixture of high fibre feed ingredients viz., Deoiled rice bran and Extracted sunflower cake by substitution, increased the fibre level of commercial diet and reflected a decrease in metabolisable energy content.

(2) As the level of fibre was increased in commercial broiler diet, a gradual decrease in feed efficiency was noted and this effect was more marked in finishing phase of growth.

(3) Addition of multienzyme (Polyzyme) at two levels (0.05% and 0.10%) resulted in significantly ($P<0.05$) higher growth in broilers with better efficiency of feed utilisation in control as well as in substituted diets.

(4) Maximum growth and best feed conversion efficiency in broilers was observed in commercial diet supplemented with 0.05% enzyme.

(5) Addition of 50g enzyme feed supplement per 100kg feed resulted in better feed efficiency and performance index in comparison to

without or with 100g enzyme feed supplement per 100kg feed, suggesting that the dose recommended by manufacturer seems to be adequate.

(6) No definite trend in various carcass traits was observed either by increasing the fibre level or by supplementation of enzyme in the diets, though a gradual decrease in meat and bone ratio was observed as the fibre level was increased, while enzyme supplementation improved the ratio.

(7) Cooking loss percentage was found to significantly ($P<0.05$) more in high fibre diet, while supplementation of enzyme reduced the loss.

(8) A significant ($P<0.05$) increase in metabolisable energy content on high fibre diet was observed due to the inclusion of enzyme feed supplement.

(9) Significant ($P< 0.05$) beneficial effect of enzyme feed supplement on nutrient retention with respect to nitrogen and phosphorus was observed.

(10) A significant ($P<0.05$) increase in excreta moisture content was observed, as the fibre level of diet was increased, while supplementation of enzyme at both levels (0.05% and 0.10%) significantly ($P<0.05$) reduced the moisture content of excreta.

(11) High fibre substituted diet supplemented with 0.05% level of enzyme gave more economical gain.

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APPENDIX

Appendix Table 1. Analysis of variance of body weight gain during different experimental periods

Sources of variation	Degree of freedom	0-4 weeks		4-7 weeks		0-7 weeks	
		Mean square	F-value	Mean square	F-value	Mean square	F-value
Treatment	11	32150.07	9.24**	39793.80	100.16**	137427.23	35.97**
Error	212	3478.58		397.27		3820.18	
Total	223						
Enzyme	2	8676.50	25.11**	10280.67	275.39**	37654.16	97.13**
Diet	3	6497.05	18.80**	6089.55	163.12**	25159.72	64.90**
Enzyme x Diet	6	232.05	0.67 NS	1469.55	39.36**	2209.72	5.70**
Error	12	345.50		37.33		387.66	
Total	23						

** Significant at 1% level (P<0.01).
NS Non significant.

Appendix Table 2. Analysis of variance of feed consumption during different experimental periods

Sources of variation	Degree of freedom	0-4 weeks		4-7 weeks		0-7 weeks	
		Mean square	F-value	Mean square	F-value	Mean square	F-value
Treatment	11	6682.40	12.42**	18232.31	14.26**	25888.95	6.60**
Enzyme	2	22483.78	41.79**	10242.03	8.01**	2480.30	0.63^{NS}
Diet	3	7192.53	13.37**	5322.95	4.16*	23935.76	6.10**
Enzyme x Diet	6	1160.21	2.15^{NS}	27350.42	21.40**	34668.44	8.84**
Error	12	537.96		1277.80		3921.42	
Total	23						

* Significant at 5% level (P<0.05).
** Significant at 1% level (P<0.01).
^{NS} Non significant.

Appendix Table 3. Analysis of variance of feed conversion ratio during different experimental periods

Sources of variation	Degree of freedom	0-4 weeks		4-7 weeks		0-7 weeks	
		Mean square	F-value	Mean square	F-value	Mean square	F-value
Treatment	11	0.01972	6.70**	0.11735	36.21**	0.06419	18.65**
Enzyme	2	0.0165	5.68*	0.47352	146.14**	0.21362	62.09**
Diet	3	0.0575	19.82**	0.09213	28.43**	0.08068	23.45**
Enzyme x Diet	6	0.0018	0.62^{NS}	0.01124	3.46*	0.00615	1.78^{NS}
Error	12	0.00294		0.00324		0.00344	
Total	23						

* Significant at 5% level (P<0.05).
** Significant at 1% level (P<0.01).
^{NS} Non significant.

