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Effects of feeding graded levels of hydrolyzed corncob based diets on growth performance, serum and haematological indices of broiler chickens under a single phase feeding regime

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***Target Audience**: Animal nutritionists, Feed millers, Poultry farmers*

Abstract

The effects of feeding graded levels of cellulase and pectinase hydrolyzed corncob based diets on growth performance, serum and haematological parameters of growing broiler chickens over a period of 8 weeks was investigated. Four dietary treatments were formulated such that diets 1, 2, 3 and 4 contained 0, 5, 10 and 15% cellulase and pectinase hydrolyzed corncobs respectively. Diet 1 served as the control. One hundred and eighty one day-old chicks with an average initial weight of 60g ±0.63 were randomly distributed into four treatment groups in three replicates. Each replicate had fifteen birds. Crushed corncobs were pretreated with NaOH to remove the lignin contents and later subjected to hydrolysis using locally prepared cellulase and pectinase solution for the degradation of the non-starch polysaccharides (NSPs) in a plastic drum for five days. Chemical and fibre compositions of corncobs, enzyme treated corncobs and diets were determined. The sample was periodically stirred / turned for 30 minutes on 3 hourly basis at room temperature (25°C) for five days for hydrolysis to take place. Data were collected on growth indices, digestibility, carcass components, organ proportions and some haematological and serum parameters. An average weekly feed intake of 571.45g ± 15.22 was recorded for the control group, while an average feed consumption of 567.69g ± 14.06, 548.54g ±13.10 and 535.74g ± 13.24 were recorded for enzymes treated groups respectively. The results showed that high levels of lignins, cellulose, hemicellulose and pentosans contained in corncobs were degraded into smaller monomers (glucose and other disaccharides). Broilers fed the control diet (T_1) had significantly ($P<0.05$) reduced performance indices when compared to that of the broilers ($P>0.05$) fed enzyme treated corncob diets (T_2, T_3 and T_4). Enzyme treated corncob diets significantly ($P<0.05$) increased packed cell volume, haemoglobin concentration, red blood cell count, white blood cell count, serum protein, aspartate amino transaminase, alanine amino transaminase, and lowered albumin and blood cholesterol levels of the birds when compared to the control diet. This study suggests that enzyme treated corncob inclusion at the levels of 5 to 15 % improved broiler growth performance and lowered blood cholesterol levels.

Keywords: Broiler chickens, Growth, Hydrolyzed Corncob, Serum and haematological indices

Description of problem

The ever increasing population growth in Nigeria means a greater demand for animal protein which is already in acute short supply (1). This animal protein shortage is due largely to low level of animal productivity. Feeds constitute about 70% of total cost of producing meat and eggs (2). It is therefore very important that maximum benefit be derived from every unit of feed offered to birds. High cost and scarcity of conventional protein concentrates and quality fibre sources have been the major constraints to increased commercial poultry production in Nigeria (3). There is the need to expand the raw material base for poultry feed formulation to accommodate unconventional feed ingredients. One of such unconventional feed resource is the corncob. Poultry production has been found to be capable of bridging the protein gap due to short generation intervals when compared with large ruminants (4). It has also proven to be the quickest and cheapest substitute to other macro animal protein sources which are expensive (5).

Corncobs are by-products of maize processing industries and households. They can constitute environmental menace not only on the farms but on the streets and in homes if not properly disposed. Corncob contains hemicelluloses that upon splitting acid produce appreciable quantities of xylose and arabinose, with lesser quantities of glucose and galactose fermentable sugars. These are webbed up in mass of lignin and other polysaccharides, which gives it characteristic hardness and insolubility in water (6). This is a contributing factor for the low feed intake and utilization of corncob despite the application of fermentation technique to reduce and unlock the fibre. (7) reported that high levels of fibrous corncobs reduced growth rate, feed efficiency, nutrient digestibility and energy utilization significantly in broiler chickens.

Carcass yield is closely linked to adequate food and nutrition of broilers as birds with adequate supply of nutrients will deposit effective muscles (8). The blood plays vital role in the transportation of nutrients, metabolic waste products and gases around the body (9). Haemato-biochemical profiles are most commonly used in nutritional studies for chickens and also data obtained from blood profile could be exploited in the improvement of broiler stocks (10).

