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Effects of cellulase and pectinase hydrolyzed corncob based diets on performance and carcass yield of broiler chickens

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

Abstract

This study was conducted to assess the effects of feeding locally produced cellulase and pectinase hydrolyzed corncob based diets on performance and carcass characteristics of one day-old chicks with initial average body weight of 60g ± 1.25. Corncobs were pretreated with NaOH to remove the lignin contents and later hydrolyzed. The degradation of the high fibre components was done for five days using locally produced cellulase and pectinase enzymes. Completely Randomized Design was the experimental design. Four experimental diets (T_1, T_2, T_3 and T_4) were formulated in all. The first diet (T_1) was a standard diet that did not contain corncob and served as the control, while other three diets (T_2, T_3 and T_4) had cellulase and pectinase hydrolyzed corncobs at 5, 10 and 15 % levels respectively. Each treatment had 45 chickens divided equally to three replicates while each replicate had fifteen birds. Diets and water were given ad libitum. The chickens had positive growth rate. However, dry matter (DM) intake varied significantly ($P<0.05$) in chickens on control diets and those on enzyme treated corncob diets. Birds on control diets consumed higher (2273.38 g ± 83.41) feeds than those on enzyme treated diets (2142.94g) but had lower performance indices in all parameters measured at the end of the eight week feeding trial. Broilers fed hydrolyzed corncob based diets had significantly ($P<0.05$) higher and better performance in terms of feed conversion efficiency (0.82 compared with 0.48 ± 0.09) in control chicks. Protein efficiency ratio (4.17 compared with 1.69 ± 0.94) in chickens on control diet, dry matter digestibility and final body weight of (2383.38g compared 1666.67g ± 41.67). Chickens fed enzyme treated corncob diets also had higher dressing percentage (80.22% versus 73.93% ± 0.71) higher, cut-up parts and organ proportions. The result showed that locally produced cellulase and pectinase hydrolyzed corncob diets at 5 to 15 % levels improved broilers performance and carcass quality. It was concluded that for optimum performance, enzyme treated corncob could be included in diets of broiler chickens up to 15 % level.

Keywords: Performance, Broiler chickens, Corncob, Cellulase and Pectinase

Description of Problem

Animal protein content in the diets of most Nigerians have been reported to be very low and has reached a deplorable state where average daily animal protein intake was estimated to be 4.5g/head/day which is lower than the minimum requirement of 35g/head/day (1). This poses a great challenge and a pointer to the inadequacy of livestock subsector to supply the needed protein which is further aggravated by the ban on the importation of both processed and live birds. Therefore, there is a need to meet these challenges of shortage in animal protein intake especially through production of animals known for their short generation intervals such as poultry (2). Research on poultry production economics carried out by (2) revealed that about 70% of total cost of poultry production in Nigeria could be attributed to the cost of feeding alone. According to (3) one major way to resolve the problem of inadequate animal protein intake by an average Nigerian is to increase the production of high quality feed ingredients. Poultry production has been found to be capable of bridging the protein gap due to its rapid multiplication rate when compared with large ruminants (4). It has also been proven to be the fastest and cheapest substitute to other macro animal protein sources which are expensive (5). 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 (6). High levels of fibre in corncobs have been reported by different authors (7, 8, 9) to cause 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 (10).

Chickens 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 (9). Although, corncob is predominantly recommended for ruminants (6), the application of biotechnology techniques, especially fermentation and enzyme additives had in recent times opened a window of opportunities for the use of corncobs in monogastric nutrition (11). The nutritional value for corncob in poultry diets may be improved by supplementing them with exogenous enzymes (12). In poultry diets, exogenous enzymes are used in the improvement of the digestibility of feed ingredients and to reduce the incidence of wet droppings significantly, which might be as a result of non-starch polysaccharides (13). This study is therefore aimed at determining the nutrient utilization by broiler chickens of diets containing graded levels of enzyme treated corncob based diets.