Appendix Table 4. Analysis of variance of performance index during different experimental periods

Sources of variation	Degree of freedom	0-4 weeks		4-7 weeks		0-7 weeks	
		Mean square	F-value	Mean square	F-value	Mean square	F-value
Treatment	11	1653.25	66.13**	1618.71	99.12**	6331.94	78.65**
Enzyme	2	3100.67	124.02**	5633.17	344.95**	18764.67	233.10**
Diet	3	3800.61	152.02**	1952.61	119.57**	10115.78	125.66**
Enzyme x Diet	6	97.11	3.88*	113.61	6.95**	295.77	3.67*
Error	12	25.00		16.33		80.50	
Total	23						

* Significant at 5% level (P<0.05).
** Significant at 1% level (P<0.01).
NS Non significant.

Appendix Table 5. Analysis of variance of live weight, preslaughter weight and shrinkage percentage (as % of live weight) at the end of experimental periods

Sources of variation	Degree of freedom	Live weight		Preslaughter weight		Shrinkage %	
		Mean square	F-value	Mean square	F-value	Mean square	F-value
Treatment	11	23268.45	12.06**	21923.97	12.36**	0.0327	6.54**
Enzyme	2	57686.78	29.90**	54500.87	30.72**	0.0252	5.04*
Diet	3	37605.07	19.49**	35385.44	19.95**	0.0513	10.26**
Enzyme x Diet	6	4627.37	2.40^{NS}	4334.27	2.44^{NS}	0.0260	5.20**
Error	24	1929.47		1773.86		0.0050	
Total	35						

* Significant at 5% level (P<0.05).
** Significant at 1% level (P<0.01).
^{NS} Non significant.

Appendix Table 6. Analysis of variance of carcass traits as percentage of preslaughter weight at the end of experimental periods

Sources of variation	Degree of freedom	Blood loss %		Feather loss %		Dressing %		Eviscerated %	
		Mean square	F-value	Mean square	F-value	Mean square	F-value	Mean square	F-value
Treatment	11	0.8641	9.17**	0.5847	10.37**	2.7470	5.18**	1.1279	3.81**
Enzyme	2	3.0900	32.80**	2.4885	44.12**	0.4570	0.86^{NS}	0.8501	2.87^{NS}
Diet	3	1.8133	19.25**	0.3917	6.95**	5.0484	9.52**	2.1733	7.34**
Enzyme x Diet	6	0.1850	1.96^{NS}	0.0466	0.83^{NS}	2.3595	4.45**	0.6978	2.36^{NS}
Error	24	0.0942		0.0564		0.5303		0.2961	
Total	35								

** Significant at 1% level (P<0.01).
^{NS} Non significant.

Appendix Table 7. Analysis of variance of carcass traits as percentage of ready to cook weight at the end of experimental periods

Sources of variation	Degree of freedom	Cooking loss%		Bone %		Ratio of raw edible meat to bone		Ratio of cooked edible meat to bone	
		Mean square	F-value	Mean square	F-value	Mean square	F-value	Mean square	F-value
Treatment	11	2.24816	15.85**	2.85590	19.58**	0.27619	18.84**	0.23126	18.37**
Enzyme	2	3.99705	28.18**	7.73985	53.06**	0.74805	51.03**	0.59430	47.20**
Diet	3	4.79547	33.81**	3.92350	26.90**	0.38357	26.16**	0.35067	27.85**
Enzyme x Diet	6	0.39155	2.76*	0.69412	4.76**	0.06522	4.45**	0.05055	4.02
Error	24	0.14185		0.14588		0.01466		0.01259	
Total	35								

* Significant at 5% level (P<0.05).
** Significant at 1% level (P<0.01).

Appendix Table 8. Analysis of variance of weight of different body/organ cuts as percentage of preslaughter weight at the end of experimental periods

Sources of variation	Degree of freedom	Liver %		Gizzard %		Heart %	
		Mean square	F-value	Mean square	F-value	Mean square	F-value
Treatment	11	0.0251	3.80**	0.02198	4.02**	0.00166	0.99^{NS}
Enzyme	2	0.0072	1.09^{NS}	0.00095	0.17^{NS}	0.00285	1.71^{NS}
Diet	3	0.0133	2.02^{NS}	0.03947	7.22**	0.00047	0.28^{NS}
Enzyme x Diet	6	0.0371	5.62**	0.02025	3.70**	0.00187	1.12^{NS}
Error	24	0.0066		0.00547		0.00167	
Total	35						

** Significant at 1% level (P<0.01).
^{NS} Non significant.

Appendix Table 9. Analysis of variance of weight of different body/organ cuts as percentage of preslaughter weight at the end of experimental periods

Sources of variation	Degree of freedom	Giblet %		Neck %		Neck + Giblet %	
		Mean square	F-value	Mean square	F-value	Mean square	F-value
Treatment	11	0.05761	2.31*	0.02951	4.83**	0.11398	2.20^{NS}
Enzyme	2	0.00625	0.25^{NS}	0.08000	13.09**	0.13255	2.56^{NS}
Diet	3	0.01843	0.74^{NS}	0.03977	6.51**	0.09037	1.74^{NS}
Enzyme x Diet	6	0.09432	3.78**	0.00755	1.24^{NS}	0.11960	2.31^{NS}
Error	24	0.02495		0.00611		0.05186	
Total	35						

* Significant at 5% level (P<0.05).
** Significant at 1% level (P<0.01).
^{NS} Non significant.