Enzyme incorporation improved feed intake, feed utilization and nutrient digestibility which culminates in high weight gain of birds (11). This suggests that enzyme enhances the degradation of non-starch polysaccharides (NSPs) constituents of the feed which eventually results in rapid digestion of starch, protein and other nutrients (12). Low carcass yield, poor haematological and serum indices in animals may be attributed to the inability of animals to obtain enough nutrients from poorly digested diets (13). This study therefore, considers the use of hydrolyzed corncob as a feed resource and as a means of lowering cost of feed and reducing environmental pollution.

Table 1: Composition of corncob experimental diets treated with enzymes under a single phase feeding regime for broiler chickens

Dietary levels of enzyme treated corncob (%)				
Ingredients(%)	0.00	5.00	10.00	15.00
Maize	45.45	40.70	36.00	32.20
Groundnut cake	34.55	34.30	33.00	31.80
Wheat offal	9.00	8.00	8.00	7.00
Corncobs	0.00	5.00	10.00	15.00
Fish meal	3.50	3.50	3.50	3.50
Bone meal	2.00	2.00	2.00	2.00
Oyster shell	1.50	1.50	1.50	1.50
Lysine	0.20	0.20	0.20	0.20
Methionine	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25
Palm oil	3.00	3.00	3.00	3.00
Salt	0.30	0.30	0.30	0.30
Cellulase	0.00	0.50	1.00	1.50
Pectinase	0.00	0.50	1.00	1.50
Total	100.00	100.00	100.00	100.00
Calculated values				
ME Kcal/kg	3000	3000	3000	3000
Crude protein (%)	23.00	23.00	23.00	23.00
Crude fibre (%)	5.15	6.10	6.50	6.75
Calcium (%)	1.61	1.62	1.61	1.63
Phosphorus (%)	0.74	0.72	0.75	0.76
Methionine (%)	0.55	0.54	0.54	0.55
Lysine (%)	1.12	1.1 1	1.15	1.15

*2.5 kg of premix supplied: Vitamin A (100 00000 iu), Vitamin D_3 (2000000iu), Vitamin E (12000iu), Vitamin K (2 iu). Thiamine B (1.5 g), Riboflavin B_2(5 g), Pyriboflavin B6(1.5 g), Vitamin B**12** (10 mg). Biotin (20 mg). Niacin (15g). Pantothenic acid (5 g), Folic acid (0.6 g). Manganese (75 g). Zinc (50 g). Iron (25 g). Copper (5 g). Iodine (1 g). Selenium (100 mg). Cobalt (300 mg), BHT (125 g). Choline Chloride (150 g)

Materials and methods

Location of the study

The experiment was carried out at the Poultry Unit of the Department of Animal Production Teaching and Research Farm, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna. Minna falls within the longitude 6^0 33’ East and latitude 9^0 45’ North and it is situated in the Northern Guinea Savannah Zone of Nigeria (14). Minna experiences approximately seven months of rainfall, it receives a Mean Annual precipitation of 1,100mm which spreads from April to October, with a Mean Annual Temperature of 30 ^{0}C. Relative humidity ranges between 60 and 75 % (14).

Sources of fibre materials and other feed ingredients

The corncobs used for the experiment were free of moulds or any fungi growth collected from within the maize processing sheds after the shelling of dried maize grains in Minna. Dried corncobs were crushed using motorized crusher, then milled using a combination of plate and hammer mills to obtain a screen size of 3mm and packed in jute bags, pending the time of use. Other feed ingredients were maize, wheat offal, groundnut cake, fish meal, bone meal, oyster shell, lysine, methionine, vitamin premix and salt all purchased from poultry feed shop in Central Market, Minna.

Raw materials and Reagents for the production of enzymes

The enzymes produced for the hydrolysis of the corncobs were crude cellulase and pectinase. The raw materials used were corncobs, snails (from whose guts *Aspergillus niger* species were isolated) pectin substrate, carboxylmethyl cellulose (CMC). While the chemical reagents were Iron II sulphate ($FeSO_4$), Sodium nitrate ($NaNO_3$), Disodium hydrogen phosphate(Na_2HPO_4) Magnesium sulphate ($MgSO_4$), Potassium chloride (KCl) and Sodium hydroxide (NaOH). Other laboratory equipments used included incubator, autoclave, glass bottles, funnels, deionized water and filter paper (No.1).

Experimental birds and design

One hundred and eighty-old chicks were used for the experiment. The birds were weighed and randomly allocated to four treatment groups with forty-five birds per treatment and three replication. Each replicate pen consisted of fifteen birds. The experimental design used for this study is the Analysis of Variance (ANOVA) in a Completely Randomized Design (CRD). The test diets were designed as T_1, T_2, T_3 and T_4 with cellulase and pectinase hydrolyzed corncob inclusion at 0, 5, 10 and 15% levels respectively.

