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Comparative evaluation of graded levels of untreated and cellulase and pectinase hydrolyzed corncob based diets on performance, carcass yield, haematological and biochemical parameters of broiler chickens

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Abstract

This study was conducted to compare the effects of feeding graded levels of untreated and cellulase and pectinase hydrolyzed corncob based diets on growth, nutrient digestibility, carcass yield, haematological and biochemical parameters of broiler chickens. Three hundred and fifteen day-old broiler chicks with an average initial body weight of 60g were used for the study. Seven dietary treatments were formulated such that Diet 1 was a control. Diets 2, 3 and 4 contained 5%, 10%, and 15% levels of untreated corncob, while diets 5, 6 and 7 contained cellulase and pectinase hydrolyzed corncob at 5%, 10% and 15% levels respectively. The birds were randomly distributed into seven treatment groups in three replicates and each replicate had fifteen birds. Crushed corncobs were pretreated with NaOH to remove the lignin contents and later subjected to locally produced cellulase and pectinase enzymes for the degradation of non-starch polysaccharides (NSPs) for five days. Proximate analyses of untreated corncobs, cellulase and pectinase hydrolyzed corncob, standard diet, diets containing untreated corncobs and diets containing cellulase and pectinase treated corncobs were carried out to determine the nutrient composition of the ingredients and feeds. Data obtained from Growth performance, nutrient digestibility, haematological and serum biochemical profile as well as carcass yield were determined in a 2x4 factorial arrangement. Feeding regime was twice daily for all the treatment groups while diets and water were supplied to birds ad libitum. The results showed that at the end of week eight when the experiment was terminated, the broilers placed on untreated corncob diets consumed higher quantities (2497.28 g) of feed than birds placed on enzyme treated diets (2142.94 g) and conversely recorded lower performance indices in all parameters measured. The result also showed that as the levels of untreated corncob diets increased, the final body weight of birds (1450.00 g) significantly ($P<0.05$) reduced when compared to 2385.33g obtained for enzyme treated birds. The result equally showed that broilers fed hydrolyzed corncob diets had significantly higher ($P<0.05$) and better performance in terms of feed conversion efficiency (0.67 as compared to 0.50) in the untreated birds, protein efficiency ratio (4.17 as compared to 1.69) in the untreated birds, feed conversion ratio (1.21 as compared to 2.70) in the untreated birds, nutrient digestibility, final body weight, dressed carcass percentage (80.22 as compared to 73.93%) in the untreated birds and carcass cuts when compared to broilers fed untreated corncob diets. Enzyme treated corncob diets significantly ($P< 0.05$) lowered the blood cholesterol levels (1.85 g/dL as compared to 2.15 g/dL) in the untreated birds and also improved other haematological indices measured in the birds compared to the control broilers. Generally, broilers fed enzyme hydrolyzed corncob diets performed better with birds fed 15.00% enzyme treated corncob diets having the highest and the best performance record which could be attributed to better utilization of nutrients since the enzymes have hydrolyzed the nutrient releasing monomers and hence are better metabolized. It is concluded that feeding broilers with enzyme hydrolyzed corn cob at the levels 5 to15.0 % improved performance and carcass values. In addition, it elevated

albumin, globulin, total protein, Aspartate amino transaminase (AST) and Alanine amino transaminase (ALT) levels in the blood.

Keywords: Corncob, Enzyme treated corncob, Diets, Growth, Haematological and serum indices, Broiler chickens.

Introduction

The ever increasing population growth in Nigeria implies a greater demand for animal protein which is already in acute short supply (Ayanwale, 2004). This population growth is characterized by increasing pressure on food resources most especially cereal grains. Maize is a major source of energy for poultry consisting of about 50-60% of the total diet (Kehinde *et al*., 2006). Maize is keenly competed for by man, industries and livestock resulting in an inadequate supply of it for use in poultry diets. There is the need therefore to explore the possibility of harnessing the industrial by-products and wastes which are not directly utilized by man and less expensive for feeding of livestock. One of such wastes from maize processing plant is the corncob (Alokan, 1998). Poultry production has been found to be capable of bridging the protein gap due to its rapid multiplication rate when compared with large ruminants (Akanji, 2002). It has also proven to be the fastest and cheapest substitute to other macro animal protein sources which are expensive (Ayanwale and Arziki, 2005). Corncobs are by-products of maize processing industry and households. They can constitute environmental menace not only on the farm but on the streets and homes if not properly disposed (Alokan, 1998). High levels of fibre in corncobs have been reported by different authors (Classen *et al*., 2004, Borris and Thomsen, 2005 and Acamovic, 2011) to have caused reduced growth rate, feed efficiency, nutrient digestibility and energy utilization in broiler chickens. Similarly, corncob utilization in broiler diets have been found to cause lowering of energy content of feed (Adejumo, 2009).