Appendix Table 10. Analysis of variance of chemical composition of thigh muscle at the end of experimental periods

Sources of variation	Degree of freedom	Moisture %		Protein %		Ether Extract %	
		Mean square	F-value	Mean square	F-value	Mean square	F-value
Treatment	11	2.15135	25.44**	1.37390	19.53**	0.81535	23.90
Enzyme	2	1.39060	16.44**	1.38715	19.72**	0.07230	2.12^{NS}
Diet	3	6.95643	82.25**	4.0950	58.21**	2.94047	86.21**
Enzyme x Diet	6	0.00240	0.03^{NS}	0.00893	0.13^{NS}	0.00047	0.01^{NS}
Error	24	0.08458		0.07035		0.03411	
Total	35						

** Significant at 1% level (P<0.01).
^{NS} Non significant.

Appendix Table 11. Analysis of variance of chemical composition of breast muscle at the end of experimental periods

Sources of variation	Degree of freedom	Moisture %		Protein %		Ether Extract %	
		Mean square	F-value	Mean square	F-value	Mean square	F-value
Treatment	11	2.92574	34.63**	1.87617	27.72**	1.02902	31.11**
Enzyme	2	2.04070	24.16**	1.80170	26.62**	0.08710	2.63^{NS}
Diet	3	9.35910	110.78**	5.67343	83.83**	3.71420	112.28**
Enzyme x Diet	6	0.00407	0.05^{NS}	0.00237	0.04^{NS}	0.00040	0.01^{NS}
Error	24	0.08448		0.06768		0.03308	
Total	35						

** Significant at 1% level (P<0.01).
^{NS} Non significant.

Appendix Table 12. Analysis of variance percent of GE metabolised at the end of starting (4th week) and finishing (7th week) periods

Sources of variation	Degree of freedom	At 4th week		At 7th week	
		Mean square	F-value	Mean square	F-value
Treatment	11	20.14973	440.24**	26.32409	363.24**
Enzyme	2	33.10565	723.30**	48.67035	671.59**
Diet	3	50.62210	1106.01**	60.46883	834.40**
Enzyme x Diet	6	0.59490	13.00**	1.80297	24.88**
Error	12	0.04577		0.07247	
Total	23				

** Significant at 1% level (P<0.01).

Appendix Table 13. Analysis of variance of percent nitrogen retention at the end of starting (4th week) and finishing (7th week) periods

Sources of variation	Degree of freedom	At 4th week		At 7th week	
		Mean square	F-value	Mean square	F-value
Treatment	11	37.16019	596.66**	36.85884	788.09**
Enzyme	2	111.68580	1793.29**	112.89545	2413.84**
Diet	3	54.62387	877.07**	56.38097	1205.49**
Enzyme x Diet	6	3.58648	57.59**	1.75223	37.46**
Error	12	0.06228		0.04677	
Total	23				

** Significant at 1% level (P<0.01).

Appendix Table 14. Analysis of variance of percent phosphorus retention at the end of starting (4th week) and finishing (7th week) periods

Sources of variation	Degree of freedom	At 4th week		At 7th week	
		Mean square	F-value	Mean square	F-value
Treatment	11	44.85409	876.06**	44.57535	985.74**
Enzyme	2	133.45555	2606.55**	130.65780	2889.38**
Diet	3	66.51937	1299.21**	68.41937	1513.03**
Enzyme x Diet	6	4.48763	87.65**	3.95920	87.55**
Error	12	0.05120		0.04522	
Total	23				

** Significant at 1% level (P<0.01).

Appendix Table 15. Analysis of variance of percent moisture content of droppings of the birds at the end of starting (4th week) and finishing (7th week) periods

Sources of variation	Degree of freedom	At 4th week		At 7th week	
		Mean square	F-value	Mean square	F-value
Treatment	11	9.27765	46.59**	9.75104	67.22**
Enzyme	2	28.82530	144.74**	30.45355	209.94**
Diet	3	13.55073	68.04**	13.97287	96.32**
Enzyme x Diet	6	0.62523	3.14*	0.73928	5.10**
Error	24	0.19915		0.14506	
Total	35				

* Significant at 5% level (P<0.05).
** Significant at 1% level (P<0.01).