Dietary treatment one (T_1) that did not contain corncob served as the control, while T_2, T_3 and T_4 contained 5, 10, and 15% of corncobs hydrolyzed with equal levels of cellulase and pectinase (10 litres/100 kg of crushed corncob). Rations were formulated to meet the (15) standard requirements for broilers as presented in Table 1.

Table 2: Proximate composition and energy values of untreated and enzyme treated corncobs

Parameters(%)	Untreated Corncob	Enzyme treated corncob
Moisture	13.30	10.10
Dry matter	86.70	89.90
Crude protein	4.90	13.60
Crude fibre	32.30	14.50
Ether extract	1.50	4.00
Total ash	7.00	13.00
Nitrogen free extract	41.00	44.80
Energy value (ME Kcal/kg)	2600.00	2750.00

Table 3: Fibre composition of untreated and enzyme treated corncobs

Fibre composition Reductioncorncob(%)	Untreated corncob (%)	Enzyme treated	(%)
Lignins	9.71	2.13	78.06
Cellulose	20.11	4.15	79.36
Hemicellulosc	14.60	1.50	89.73
Neutral detergent fibre	44.42	7.78	82.49
Acid detergent fibre	55.58	10.56	81.00
Silica	4.50	3.20	28.90
Reducing sugars (mg/100g)	23.04	11.60	49.70

Management of experimental chicks

The experimental chicks were housed in a deep litter system that allowed effective sanitation, cross ventilation and properly insulated to prevent the chicks from vermins like cats, rats and predatory birds. Each replicate had a dimension of 1.5m x 1m floor spacing. Litters were changed when wet to maintain it in crumble form. Feed and water were supplied to the chicks *ad libitum*. Structures and equipment such as pens, feeders, drinkers and tools were properly cleaned and sanitized frequently as recommended by (16).

Preparation of cellulase and pectinase hydrolyzed corncob

About 100 kg of crushed and pretreated (de-lignified) corncobs was emptied into a large size plastic drum for hydrolysis to take place. 10 litres each of prepared cellulase and pectinase solution were added to the corncob and thoroughly mixed by continuous stirring/turning with a wooden turning stick for 30 minuets and left tightly covered. These was periodically stirred on 3 hourly basis at room temperature (25 ^{0}C) for 5 days. (17). During this period, cellulase enzyme hydrolyzed cellulose and hemicellulose components of the corncob into smaller sub – units of carbohydrates i.e. glucose and other disaccharides, while on the other hand pectinase hydrolysed pectins and pentosans into small monomers (glucose and other dissacharides) which were bioavailable for utilization by the chickens. Reducing sugars test was done every 24 hours to determine the glucose yield from the 3rdto the 5th day of the hydrolysis process using spectrophotometer (18). At the termination of the hydrolysis process, the hydrolyzed corncobs were sun dried for 5 days and packed in jute bags pending the time of use.

Blood collection for biochemical studies

At the 56th day of the experiment (8 weeks), 10ml of blood samples were collected from nine birds per treatment group through neck slitting into sterile disposable hypodermic syringes. About 5 ml of blood samples were transferred immediately into plastic tubes containing anti-coagulant ethylene diaminitetra-acetic acid (EDTA) for haematological studies, while the other 5 ml was collected in to a sterile anti-coagulant free plastic tubes for serum biochemical studies.

Chemical analyses

Ground samples of raw and enzyme treated corncobs were taken to the National Research Institute for Chemical Technology (NARICT) Zaria, for proximate composition determination according to the method of (19). Fibre components in both raw and enzyme treated corncob determined included cellulose, hemicellulose, Neutral detergent fibre (NDF), Acid detergent fibre (ADF) and Acid detergent lignin (ADL) according to the procedure of (20),

The metabolizable energy (ME) of samples was calculated from the proximate composition data using the formula described by (21) as detailed below:

ME(Kcal/kg) = 37x (% CP) + 81.8 x (% EE) + 35.5 x (% NFE).

Where:

CP = crude protein, EE = ether extract and NFE = nitrogen free extract.