Poultry birds lack the ability to degrade feed ingredients that contain high fibre such as corncobs, thereby resulting in poor feed utilization which translates into poor growth and low carcass yield (Acamovic, 2011). Although, corncob is predominantly recommended for ruminants (Alokan, 1998), the application of biotechnology techniques, especially fermentation and enzyme additives had in recent years opened a window of opportunities for the use of corncobs in monogastric nutrition (Adeyemi and Familade, 2003). The nutritional value of corncob in poultry diets may be improved by treating them with exogenous enzymes (Bedford, 2003). In poultry diets, exogenous enzymes are used in order to improve the digestibility of feed ingredients and significantly reduce the incidence of wet droppings which might be as a result of non-starch polysaccharides contents (Gao *et al*., 2007). 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.

Materials and methods

Experimental site

The experiment was conducted at the Poultry Unit of the Department of Animal Production Teaching and Research Farm, School of Agriculture and Agricultural Technology, while the production of cellulase and pectinase were both carried out at the Laboratories of Microbiology and Biochemistry Departments, Federal University of Technology, Minna.

Sources of fibre materials and other feed ingredients

The corncobs used for the experiment were those 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, milled using a combination of plate and hammer 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 werecorncobs, 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) (Pellet). Other laboratory equipmentsused included incubator, autoclave, glass bottles, funnels, deionized water and filter paper (No.1).

Experimental birds and their management

Three hundred and fifteen day-old Arbor Acre breed of broiler chicks were used for the study which lasted for eight weeks. The birds were housed in a deep litter system that permitted effective sanitation, cross ventilation and properly insulated to prevent the birds from drought and vermins like cats, rats and predatory birds. Each replicate had a dimension of 1.5m x 1m floor spacing. Accessibility of birds to feed and water was ensured *ad libitum* as recommended by (Maurice and Gerry, 2005). Good sanitary management practices were best guarantee against diseases, therefore litters were changed when wet to maintain it in crumble form, structures and equipment such as pens, feeders, drinkers and tools were properly cleaned and sanitized frequently as recommended by (Maurice and Gerry, 2005). The routine medication and vaccination programmes as outlined by (Carmen and George, 2004) were observed for the birds during the period of the experiment. On arrival of the chicks, they were administered with only glucose and anti-stress (vitalyte) dissolved in their drinking water against stress condition. This was followed with antibiotics and vitamins premix on the 3rd and 5th days. Thereafter, the birds were orally immunized on the 7th and 14th days of brooding against infectious bursal disease (gumboro) with IBDV – 1st dose and IBDV – 2nd dose respectively. On the 6th to 11th day, preventive treatment against coccidiosis was carried out and this was observed at two weeks intervals. At the 4th week, the birds were vaccinated against Newcastle disease using 1st NDV Lasota vaccine and repeated at the 6th week as 2nd NDV Lasota.

Experimental design and feeding

Three hundred and fifteen chicks were randomly allotted to seven treatment groups. Completely Randomized Design (CRD) was used for the experiment. Each treatment had forty-five birds consisting of three replicates with fifteen birds per replicate. The test diets were designated as T_1 (Diet without corncob and served as the control), T_2, T_3 and T_4 (Untreated corncob diets at 5, 10 and 15% levels of corncob respectively), T_5, T_6 and T_7 (Cellulase and pectinase treated corncob diets at 5, 10, and 15% levels of corncob respectively). Fresh water was supplied *ad libitum*. Equal levels of cellulase and pectinase solutions (10 litres/100kg of crushed corncob) was used to hydrolyze the corncobs. Two types of isocaloric and isonitrogenous diets containing 23% crude protein and 3000 Kcal/kg metabolisable energy (Table 1) were formulated for the birds to meet the NRC (1994) standard requirements for

broilers.

Production of Cellulase and Pectinase

Production of Cellulase

Aspergillus niger species were grown for the production of cellulase in a minimum salt medium, (500 mL) containing $FeSO_4$, 0.001 g; $NaNO_3$, 1.5 g; Na_2HP0_4, 0.5 g; $MgSO_4$, 0.5 g; KCl, 0.25 g; 500 ml distilled water of carboxylmethyl cellulose (CMC) as carbon source (the medium was sterilized at 121 ^{0}C for 15 minutes and allowed to cool before inoculation). The culture broth was grown at 60 ^{0}C for 4 days for minimum yield of enzyme (16). Culture filtrate was obtained by filtration through Whatman filter paper. The filtrate was regarded as crude cellulase enzyme (Singh, 2003).

