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Effects of Feeding Diets Containing Pearl Millet Supplemented with Enzyme on the Carcass and Haematological Values of Broiler Chicken

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Authors' contributions

This work was carried out in collaboration among all authors. Author JAE designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors LI and SEE managed the literature searches and animal management. All authors read and approved the final manuscript.

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ABSTRACT

Pearl millet, which is comparable to maize in terms of its metabolizable energy content is an identified potential replacement for maize in broiler diets. However, as the competition and price of maize continues to spike, the continuous need to completely replace maize in broiler diets is imperative. Therefore, the objectives of this study were to investigate the effects of feeding diets containing pearl millet supplemented with enzyme Natuzyme^{TM} on the carcass characteristics and haematological values of broiler chickens. 150 two weeks-old broilers were randomly divided into 5 groups with 10 birds per pen translating into 10 birds per replicate and fed an isonitrogenous (23%CP) starter diet of control diet (A); 0% (B); 10% (C); 20% (D); 30.01% and (E) 37.41 % pearl millet. Similarly, an isonitrogenous (21%CP) finisher diet of control diet (A); 0% (B); 10.64% pearl millet (C); 21.28% (D); 31.92% and (E) 39.27 % of pearl millet for 6 weeks. The birds were randomly allotted to the diets in a completely randomized design with feed and water given ad libitum. With the exception of drumstick of birds fed diet D which was significantly lower than the

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other diets, the results showed that the carcass values (parameters) of broilers fed 100% pearl millet were similar or non-superior to the control group and the other diets. Similarly, blood parameters were not significantly different between groups. These results show that pearl millet supplemented with enzyme can replace maize in broiler diets without affecting carcass yields and haematological parameters.

Keywords: Pearl millet; natuzyme^{tm}; haematology; carcass characteristics; broiler chickens.

1. INTRODUCTION

Interests have grown considerably in the search for alternative feed grains for the poultry sector as there is an established competition between man and poultry for maize grains. Besides this competition, there is also an increase in the cost of maize grain and it is now imperative to substitute maize with unconventional feed stuffs to match the demands of the growing Nigeria population for food and other livestock products [1,2]. Of the several unconventional feed materials available, pearl millet has been repeatedly reported to be a suitable replacement for maize and can be included up to 50% [3,4] or 75% [5,6] of the total diet without any deleterious effects.

Pearl millet (*Pennisetum glaucum*) is native to the western edges of the Sahara Desert and is commonly grown as a forage and grain crop in arid areas of Africa and India. It grows well under conditions of erratic rain, high temperatures, and poor soil conditions [4] and it does not contain major anti nutritional factors [7,8]. In Nigeria, the dominant species of pearl millet are classified into three types: the early maturing 'Gero' -which is the most widespread and cultivated in the Southern and Northern Guinea savanna areas as well as in the Sudan savanna and Sahel zones, 'Maiwa' and 'Dauro' types are late maturing and are mostly grown in the southern and northern Guinea savanna area [9]. Pearl millet is a drought-resistant grain [10] that grows in a short, dry summer season and does well in infertile sandy soils. This crop appears to be resistant to *Aspergillus flavus* infestation [11].

The protein content of pearl millet, although variable, is higher than corn [12,13] and the essential amino acid profile is more balanced than corn [14,13]. Pearl millet is a superior source of antioxidant [15], and also has higher oil content than other common cereal grains [13,16] and is a better source of linolenic acid [16]. The metabolizable energy of pearl millet is equal [3] or marginally lower than maize, and comparable with common cereals. Based on the performance of broilers [6,17] and laying hens [8,18,19] fed pearl millet, it appears that pearl millet is equivalent or superior to maize as a grain source for poultry rations. However, a decrease in feed intake, egg production, egg weight and egg yolk pigmentation were observed in laying hens fed 100% of pearl millet [8] and lower weight gain in broilers when 43% Malian pearl millet was included in the diet [17].

Pearl millet contains arabinose and xylans as the major water-soluble non-saturated polysaccharide (NSP) [20]. The presence of NSP in pearl millet grains makes it antinutritive, and one way of countering the effect of the water soluble NSP and consequently improving their nutritive value is by enzyme supplementation [21,22]. However, whilst authors [22] found no significant difference in body weight gain and feed conversion ratio of broilers fed pearl millet in combination with enzymes, some others [23] showed that the absorptive capacity of nutrients can be improved with marked increases in villi height and villus crypt depth when pearl millet in combination with enzymes was fed to broilers.