Blood samples were analyzed to determine the Packed cell volume (PCV), Red blood cell count (RBC), White blood cell count (WBC), Haemoglobin concentration (Hb), Mean corpuscular volume (MCV), Mean corpuscular haemoglobin (MCH) as outlined by (22, 23), where:

MCV (fl) = PCV/RBC X 10

MCH (pg) = Hb/RBC X 10

MCHC (g/dl) = Hb/PCV X 100

fl = femtolitre, pg = picagram, dl = decilitre

The serum biochemical indices determined included Aspartate amino transaminase (AST), Alanine amino transaminase (ALT), serum total protein, albumin, globulin, urea and total cholesterol levels using the routine standard clinical chemistry procedure as described by (22) and formula given by (24).

Data analysis

Data collectedfrom the various parameters measured were subjected to statistical analysis using one way analysis of variance (ANOVA), (25). Significant means were separated using the New Duncan's Multiple Range Test (26). The computer package used is the Statistical Analysis System (SAS) (27), version 10.0.

Results and Discussion

The results of proximate composition of corncob in Table 2 indicated that its hydrolysis using cellulase and pectinase are similar to those of (28) who reported improvement of dry matter, crude protein, ether extract and reduction in crude fibre in nutrient composition of fermented corncob fed to ruminants. The improved crude protein and reduction in crude fibre values suggest the positive effect of the enzymes on the corncob and gave values which compared well with those reported by (6) and (29) who attributed the nutritional improvement observed in degraded corncob to the fact that corncob served as the medium for metabolism and subsequent growth of the inoculated organism. The result from this study can also be explained on the basis that

(*Aspergillus niger*) depolymerized the crude fibre and detergent fibre

(Table 3) there in and then converted the products into other useful components such as protein and other nutrients which is in agreement with the work of (30) and (31) who severally obtained reduced values of high fibrous materials that were either fermented or treated with enzymes.

Table 4 shows that the crude protein content of the control diet were higher than those of the enzyme treated diets, their values were within the range recommended for broilers in the tropics (32). The crude fibre content of 3.50% to 6.50% also fell within the range tolerated by starter broilers (33) and much lower than levels tolerated by adult chicks.

The growth performance of broiler chickens fed different levels of hydrolyzed corncob diets is shown in Table 5. Birds fed enzyme treated corncob diets had higher final body weight. Their body weights increased as the levels of corncob inclusion increased. This result is similar to that obtained by (34) that increasing dietary level of enzyme treated fibre diets allowed chicks to exhibit better feed utilization which translated into heavier body weight. Feed efficiency values of treatment groups showed that enzyme treated diets were superior and significantly ($P<0.05$) different from those of the control diet. Similarly, birds on treated diets converted their feeds at almost the same level of efficiency.

Table 4: **Proximate composition and energy values of the corncob experimental diets**

	Dietary levels of enzyme treated corncob (%)			
	T_1	T_2	T_3	T_4
Parameters (%)	0.00	5.00	10.00	15.00
Dry matter	89.50	92.00	92.70	92.75
Crude Protein	23.00	21.00	21.50	21.75
Crude fibre	6.10	5.50	5.30	6.00
Ether extract	5.00	9.00	9.75	10.00
Total ash	6.00	7.25	7.00	7.50
Nitrogen free extract	49.40	49.25	49.15	47.50
Energy value (ME kcal/kg)	3050	3150	3250	3350

Table 5: Performance characteristics of broilers fed cellulase and pectinase hydrolyzed corncob diets