Production of Pectinase

The active pectinase producers (*Aspergillus niger*) were placed in a basal medium, the medium consisted of $NaNO_3$, 2 %, K_2HPO_4, 1 %, $MgSO_4$, 5 %, $FeSO_4$, 0.001 %, pectin 15 %. The culture was grown for seven days at 25 ^{0}C for fungi and 30 hours for bacteria. The culture broth was sampled every 24 hours for fungi and 6 hours for bacteria; it was centrifuged and the supernant was considered as crude pectinase enzyme (Oyeleke *et al*., 2012). Proximate composition and energy values of untreated and enzyme treated corncobs were determined (Table 1) according to the methods of (Bertrand *et al*.

Table 1: Gross composition of corncob experimental diets treated with and without enzymes under a single phase feeding regime for broiler chickens

Ingredients (%)	Control diet	Untreated corncob levels (%)			Enzyme treated corncob levels (%)		
	0.00	5.00	10.00	15.00	5.00	10.00	15.00
Maize	45.45	40.45	35.45	30.45	40.70	36.00	32.20
Groundnut cake	34.55	34.55	34.55	34.55	34.30	33.00	31.80
Wheat offal	9.00	9.00	9.00	9.00	8.00	8.00	7.00
Corncobs	0.00	5.00	10.00	15.00	5.00	10.00	15.00
Fish meal	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Oyster meal	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Lysine meal	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Palm oil	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Cellulase	0.00	0.00	0.00	0.00	0.50	1.00	1.50
Pectinase	0.00	0.00	0.00	0.00	0.50	1.00	1.50
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated values							
ME Kcal/kg	3000	3000	3000	3000	3000	3000	3000
Crude protein (%)	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Crude fibre (%)	5.15	7.00	7.30	7.50	6.10	6.50	6.75
Calcium (%)	1.61	1.62	1.62	1.63	1.62	1.61	1.63
Phosphorus (%)	0.74	0.72	0.75	0.76	0.72	0.75	0.76
Methionine (%)	0.55	0.54	0.54	0.55	0.54	0.54	0.55
Lysine (%)	1.12	1.11	1.15	1.15	1.11	1.15	1.15

*2.5kg of premix supplied: Vit amin A (10000000), Vitamin D3(200000iu), Vitamin E (12000iu), Vitamin K (2iu), Thiamine B (1.5g), Riboflavin B2(5g), Pyriboflavin B6(1.5g), Vitamin B12(10mg), Biotin (20mg), Niacin (15g), Pantothenic acid (5g), Folic acid (0.6g), Manganese (75g), Zinc (50g), Iron (25g), Copper (5g), Iodine (1g), selenium (100mg), C0balt (300mg), BHT (125g), Choline Chloride (150g).

Preparation of cellulase and pectinase hydrolyzed corncob

About 100 kg of crushed and pretreated (de-lignified) corncobs was emptied into a large sized plastic drum after which 10 litres each of prepared cellulase and pectinase enzymes solution were added to the corncob and thoroughly mixed by continuous stirring/turning with a wooden turning stick and left tightly covered. The sample was periodically stirred/turnedon 3 hourly basis at room temperature (25 ^{0}C) for 5 days for hydrolysis to take place (Oyeleke *et al*., 2012). During this period, cellulaseenzyme hydrolyzed cellulase and hemicellulose components of the corncob into smaller sub – units of carbohydrates i.e. glucose and other disaccharides, while on the other hand pectinase enzyme hydrolyzed pectins and pentosans into small monomers (glucose and other disaccharides) which were hitherto made bioavailable for utilization by birds. 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 (AOAC, 2005). At the termination of the hydrolysis process, the hydrolyzed corncob was sun dried for 5 days and packed in jute bags pending the time of use.

Data collection

During the period of the feeding trial, some measurable parameters as indicators of performance were measured, they included feed intake, body weight, body weight gain, feed conversion efficiency (FCE), protein efficiency ratio (PER), feed conversion ratio (FCR) and apparent nutrient digestibility (AND) and carcass yield.

Weighed quantities of feed were supplied to the chicks daily and the remnant feed in feed bags were also weighed. The feed consumed by a chick for a day was obtained by the difference between feed supplied and the remnant feed divided by the number of chicks in each replicate.

Body weight was determined by weighing the birds in each replicate on weighing scale on arrival (initial body weight) and at the end of each week. The difference between the initial body weight and that computed as final body weight at the end of the feeding trial constituted the final body weight gain.

The FCE, FCR, PER and AND were calculated using the formula of (Mc Donald *et al.,* 1987).