Previous studies to elucidate the feed potentials of pearl millet in the diets of broiler chickens as a replacement for maize have been previously reported [3,6]. In their report, 50% of new pearl millet in the diets of broilers was equivalent or better than conventional corn-soyabean diet. However, since there is paucity of information on the complete replacement of maize with pearl millet in broiler diets, the objectives of this study were to investigate the effects of feeding broilers diets containing varying levels of pearl millet with enzyme on carcass characteristics and haematological values.

2. MATERIALS AND METHODS

2.1 Birds, Housing and Management

One hundred and fifty, two-weeks old broilers of mixed sexes (of the breed arbor arcre) having a trade name 'agrited' obtained from a local commercial hatchery (Yola Adamawa State,

Nigeria) were used in this study. They were uniform in size and housed in deep litter house, partitioned into 15 pens with wire mesh to allow for adequate ventilation. At the starter phase, these birds were offered one of five diets containing either 0 (control), 10, 20, 30.01 or 37.41% of pearl millet (Table 1) at thirty birds per diet. The birds were randomly allocated to the diets in a completely randomized design.

The birds occupied 15 pens with 10 birds per pen translating into 10 birds per replicate. The experimental diets were designated A, B, C, D and E respectively. All birds from each unit were weighed at the beginning and weighed weekly. All vaccination (new castle disease intra ocular, two stages of gumboro vaccine, new castle disease LaSota) schedules and management procedures (antibiotic/antistress, anticoccidial drugs administration) were strictly adhered to. Feed and water were given *ad libitum* for two weeks. At the finisher phase, 30 birds per treatment were randomly allotted to the finisher diets in a completely randomized design. Each diet was again replicated three times with ten birds per replicate. Feed and water were given *ad libitum* for four weeks.

2.2 Source of Pearl Millet, Chemistry and Experimental Diets

Pearl millet was purchased from feed material shops in Bukuru, Jos South LGA of Plateau State, Nigeria. They were obtained dry and before being incorporated into the diets of broilers, they were ground to ~400 µm diameter particle size using corn milling machine and adequately preserved free from mould and weevils. Chemical composition of pearl millet conducted from the procedure outlined [24] showed that it contained: moisture, 3.99%; crude protein, 5.98%; crude fibre, 8.43%; ash, 3.12%; lipid, 4.93%; and carbohydrate, 81.99%.

Five isonitrogenous (23% CP) broiler starter diets containing graded levels [0, (control), 10, 20, 30.01 and 37.41%] (Table 1) of pearl millet were used in this study. The diets containing pearl millet was treated with Natuzyme ^{TM} at the rate of 100g/100kg of the diet and were mixed homogenously to achieve a complete blend. Natuzyme^{TM} (a bioproton) contains phytase, β-glucanase, α-amylase, cellulase, pectinase, amyloglycosidase, xylanase and protease. The enzymes have a wide range pH long-term stability and good thermostability, combining with high levels of enzyme activity to allow Natuzyme to be successfully applied to animal feeds with excellent results under wide ranging conditions. The diets were designated A, B, C, D and E respectively and contained metabolizable energy (ME) levels; 2,640.46, 2,608.64, 2,576.51, 2,544.36 and 2,525.35kcal/kg ME respectively. The finisher diets (Table 2) contained graded levels (0 (control), 10.64, 21.28, 31.92 and 39.27%) of pearl millet designated A, B, C, D and E respectively. The diets containing pearl millet were again treated with Natuzyme^{TM} at 100g/100kg of the diet. The energy levels of the finisher diets ranged from 2,656.47, 2,622.53, 2588.39, 2554.36 and 2530.80 ME respectively.

2.3 Carcass Evaluation

At the end of the 6 weeks feeding trial, two birds per replicate comprising one male and one female of live weight as close as possible to the mean of the treatment were randomly selected for slaughter. Prior to slaughter, the birds were starved overnight and weighed. Dressing percentage, prime cuts (drumstick, breast, back, wings and thigh) and visceral organs (heart, gizzard, liver, and intestines) expressed as a percentage of live weight was determined according to the procedure outlined [25].