	Dietary levels of enzyme treated corncob (%)					
	T_1	T_2	T_3	T_4		
	0.00	5.00	10.00	15.00	SEM	LS
Starter Phase						
Initial body weight (g/bird)	64.67	65.00	61.50	64.50	1.25	NS
Final body weight (g/bird)	576.77^{b}	630.00^{a}	606.67^{ab}	633.33^{a}	16.12	*
Final body weight gain (g/bird)	512.10^{b}	565.00^{a}	542.17^{a}	568.83^{a}	15.13	*
Total feed intake (g/bird)	I455.63^{b}	1412.44^{c}	1392.83^{d}	1357.3^{e}	15.03	*
Daily protein intake (g/bird)	11.96^{c}	10.59^{d}	10.70^{de}	10.54^{de}	0.14	*
Feed conversion efficiency	0.35^{b}	0.40^{a}	0.39^{a}	0.42^{a}	0.003	*
Feed conversion ratio	2.84^{c}	2.50^{d}	2.57^{d}	2.39^{e}	0.13	*
Protein efficiency ratio	1.53^{c}	2.00^{b}	1.99^{ab}	2.12^{a}	0.02	*
Total protein in feed (%)	23.00	21.00	21.50	21.75	-	-
Cost/kg of feed (₦/kg)	284.28^{e}	359.38^{c}	497.94^{b}	574.20^{a}	6.51	*
Finisher Phase						
Initial body weight (g/bird)	576.77^{b}	630.00^{a}	606.67^{ab}	633.33^{a}	20.72	*
Final body weight (g/bird)	1666.67^{cd}	2116.67^{b}	2150.00^{b}	2383.33^{a}	41.67	*
Final body weight gain (g/bird)	1089.90^{d}	1486.67^{c}	1543.33^{b}	1766.67	68.30	*
Total feed intake (g/bird)	2273.38^{c}	2270.75^{c}	2194.15^{d}	2142.94^{e}	83.41	*
Daily protein intake (g/bird)	18.67^{b}	17.03^{c}	16.85^{d}	16.65^{d}	1.06	*
Feed conversion efficiency	0.48^{c}	0.65^{b}	0.70^{b}	0.82^{a}	00.9	*
Feed conversion ratio	2.09^{c}	1.53^{d}	1.42^{d}	1.21^{e}	0.16	*
Protein efficiency ratio	2.08^{d}	3.27^{c}	3.59^{b}	4.17^{a}	0.94	*
Total protein in feed (%)	23.00	21.00	21.50	21.75	-	-
Cost/kg of feed (₦/kg)	209.21^{e}	219.94^{d}	275.13^{b}	290.70^{a}	03.45	*

a, b, c, d, e: Mean values on the same row with different superscript (s) are significantly different ($P \leq 0.05$)

*: significant at 5% level ($P < 0.05$)

NS: not significant

SEM: standard error of mean

The results of chemical evaluation of haematological and serum metabolites are shown in Table 6. Broiler chickens fed the control diet had lower albumin, globulin and total protein. These lower values observed suggest lower ability of the blood to clot, hence, poor prevention of harmorrhage, poor tissue deposition and low ability to fight foreign body diseases which are similar to earlier report by (35). The alanine amino transaminase (ALT) and aspartate amino transaminase (AST) values reduced as the levels of enzyme treated corncob increased which is in agreement with findings by (36) who reported that with sufficient energy, transaminase enzyme promoted the removal of amino acid group to yield corresponding acid which enters tricarboxylic acid cycle for additional energy generation, hence, this observation might be responsible for the improved protein intake. The similarity (P>0.05) in packed cell volume (PCV) and haemoglobin (Hb) values of birds fed the control and enzyme treated diets are indication of good oxygen carrying capacity in which the birds were not bound to succumb to any form of respiratory diseases. This result is in agreement with the findings of (37) who reported similar PCV and haemoglobin values for indigenous chickens fed high energy level diets under intensive management system.

Table 5: Performance characteristics of broilers fed cellulase and pectinase hydrolyzed corncob diets

	Dietary levels of enzyme treated corncob (%)					
	T_1	T_2	T_3	T_4		
Parameters	0.00	5.00	10.00	15.00	SEM	LS
Starter Phase						
Initial body weight (g/bird)	64.67	65.00	61.50	64.50	1.25	NS
Final body weight (g/bird)	576.77^{b}	630.00^{a}	606.67^{ab}	633.33^{a}	16.12	*
Final body weight gain (g/bird)	512.10^{b}	565.00^{a}	542.17^{a}	568.83^{a}	15.13	*
Total feed intake (g/bird)	1455.63^{b}	1412.44^{c}	1392.83^{d}	1357.3^{e}	15.03	*
Daily protein intake (g/bird)	11.96^{c}	10.59^{d}	10.70^{de}	10.54^{de}	0.14	*
Feed conversion efficiency	0.35^{b}	0.40^{a}	0.39^{a}	0.42^{a}	0.003	*
Feed conversion ratio	2.84^{c}	2.50^{d}	2.57^{d}	2.39^{e}	0.13	*
Protein efficiency ratio	1.53^{c}	2.00^{b}	1.99^{ab}	2.12^{a}	0.02	*
Total protein in feed (%)	23.00	21.00	21.50	21.75	-	-
Cost/kg of feed (₦/kg)	284.28^{e}	359.38^{c}	497.94^{b}	574.20^{a}	6.51	*
Finisher Phase						
Initial body weight (g/bird)	576.77^{b}	630.00^{a}	606.67^{ab}	633.33^{a}	20.72	*
Final body weight (g/bird)	1666.67^{cd}	2116.67^{b}	2150.00^{b}	2383.33^{a}	41.67	*
Final body weight gain (g/bird)	1089.90^{d}	1486.67^{c}	1543.33^{b}	1766.67	68.30	*
Total feed intake (g/bird)	2273.38^{c}	2270.75^{c}	2194.15^{d}	2142.94^{e}	83.41	*
Daily protein intake (g/bird)	18.67^{b}	17.03^{c}	16.85^{d}	16.65^{d}	1.06	*
Feed conversion efficiency	0.48^{c}	0.65^{b}	0.70^{b}	0.82^{a}	00.9	*
Feed conversion ratio	2.09^{c}	1.53^{d}	1.42^{d}	1.21^{e}	0.16	*
Protein efficiency ratio	2.08^{d}	3.27^{c}	3.59^{b}	4.17^{a}	0.94	*
Total protein in feed (%)	23.00	21.00	21.50	21.75	-	-
Cost/kg of feed (₦/kg)	209.21^{e}	219.94^{d}	275.13^{b}	290.70^{a}	03.45	*