Materials and methods

Experimental site

The production of cellulase and pectinase was carried out at the Laboratories of Micro biology and Biochemistry Department, while the feeding trial was conducted at the poultry unit of the Department of Animal Production all in Federal University of Technology Minna, Niger State

Experimental birds and their management

One hundred and eighty one- day old Arbor Acre breed strain broiler chicks were used for the study which lasted for eight weeks. The chicks were housed in a deep litter system that permitted effective sanitation, cross ventilation and properly insulated to properly insulated to prevent the chicks from drought and vermins like cats, rats and predatory birds. Each replicate had a dimension of 1.5m x 1m floor spacing. Feeds and water was supplied to the chickens *ad libitum* as recommended (14). Good sanitary management practices were best guaranteed against diseases, therefore litters were changed when wet to maintain it in a crumble form, structures and equipment such as pens, feeders, drinkers and tools were properly cleaned and sanitized frequently as recommended by (14). The routine medication and vaccination programmes as outlined by (15) were observed during the experiment. On arrival, the chicks were administered with only glucose and anti-stress (vitalyte) dissolved in water against stress condition.

Experimental design and feeding

Completely Randomized Design (CRD) was used for the experiment. One hundred and eighty chicks were randomly allotted to four treatment groups. Each treatment had forty-five birds consisting of three replicates with fifteen birds per replicate. The test diets were designed as T_1, T_2, T_3, T_4 with cellulase and pectinase hydrolyzed corncob inclusion at 0, 5, 10 and 15% respectively. Fresh water was supplied *ad libitum*.

Production of Cellulase and Pectinase

Production of *Cellulase*

Aspergillusniger 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 121^0C 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 What man filter paper. The filtrate was regarded as crude cellulase enzyme (17).

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 7 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 supernatant considered as crude pectinase (16).Proximate composition and energy values of untreated and enzyme treated corncobs were determined (Table 1) according to the (19) methods.

In this experiment, the four diets formulated were isocaloric and isonitrogenous containing 23 % crude protein and 3, 000 Kcal/kg metabolisable energy, while the crude fibre content of the control diets was 5.15%, crude fibre in the enzyme treated diets varied between 6.10 to 6.75%. (Table 2).

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 after which 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 and left tightly covered. The sample was periodically stirred/turned on three hourly basis at room temperature (25 ^{0}C) for five days for hydrolysis to take place (16). During this period, cellulase hydrolyzed the cellulose and hemicellulose components of the corncob into smaller sub – units of carbohydrates i.e. glucose and other disaccharides, while on the other hand ectinase hydrolyzed pectins and pentosans into small monomers (glucose and other disaccharides) which were then made bioavailable for utilization by 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 corncob were sun dried for five days and packed in jute bags pending their analysis and use.

Table 1: 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 2: 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	*I 00.00*	*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*
1VTcthioninc (%)	*0.55*	*0.54*	*0.54*	*0.55*
Lysine (%)	*1.12*	*1.11*	*1.15*	*1.15*

*2.5 kg of prcmix supplied: Vitamin A (I 00 00000 iu), Vitamin D_3 (2000000 iu), Vitamin E (12000iu), Vitamin K (2 iu). Thiamine B (1.5 g). Riboflavin B_2 (5 g), Pyriboflavin B_6(1.5 g). Vitamin B*12* (10 mg), Biotin (20 mg), Niacin (1.5g), 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)

Data collection

During the period of the feeding trial, performance indicators measured, were: feed intake, body weight, body weight gain, feed conversion efficiency (FCE), feed conversion ratio (FCR), apparent nutrient digestibility (AND) and carcass yield. Weighed quantities of feed were supplied to the chicks daily and the remnant also weighed. The feed consumed by a chick for a day was obtained by the difference between feed supplied and the remnant divided by the number of chicks in each replicate.

Body weight was determined by weighing the birds in each replicate 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 (20).
Where

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

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

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

While slaughter procedures and carcass analysis were carried out as described by (21) and carcass yield was calculated using the formula of (21).

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

Digestibility trial

A five-day digestibility trial was conducted at both starter and finisher phases of the experiment. At each phase, thirty-six birds were randomly selected with each treatment having nine birds with three birds per replicate. The chickens 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 with a dropping tray for easy collection of faecal dropping.