Where:

$$\text{FCE} = \frac{\text{average body weight (g)}}{\text{average feed intake (g)}}$$

$$\text{FCR} = \frac{\text{total feed intake (g)}}{\text{body weight gain (g)}}$$

$$\text{PER} = \frac{\text{gain in body weight (g)}}{\text{protein consumed (g)}}$$

$$\text{AND coeff.} = \frac{\text{total nutrient consumed} - \text{total nutrient voided}}{\text{total nutrient consumed}} \times \frac{100}{1}$$

While slaughter procedures and carcass analysis were carried out as described by (Han and Spindler, 2012).

$$\text{Meat yield \%} = \frac{\text{eviscerated weight}}{\text{liveweight}} \times \frac{100}{1}$$

Digestibility trial

A five-day digestibility trial was conducted at both starter and finisher phases of the experiment. At each phase, sixty-three birds were randomly selected with each treatment having nine birds with three birds per replicate. The birds were housed in a two-tier wire floor metabolic cages. Each compartment of the cages had a dimension of 0.7m x 0.6m floor spacing and a dropping tray for easy collection of faecal dropping.

The birds were kept for a period of five days for acclimatization during which feed and water were given *ad libitum* as recommended by (Maurice and Gerry, 2005). The birds were supplied known quantities of feed daily for five consecutive days and their droppings collected on 24 hourly basis using the total collection

method of (Bourdillon *et al*., 1990) by covering each dropping tray with aluminium foil. The pooled faecal samples were then dried using GallenKamp® oven at 80 °C to obtain a constant weight (Bourdillon *et al*., 1990), ground to pass through a standard 0.02mm sieve. The representative samples were taken for proximate analysis (AOAC, 2005) and the results were used to calculate the dry matter, crude protein, crude fibre, ether extract and ash digestibility coefficients.

Carcass traits evaluation

At the end of the feeding trial, nine birds from each treatment (Three birds per replicate) were randomly selected, fasted overnight and slaughtered by severing the jugular veins. These were used for carcass and internal organs parameters determination.

Blood collection for biochemical studies

At the 56th day of the experiment (8 weeks), 10ml of blood samples were collected from nine (9) 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. The other 5 mL was collected in to a sterile anti-coagulant free plastic tube *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 (AOAC, 2005). 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 (Van Soest, 1994).

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 (Magyar, 2005; Ahamefule *et al*., 2008),

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 (Magyar, 2005) and formula given by (Merck Manual, 2012).

Cost benefits

The prevailing market prices of the ingredients at the time of the study were used to calculate the cost of 1kg feed consumed and the cost of 1kg feed consumed / weight gain.

Data analysis

Data collected from the various parameters measured were subjected to Analysis of Variance (ANOVA) in a 2x4 factorial arrangement within Complete Randomized Design (CRD) as described by (Gomez and Gomez, 1984). Significantly Means were separated at 5% levels of probability using the New Duncan's Multiple Range Test (DMRT). (Duncan, 2009). The computer package used is the Statistical Analysis System (SAS, 2002), version 10.0.

Results and discussion

The results of proximate composition of corncob in (Table 2) indicated that hydrolysis of corncob using cellulase and pectinase enzymes were similar to those of Alokan (1998) 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 values suggest the positive effect of the enzymatic treatment of corncobs which significantly reduced the fibre composition and gave values which compared well with those reported by Warren (1996) and Okon and Ogunmodele (1996) who attributed the nutritional improvement observed in degraded corncob to the fact that it served as a 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 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 Sabu*et al*. (2006) and Oluyemi and Roberts (2007) who severally obtained reduced values of high fibrous materials that were either fermented or treated with enzymes.

The performance of broiler chickens fed graded levels of untreated and enzyme treated corncob diets are shown in (Table 3). The result revealed that broilers fed the control and enzyme treated diets showed positive growth response. Although birds fed enzyme treated diets consumed less feed than birds placed on the untreated diets, these pattern of feed intake continued in the finisher phase where the result showed that feed intake of birds on untreated diets were significantly ($P<0.05$) higher than those of the control and enzyme treated groups. This is similar to the findings of Van Krimpen *et al*. (2006) who reported that higher feed consumption rate could be attributed to that fact that monogastric animals attempt to feed intake when given diets that contained increasing levels of insoluble non-starch polysaccharides. The observed result from this study however, contradicts with the report by Ibiyo and Atteh (2003) who reported that feed intake reduced with increase in high dietary fibre level diets.