a,b,c,d,e: Mean values on the same row with different superscript (s) are significantly different ($P \leq 0.05$)
*: significant at 5% level ($P < 0.05$)
NS: not significant
SEM: standard error of mean

Low PCV and haemoglobin levels are usually due to iron deficiency as reported by (38). Cholesterol level was lower in birds fed degraded corncob diets, this result is also similar to that of (39) who reported that cholesterol and triglycerides consistently reduced in blood of birds fed degraded fibrous feed. The authors further explained that the low cholesterol levels could be as a result of slight reduction in lipogenesis.

Table 6: Haematological and serum metabolites of broiler chickensfed enzyme treated corncob diets

	Dietary levels of enzyme treated corncob (%)					
	T_1	T_2	T_3	T_4		
Parameters	0.00	5.00	10.00	15.00	SEM	LS
PCV {%)	30.00^{d}	38.15^{a}	37.00^{bc}	35.25^{c}	0.24	*
Hb (g/dl)	10.00^{e}	12.72^{a}	12.33^{a}	11.75^{ab}	0.06	*
RBC (xl0^{6}mm^{3})	3.20^{c}	3.50^{a}	3.45^{ab}	3.5 l^{a}	0.08	*
WB(x10^{3}mm^{3})	31.35^{a}	31.51^{a}	31.65^{a}	31.80^{a}	0.27	*
MCV(fl)	93.74^{d}	109.00^{a}	107.25^{b}	100.43^{c}	7.50	*
MCH (pg)	31.25^{e}	36.34^{a}	35.74^{a}	33.48^{b}	3.40	*
AST (µl/l)	26.80^{a}	22.15^{bc}	21.90^{be}	20.40^{d}	0.30	*
ALT (µl/1)	30.15^{a}	28.00^{ab}	22. 10^{d}	24.00^{c}	0.08	*
Urea (mg/dl)	36.05^{a}	30.55^{b}	31.15^{b}	28.30^{c}	1.20	*
Total serum protein	6.10^{b}	7.5 0^{a}	7.20^{a}	7.00^{a}	0.05	*
Albumin (g/dl)	2.90^{a}	2.8 l^{a}	2.85^{a}	2.80^{a}	0.08	*
Globulin (g/dl)	2.10^{a}	2.15^{a}	2.05^{b}	2.00^{c}	0.05	*
Total Cholesterol (g/dl)	2.09^{b}	1.85^{d}	1.90^{cd}	1.95^{c}	0.03	*

a, b, c, d: Mean values on the same row with different superscript (s) are significantly different ($P \leq 0.05$)
* Significant at 5% level ($P<0.05$)

Conclusion and Application

It was concluded that:

1. Treatment of corncobs with cellulase and pectinase significantly increased the nutrient composition and metabolizable energy and also reduced significantly the crude fibre contents of corncobs and diets.
2. Birds fed enzyme treated corncob diets had improved final body weight, body weight gain and converted their feeds on higher efficiency levels.
3. Although, haematological indices and serum metabolites for broilers in all treatment groups were within the normal range for poultry birds, broilers fed enzyme treated diets showed better haematological and serum indices than birds fed the control diets.
4. Enzyme treated corncob diets can be included in the diets of broiler chickens up to 15% to improve broiler growth performance and lower their blood cholesterol levels.

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