The chicks were kept for a period of five days for acclimatization during which feed and water were given *ad libitum* as recommended (14). The chicks 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 (22) 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 (22), ground to pass through a standard 0.02mm sieve. The representative samples were taken for proximate analysis (19) 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 chicks from each treatment (Three chicks per replicate) were selected, fasted overnight and slaughtered by severing the jugular veins. These were used for carcass and internal organs parameters determination.

Statistical analysis

Data generated were subjected to statistical analysis using one way analysis of variance (ANOVA), (23). Means were separated using New Duncan's Multiple Range Test (24). The computer package used was the Statistical Analysis System (25), version 10.0.

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 gained.

Results and Discussion

Performance characteristics of experimental broiler chickens

The performance of the broiler chickens fed graded levels of *cellulase* and *pectinase* hydrolyzed corncob diets is shown in (Table 3). The result revealed that broilers in all the treatments had positive growth response. Feeding enzyme treated corncob diets at 5, 10, 15% inclusion levels significantly ($P<0.05$) increased final body weight and body weight gain of birds at both starter and finisher phases. However, feed intake varied significantly ($P<0.05$) between those fed control diet and the enzyme treated diets. The enzyme treated corncobs fed broilers also converted their feeds more efficiently than those of the control group. Final body weight of birds improved significantly by treatment of diets with enzymes. This result agrees with the findings of (26) 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. Feed conversion ratio values for individual treatment group showed that enzyme treated diets were superior and significantly different from those of the control diet. All birds on 15% corncob based diets converted their feeds better than birds fed 0, 5, 10% levels of corncob.

Digestibility coefficients

Broilers fed enzyme treated corncob based diets had significantly ($P<0.05$) better nutrient digestibilities compared to those on the control diets (Table 4). This result is in agreement with the work of (27, 28, 29) who observe an inverse relationship between dietary fibre digestibility coefficient and or bioavailability of nutrients when diets were supplemented with exogenous enzymes. Digestibility values of nutrients were higher at the finisher phase compared with the starter phase. The trend in age difference was consistent with the fact that the digestive system of the chicks were not well-developed at the starter phase. This observation was supported by (30) that, retention of intestinal digests in chicks could be as early as from 2 and 3 weeks of age, it was also observed that the larger retention times in older birds was due to the volume of the digestive tract which improved digestibility as reported (31).

Table 3: 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 (e/bird)	*576.77*^{b}	*630.00*^{a}	*606.67*^{ab}	*633.33*^{a}	*16.12*	*
Final body weight gain (c/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*^{a}	*1392.83*^{d}	*1357.3*^{e}	*15.03*	*
Daily protein intake (g/bird)	*11.96*^{c}	*10.59*^{d}	*10.70*^{de}	*I0.54*^{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*^{c}	*0.13*	*
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≤ 0.05)
*: significant at 5% level (P< 0.05) NS: not significant SEM: standard error of mean

Table 4: Nutrient digestibility of broiler chickens fed cellulase and pectinase hydrolyzed corncob diets

	Dietary levels of enzyme treated corncob (%)					
	T_1	T_2	T_3	T_4		
Parameters (%)	0.00	5.0	10.00	15.00	SEM	LS
Starter Phase						
Dry matter	80.78^{a}	80.13^{a}	77.52^{a}	75.67^{a}	0.56	NS
Nitrogen retention	71.29^{c}	81.05^{ab}	78.18^{b}	80.33^{ab}	1.12	*
Crude fibre	66.70^{c}	74.65^{b}	77.20^{a}	78.32^{a}	0.66	*
Ether extract	68.22^{b}	70.22^{b}	72.22^{b}	74.23^{a}	0.69	*
Ash retention	80.62^{b}	80.50^{b}	81.12^{b}	80.3 I^{b}	0.76	*
Nitrogen free extract	75.51^{b}	82.20^{a}	78.24^{b}	77.38^{b}	0.91	*
Finisher Phase						
Dry matter	80.40^{c}	83.23^{b}	83.10^{b}	83.04^{b}	0.22	*
Nitrogen retention	82.60^{c}	84.12^{b}	84.2 I^{b}	84.00^{b}	0.25	*
Crude fibre	66.53^{C}	70.19^{b}	69.97^{b}	64.79^{d}	0.30	*
Ether extract	69.1I^{b}	72.14^{a}	69.88^{b}	67.53^{c}	0.27	*
Ash retention	67.37^{c}	69.93^{b}	67.33^{c}	70.00^{b}	0.26	*
Nitrogen free extract	70.18^{e}	80.99^{b}	80.34^{bc}	79.33°	0.35	*

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) NS: not significant SEM: standard error of mean

Carcass characteristics of broiler chickens fed enzyme treated corncob diets

The carcass yield of broiler chickens fed experimental diets are presented in Tables 5 and 6.