2.4 Blood Collection

During slaughter, blood was collected via the jugular vein aseptically and into a sterile EDTA (as anticoagulant) treated bottles for the determination of packed cell volume (PCV), hemoglobin concentration (Hb), white blood cell (WBC) and red blood cell (RBC), and this was conducted according to procedures outlined [26]. Other blood parameters measured were mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) determined by simply finding proportions such as MCV measured by dividing the value for PCV by RBC, MCH measured by dividing the value for Hb by RBC. The value for Hb is divided by the value for PCV to obtain the value for MCHC [26]

2.5 Statistical Analysis

Data collected was subjected to analysis of variance (ANOVA) according to these authors [27] using Minitab version 14 [28] and a $p<0.05$ was declared significant. Where significant differences occurred, means were separated by Duncan's new multiple range test [29].

Table 1. Composition of experimental starter broiler diets (%)

Ingredients	A	B	C	D	E
Maize	40.01	29.19	18.34	7.48	0.00
Pearl millet	0.00	10.00	20.00	30.01	37.41
Soyabean	33.29	34.11	34.96	35.81	35.89
Palm kernel cake	10.00	10.00	10.00	10.00	10.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Bone meal	2.50	2.50	2.50	2.50	2.50
Lime stone	1.50	1.50	1.50	1.50	1.50
Premix	0.25	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10
Natuzyme™	-	+	+	+	+
Calculated composition (%)					
CP	23.00	23.00	23.00	22.99	22.80
ME (Kcal/kg)	2640.46	2608.64	2576.51	2544.36	2525.35
Ca	1.68	1.71	1.71	1.69	1.69
P	0.73	0.76	0.79	0.81	0.83
CF	5.01	5.69	5.68	7.05	7.55
Feedcost/kg(₦)	110.56	108.97	107.40	100.82	104.41

**Hi Nutrient premix supplied the following per 100kg of diet: Vitamin A, 1,200,000 I.U; Vitamin D3 250,000 I.U; Vitamin E, 3,000 I.U; Vitamin K, 200mg; Thiamin, (B1) 225mg; Riboflavin, (B2) 600mg; Pyridoxine (B6), 450mg; Niacin, 4000mg; Vitamin B12, 2mg; Pantothenic acid, 1,500mg; Folic acid, 150mg; Biotin, 8mg; Choline chloride, 30,000mg; anti-oxidant, 12,500mg; Manganese, 8,000mg; Zinc, 5,000mg; Iron, 2,000mg; Copper, 500mg; Iodine, 100mg; Selenium, 20mg; Cobalt, 50mg. Key: C.P=crude protein; M.E=metabolizable energy; Ca=calcium; P=phosphorus; C.F=crude fibre*

Table 2. Composition of experimental finisher broiler diets (%)

Ingredients	A	B	C	D	E
Maize	42.56	31.04	19.50	7.97	0.00
Pearl millet	0.00	10.64	21.28	31.92	39.89
Soyabean cake	26.74	27.62	28.52	29.41	30.03
Wheat offal	10.00	10.00	10.00	10.00	10.00
Palm kernel cake	14.00	14.00	14.00	14.00	14.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Bone meal	2.50	2.50	2.50	2.50	2.50
Lime stone	1.50	1.50	1.50	1.50	1.50
Premix	0.25	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10
Natuzyme™	-	+	+	+	+
Total	100	100	100	100	100
Calculated composition (%)					
CP	21.00	21.00	21.00	21.00	21.00
ME (Kcal/kg)	2656.47	2622.53	2588.39	2554.36	2530.80
Ca	1.67	1.68	1.69	1.69	1.69
P	0.69	0.73	0.75	0.64	0.72
CF	5.12	5.84	6.58	7.28	7.79
Feedcost/kg(N)	105.48	103.80	102.12	100.44	99.28