Performance indices of the experimental broiler chickens showed that feeding enzyme treated corncob diets at 5%, 10%, and 15% inclusion levels significantly ($P<0.05$) increased final body weight and body weight gain of birds at both starter and finisher phases. This result agrees with the findings of Brenes *et al*. (1993) who reported that dietary levels of fibre in enzyme treated diets allowed the birds to exhibit better feed utilization which translated into better body weight gain. On the other hand, the poor body weight recorded for untreated birds were similar to those values reported by Adesina *et al*. (2006) who reported slow growth, poor body weight gain and wet droppings from birds fed high dietary diets containing NSP which is highly indigestible in gastro intestinal tracts of monogastric animals and therefore have little nutritional value. Feed conversion ratio values for individual treatment group showed that enzyme treated diets were superior and significantly ($P<0.05$) different from those of the control and untreated diets. All birds on 15% enzyme treated diets converted their feeds better than birds fed 0, 5 and 10% levels of corncob.

Dry matter and crude fibre digestibilities (Table 4) decreased as the levels of untreated corncob increased in both starter and finisher phases respectively. This might be as a result of increased crude fibre which exerted more fibre load for broilers on these diets to handle that might have been responsible for low digestibilities recorded. This result is in agreement with the findings of (Edwards, 1996; Bach Knusden, 2011; and Classen *et al*., 2004) who reported an inverse relationship between dietary fibre digestibility coefficients and bioavailability of nutrients. Digestibility of nutrients was

higher at finisher phase when compared to the starter phase. The trend in age difference was consistent with the fact that the digestive system of the broilers were not well developed at the starter phase when compared with well-developed digestive system at the finisher phase. This observation supports the findings reported by Yasar and Forbes (2000) that retention of intestinal digests in chicks could be as early as between two and three weeks of age, it was also observed that the larger retention times in older birds due to the volume of the digestive tract improved digestibility as earlier reported by Palander *et al*. (2005).

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

Parameters (%)	Untreated corncob (%)	Enzyme treated corncob (%)	(%) Difference
Moisture	13.30	10.10	24.06
Dry matter	86.70	89.90	3.56
Crude protein	4.90	13.60	63.97
Crude fibre	32.30	14.50	55.11
Ether extract	1.50	4.00	62.50
Total ash	7.00	13.00	46.15
Nitrogen free extract	41.00	44.80	8.42
Energy value (ME Kcal/kg^{-})	2600.00	2750.00	5.45
Lignin	9.71	2.13	78.06
Cellulose	20.11	4.15	79.36
Hemicellulose	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 (m/100g)	23.04	11.60	49.70

The carcass yield of broiler chickens fed experimental diets presented in Tables 5 and 6. Birds fed the untreated corncob diets had lower final body weight than the birds in other experimental groups. This result is similar to that obtained by Cowieson *et al*. (2010) who reported heavier final body weight and carcass yield of broiler chickens when enzymes were added to their highly fibrous diets. The result also indicated that birds fed the untreated corncob diets had significantly ($P<0.05$)lower dressing percentage, head, neck, wings, breast, back, thigh, drumstick and shank weights when compared with birds fed treated diets. Similarly, birds fed enzyme treated diets had improved organs proportion values (Table 6) than the control and untreated birds.

The proportion of heart, lungs, liver, spleen, intestines, gizzard, proventriculus and abdominal fats of enzyme treated birds were observed not to be significantly ($P>0.05$) different from each other and agrees with the work of Cowieson *et al*. (2010) who reported enzyme inclusion in diets of broiler chickens fed high fibrous diets had no significant ($P>0.05$) effect on internal organ proportions.

The results of haematological and serum metabolites (Table 7) show that broiler chickens fed the untreated diets had lower albumin, globulin and total serum protein. These lower values observed suggest lower ability of the blood to clot, hence, poor prevention of haemorrhage, poor tissue

Table 3: Performan ce characteristics of broilers fed untreated and cellulose and pectinase hydrolyzed corncob diets