Chicks on the control diet had lower final live body weight than those on other experimental groups. This result is similar to that obtained authors (32) with the 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 control diet 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 birds. The proportions of heart, lungs, liver, spleen, intestines, kidney, 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 (32) who reported that varying levels of enzyme inclusion in diets of broiler chickens fed high fibrous diets had no significant (P>0.05) effect on internal organ proportions.

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

Parameters (%)	Dietary levels of enzyme treated corncob *(%)*					
	T_1 0.00	T_2 5.00	T_3 10.00	T_4 15.00	SEM	LS
Live wt. (kg)	1.63^{cd}	2.10^{b}	2.10^{b}	2.40^{a}	0.05	*
Dressed wt. (kg)	1.28^{c}	1.70^{b}	1.68^{b}	1.98^{a}	0.06	*
Dressing %	76.47^{b}	80.76^{ab}	79.92^{ab}	83.23^{a}	1.43	*
Head wt.	2.51^{cd}	2.75^{b}	2.59^{b}	2.88^{a}	0.14	*
Neck wt.	4.79^{c}	5.23^{b}	5.03^{b}	5.42^{a}	0.31	*
Wings wt.	6.73^{cd}	6.85^{b}	6.77^{b}	7.22^{a}	0.39	*
Breast wt.	20.21^{b}	21.05^{a}	20.67^{a}	19.81^{a}	0.73	*
Back wt.	15.28^{cd}	15.74^{b}	15.51^{b}	16.14^{a}	0.54	*
Thigh wt.	13.52^{c}	14.17^{b}	13.74^{b}	14.42^{a}	0.46	*
Drumstick wt.	10.25^{c}	10.53^{b}	10.40^{b}	$I0.82^{a}$	0.41	*
Shanks wt.	4.10^{c}	4.15^{b}	4.14^{b}	4.30^{a}	0.53	*

a, b, c, d: 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 of mean

Table 6: Mean internal organ proportions of broiler chickens fed cellulase and pectinase hydrolyzed corncob diets expressed as percentage

Parameters (%)	Dietary levels of enzyme treated corncob (%)					
	T_1	T_2	T_3	T_4		
	0.00	5.00	10.00	15.00	SEM	LS
Heart	0.26^c	0.23^b	0.23^b	$0.2\ 1^a$	0.034	*
Lungs	0.32^c	0.33^b	0.33^b	$0.3\ 1^a$	0.061	*
Liver	1.13^C	0.87^c	0.87^c	0.67^d	0.12	*
Spleen	0.07^b	0.08^b	0.08^b	0.10^a	0.002	*
Intestines	0.62^b	$0.6\ l^{ab}$	0.58^b	0.57^a	0.07	*
Kidney	$0.4\ l^d$	0.38^b	0.39^{ab}	0.37^a	0.049	*
Gizzard	1.11^c	1.119^{ab}	1.03^b	1.02^s	0.133	*
Proventriculus	0.28^c	0.311^{ab}	0.30^b	0.35^a	0.028	*
Abdominal fats	0.75^c	0.73^b	0.73^b	0.66^a	0.072	*

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 ($P<0.05$)
SEM: standard error of mean

Conclusion and Application

It was concluded that:

1. Feeding broiler chickens with enzyme treated corncob based diets improved feed intake, final body weight, body weight gain, and feed conversion efficiency and protein efficiency ratio (PER).
2. Cellulase and pectinase hydrolyzed corncob could be included in the diets of poultry up to 15% level without any adverse effect on the performance and carcass characteristics of growing broiler chickens.

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