	Control diet	Untreated corncob levels (%)			Enzyme treated corncob levels (%)			
	T1	T2	T3	T4	T5	T6	T7	
Parameters (%)	**0.00**	**5.00**	**10.00**	**15.00**	**5.00**	**10.00**	**15.00**	**SEM**
Starter Phase								
Initial body weight (g/bird)	64.67	64.67	64.50	65.00	65.00	61.50	64.40	1.25
Final body weight (g/bird)	576.77^{b}	533.33^{c}	523.38^{c}	523.50^{c}	630.00^{a}	606.67^{ab}	633.33^{a}	16.12
Final body weight gain (g/bird)	512.10^{b}	468.66^{c}	458.88^{c}	458.50^{c}	565.00^{a}	542.17^{a}	568.83^{a}	15.13
Total feed intake (g/bird)	1455.63^{b}	1532.42^{a}	1549.20^{a}	1562.41^{a}	1412.44^{c}	1392.83^{d}	1357.3^{e}	15.03
Daily protein intake (g/bird)	11.96^{c}	12.45^{a}	12.17^{c}	12.38^{b}	10.59^{d}	10.70^{de}	10.54^{de}	0.14
Feed conversion efficiency	0.35^{b}	0.31^{c}	0.30^{c}	0.29^{c}	0.40^{a}	0.39^{a}	0.42^{a}	0.003
Feed conversion ratio	2.84^{c}	3.27^{b}	3.38^{a}	3.41^{a}	2.50^{d}	2.57^{d}	2.39^{e}	0.13
Protein efficiency ratio	1.53^{c}	1.34^{d}	1.35^{d}	1.33^{d}	2.00^{b}	1.99^{ab}	2.12^{a}	0.02
Total protein in feed (%)	23.00	22.75	22.00	22.00	21.00	21.50	21.75	-
Cost/kg of feed (₦/kg)	284.28^{e}	311.47^{d}	316.88^{d}	307.73	359.38^{c}	497.94^{b}	574.20^{a}	6.51
Finisher phase								
Initial body weight (g/bird)	576.77^{b}	533.33^{bc}	523.38^{c}	523..50^{c}	630.00^{a}	606.67^{ab}	633.33^{a}	20.72
Final body weight (g/bird)	1666.67^{cd}	1716.67^{c}	1550.00^{d}	1450.00^{d}	2116.67^{b}	2150.00^{b}	2383.33^{a}	41.67
Final body weight gain (g/bird)	1089.90^{d}	1183.34^{d}	1026.62^{de}	926.50^{e}	1486.67^{c}	1543.33^{b}	1766.67	68.30
Total feed intake (g/bird)	2273.38^{c}	2462.91^{b}	2449.23^{b}	2497.28^{a}	2270.75^{c}	2194.15^{d}	2142.94^{e}	83.41
Daily protein intake (g/bird)	18.67^{b}	20.01^{a}	19.24^{a}	19.62^{a}	17.03^{c}	16.85^{d}	16.65^{d}	1.06
Feed conversion efficiency	0.48^{c}	0.48^{c}	0.42^{c}	0.37^{d}	0.65^{b}	0.70^{b}	0.82^{a}	00.9
Feed conversion ratio	2.09^{c}	2.08^{c}	2.39^{b}	2.70^{a}	1.53^{d}	1.42^{d}	1.21^{e}	0.16
Protein efficiency ratio	2.08^{d}	1.11^{e}	1.91^{a}	1.69^{e}	3.27^{c}	3.59^{b}	4.17^{a}	0.94
Total protein in feed (%)	23.00	22.75	22.00	22.00	21.00	21.50	21.75	-
Cost/kg of feed (₦ /kg)	209.21^{e}	198.12^{e}	224.06^{d}	243.68^{c}	219.94	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 ($P \leq 0.05$)

SEM: standard error mean

Table 4: Nutrient digestibility of broiler chickens fed untreated and cellulose and Pectinase hydrolyzed corncob diets

	Control diet	Untreated corncob levels (%)			Enzyme treated corncob levels (%)			
	T1	T2	T3	T4	T5	T6	T7	
Parameters	**0.00**	**5.00**	**10.00**	**15.00**	**5.00**	**10.00**	**15.00**	**SEM**
Starter phase								
Dry matter	80.78^{a}	79.35^{a}	75.64^{a}	74.22^{a}	80.13^{a}	77.52^{a}	75.67^{a}	0.56
Nitrogen retention	71.29^{c}	71.65^{c}	73.29^{c}	72.67^{c}	81.05^{ab}	78.18^{b}	80.33^{ab}	1.12
Crude fibre	66.70^{c}	60.88^{d}	60.21^{de}	58.63^{e}	74.65^{b}	77.20^{a}	78.32^{a}	0.66
Ether extract	68.22^{b}	65.02^{c}	61.98^{d}	60.14^{d}	70.22^{b}	72.22^{b}	74.23^{a}	0.69
Ash retention	80.62^{b}	63.20^{c}	64.60^{c}	60.09^{d}	80.50^{b}	81.12^{b}	80.31^{b}	0.76
Nitrogen free extract	75.51^{b}	63.08^{d}	60.70^{d}	66.98^{c}	82.20^{a}	78.24^{b}	77.38^{b}	0.91
Finisher phase								
Dry matter	80.40^{c}	78.07^{d}	75.55^{c}	78.48^{d}	83.23^{b}	83.10^{b}	83.04^{b}	0.22
Nitrogen retention	82.60^{c}	69.07^{d}	64.18^{e}	62.30^{f}	84.12^{b}	84.21^{b}	84.00^{b}	0.25
Crude fibre	66.53^{c}	75.19^{a}	61.22^{c}	60.27^{f}	70.19^{b}	69.97^{b}	64.79^{d}	0.30
Ether extract	69.11^{b}	63.18^{d}	60.49^{e}	67.30^{c}	72.14^{a}	69.88^{b}	67.53^{c}	0.27
Ash retention	67.37^{c}	63.37^{d}	53.74^{f}	60.35^{e}	69.93^{b}	67.33^{c}	70.00^{b}	0.26
Nitrogen free extract	70.18^{c}	71.08^{e}	72.48^{d}	68.36^{f}	80.99^{b}	80.34^{bc}	79.33^{c}	0.35

a,b,c,d,e,f Mean values on the same row with different superscr ipt(s) different ($P \leq 0.05$) . SEM: standard error of mean

Table 5: Mean carcass cut -parts of broiler chickens fed untreated and cellulase and pectinase hydrolyzed corncob diets expressed as percentage live weight

	Control diet	Untreated corncob levels (%)			Enzyme treated corncob levels (%)			
	T1	T2	T3	T4	T5	T6	T7	
Parameters (%)	0.00	5.00	10.00	15.00	5.00	10.00	15.00	SEM
Live wt. (kg)	1.63^{cd}	1.70^{c}	1.53^{d}	1.43^{d}	2.10^{b}	2.10^{b}	2.40^{a}	0.05
Dressed wt. (kg)	1.28^{c}	1.26^{c}	1.13^{cd}	1.02^{d}	1.70^{b}	1.68^{b}	1.98^{a}	0.06
Dressing %	76.47^{b}	74.12^{bc}	73.94^{bc}	71.20^{c}	80.76^{ab}	79.92^{ab}	83.23^{a}	1.43
Head wt.	2.51^{cd}	2.06^{cd}	2.24^{d}	1.91^{d}	2.75^{b}	2.59^{b}	2.88^{a}	0.14
Neck wt.	4.79^{c}	4.53^{c}	4.57^{cd}	4.31^{d}	5.23^{b}	5.03^{b}	5.42^{a}	0.31
Wings wt.	6.73^{cd}	6.37^{cd}	6.15^{d}	6.13^{d}	6.85^{b}	6.66^{b}	7.22^{a}	0.39
Breast wt.	20.21b	18.88bc	18.96bc	18.50c	21.05a	20.67a	19.81a	0.73
Back wt.	15.27cd	14.18d	14.28de	13.91e	15.74b	15.51b	16.14a	0.54
Thigh wt.	13.52c	12.47c	12.66cd	12.17d	14.17b	13.74b	14.23a	0.46
Drumstick wt.	10.25c	9.60c	9.57cd	9.28d	10.53b	10.40b	10.28a	0.41
Shanks wt.	4.10c	3.83c	3.79cd	3.71d	4.15b	4.14b	4.30a	0.53

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 ($P \leq 0.05$)

SEM: standard error mean

Table 6:Mean internal organ proportions of broiler chicken fed untreated and cellulase and pectinase hydrolyzed corncob diets expressed as percentage live weight

	Control diet	Untreated corncob levels (%)			Enzyme treated corncob levels (%)			
	T1	T2	T3	T4	T5	T6	T7	
Parameters (%)	0.00	5.00	10.00	15.00	5.00	10.00	15.00	SEM
Heart	0.26^{c}	0.24^{c}	0.27^{d}	0.28^{d}	0.23^{b}	0.23^{b}	0.21^{a}	0.03
Lungs	0.32^{c}	0.28^{d}	0.33^{c}	0.36^{c}	0.33^{b}	0.33^{b}	0.31^{a}	0.06
Liver	1.13^{c}	1.08^{c}	1.19^{c}	1.13^{d}	0.87^{c}	0.87^{c}	0.67^{d}	0.12
Spleen	0.07^{b}	0.06^{c}	0.07^{c}	0.07^{c}	0.08^{b}	0.08^{b}	0.10^{a}	0.002
Intestines	0.62^{b}	0.60^{d}	0.66^{d}	0.57^{e}	0.61^{ab}	0.58^{b}	0.57^{a}	0.07
Kidney	0.41^{d}	0.38^{d}	0.40^{d}	0.^{35e}	0.38^{b}	0.39	0.37^{a}	0.05
Gizzard	1.11^{c}	1.06^{c}	1.18^{c}	1.14^{c}	1.11^{ab}	1.03^{b}	1.02^{a}	0.133
Proventriculus	0.28^{c}	0.26^{c}	0.26^{cd}	0.23^{d}	0.31^{ab}	0.30^{b}	0.35^{a}	0.023
Abdominal fats	0.75^{c}	0.72^{c}	0.79^{c}	0.73^{d}	0.73^{b}	0.73^{b}	0.66^{a}	0.072

a, b ,c, d, e: Mean values on the same row with dif ferent superscript (s) are significantly different (P≤0.05)

*significant at 5% level (P≤0.05)

SEM: standard error mean

Table 7: Haematological and serum metabolites of broiler chickens fed untreated and enzyme treated corncob diets

	Control diet	Untreated corncob levels (%)			Enzyme treated corncob levels (%)			
	T1	T2	T3	T4	T5	T6	T7	
Parameters (%)	0.00	5.00	10.00	15.00	5.00	10.00	15.00	SEM
PCV (%)	30.00^{d}	32.05^{d}	35.00^{c}	40.05^{a}	38.15^{a}	37.00^{bc}	35.25^{c}	0.24
Hb (g/dl)	10.00^{c}	10.68^{c}	11.67^{ab}	13.35^{a}	12.72^{a}	12.33^{a}	11.75^{ab}	0.06
RBC (x10$^{6}{}_{mm^{3}}$)	3.20^{c}	3.10^{c}	3.05^{d}	3.21^{c}	3.50^{a}	3.45^{ab}	3.51^{a}	0.08
WBC(x10$^{3}{}_{mm^{3}}$)	31.35^{a}	31.00^{b}	29.40^{b}	29.85^{c}	31.51^{a}	31.65^{a}	31.80^{a}	0.27
MCV (fl)	93.75^{d}	103.39^{c}	114.75^{b}	124.77^{a}	109.00^{c}	107.25^{c}	100.43^{bc}	7.50
MCH (pg)	31.25^{d}	34.45^{c}	38.26^{b}	41.59^{a}	36.34^{b}	35.74^{c}	33.48^{c}	3.40
AST(µl/l)	26.80^{a}	24.70^{b}	23.30^{b}	24.15^{b}	22.15^{bc}	21.90^{bc}	20.40^{d}	0.30
ALT(µl/l)	30.15^{a}	28.20^{a}	27.35^{b}	28.40^{ab}	28.00^{ab}	22.10^{d}	24.00^{c}	0.08
Urea (mg/dl)	36.05^{a}	33.00^{b}	35.72^{a}	35.25^{a}	30.55^{b}	31.15^{b}	28.30^{c}	1.20
Total serum protein (g/dl)	6.10^{b}	6.20^{b}	6.15^{b}	6.11^{b}	7.50^{a}	7.20^{a}	7.00^{a}	0.05
Albumin (g/dl)	2.90^{a}	2.88^{a}	2.70^{b}	2.82^{a}	2.81^{a}	2.85^{a}	2.80^{a}	0.08
Globulin (g/dl)	2.10^{a}	2.10^{a}	2.15^{a}	2.10^{a}	2.15^{a}	2.05^{b}	2.00^{c}	0.05
Total cholesterol (g/dl)	2.09^{b}	2.15^{a}	2.08^{b}	2.06^{b}	1.85^{d}	1.90^{cd}	1.95^{c}	0.03

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

*significant at 5% level (P≤0.05)

SEM: standard error mean

deposition and lowability to fight foreign body diseases which agrees with earlier reports by Arora (2010).

The ALT and AST values reduced as the levels of treated corncob increased which is in agreement with findings by Robert *et al*. (2003) who reported that with sufficient energy,transaminase enzyme promoted the removal of amino acid group to yield corresponding acid which enters tricarboxylicacid cycle for additional energy generation, hence, this observation might be responsible for the improved protein intake. The similarity (P>0.05) in PCV and haemoglobin values of birds fed the untreated diets and enzyme treated diets are indications 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 Adeniyi and Ogunmodele (2006) who reported similar PCV and haemoglobin values for indigenous chickens fed high energy level diets under intensive management system. Low PCV and haemoglobin levels are usually due to iron deficiency as reported by Addass *et al*. (2012). Cholesterol level was lower in birds fed degraded corncob diets, this is also similar to values reported by Arora (2010) 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.

Conclusion

The study showed that treatment of corncobs with cellulase and pectinase significantly improved the nutrient composition and metabolizable energy and also reduced significantly the crude fibre contents of corncob and diets.

Birds fed enzyme treated corncob diets had improved final body weight, body weight gain and converted their feeds on higher efficiency levels.

Enzyme treated corncob diets can be included in the diets of broiler chickens up to 15% level for improved performance, carcass characteristics, total blood protein and conversely reduce cholesterol levels of growing broiler chickens.

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