**Hi Nutrient premix supplied the following per 100kg of diet: Vitamin A, 1,200,000 I.U; Vitamin D3 250,000 I.U; Vitamin E, 3,000 I.U; Vitamin K, 200mg; Thiamin, (B1) 225mg; Riboflavin, (B2) 600mg; Pyridoxine (B6), 450mg; Niacin, 4000mg; Vitamin B12, 2mg; Pantothenic acid, 1,500mg; Folic acid, 150mg; Biotin, 8mg; Choline chloride, 30,000mg; Anti-oxidant, 12,500mg; Manganese, 8,000mg; Zinc, 5,000mg; Iron, 2,000mg; Copper, 500mg; Iodine, 100mg; Selenium, 20mg; Cobalt, 50mg. Key: C.P=crude protein; M.E=metabolizable energy; Ca=calcium; P=phosphorus; C.F=crude fibre*

3. RESULTS AND DISCUSSION

The chemical composition of pearl millet used in this study contained 3.99, 5.98, 8.43, 3.12, 4.93 and 81.99 % for moisture, CP, CF, ash, lipid and Carbohydrate respectively. The CF, ash and carbohydrate are close to values 7.52, 1.68 and 74.14 % reported [30]. Moisture and CF differed from what was reported [30] and such observed variations may be due to cultivar differences or to changes in weather. Similar varied result was observed by [31] who reported a lower (2.4%) CF value compared to this present study.

Carcass values of broilers fed graded levels of pearl millet are presented in Table 3. The live weight, bled weight, plucked weight and carcass weight did not differ significantly (P=0.05) from the control. Live weight ranged between 2.23 (diet D) to 2.00kg (diet C). The differences however were not statistically significant (P =0.527). Bled weight followed similar trend. It varied from 2.18kg (diet B) to 1.87kg (diet E) but did not differ significantly (P =0.292) from the control. Plucked weight was numerically higher on diet B (1.95kg) than on the control (1.87kg). However, the differences were not significant (P =0.528). Other values though in between were statistically similar. Carcass weight was highest on diet B (1.73kg) but lowest on diet E (1.53kg) but were statistically similar. Dressing percentage was highest on diet C (72.02) and lowest on diet E (65.49%) but did not differ significantly (P=0.617) from the control. Prime cuts (breast, 27.42-22.03%; back, 20.10-13.72%; wings, 12.05-9.01% and thigh, 15.3-11.94%) did not differ significantly (P=0.05) across the diets. The relative organ measures (heart 1.27-2.16%, gizzard 1.73-2.94%, liver 1.73-2.94%, intestine 0.92-1.19%) whose values were recorded in the study varied across the diets but were not significantly (P=0.05) affected by the diets. However, drumstick percentage was significantly lower on diet D (9.01%) than on diets B (15.38%), C (16.59%) and E (14.79%) respectively. Similar results have been reported by some authors [32]. Results of live weight values in this study are quite close to 2.03-2.43kg reported [32].

Similarly, plucked weight of between 1.70 (diet C) and 1.95kg (diet B) reported in this study were close to 1.71 to 2kg of plucked weight in the report by others [32]. The result of dressing percentage in this study is comparable to that (65-70%) reported by these authors [33], but higher than (63.09-64.87%) reported by others [32]. Similar to the result obtained in this study have been previously reported elsewhere [34,35]. In another study, [34] gizzard, heart, liver weight, carcass yield and prime cuts of broilers fed millet diets were similar to the control irrespective of the level of pearl millet levels of inclusion. However, interestingly, Hildago and others [4] in a previous study reported an increased gizzard weight in birds fed 10% or more pearl millet than the control and this may be due to different weather conditions where their work was carried out.

These authors [36] reported that except for breast, full crop and abdominal fat, there were no significant differences among all the treatment groups for carcass measures and organ weights. However, this is slightly different from the result of this study where drumstick percentage was significantly higher on diet D than on all the other diets and control. This may be due to the tannin content of the diets they used as against what was used in this study. This has been supported by [37]. However, these authors [38] observed no depressive effect on performance, carcass and organ weights when 60% of maize was replaced by millet which agrees with the results from this study. Clearly, the results from this study showed that up to 100% of maize replaced by pearl millet produced no adverse effect on carcass values apart from the significant effect on drumstick which did not follow any particular trend. This may need further investigation.

Other internal organs measured (heart, liver, gizzard and intestine) were not significantly (P=0.05) affected by the diets. Heart percentage of 0.31-0.36 and liver of 1.38-1.78% reported by some authors [32] were lower than what was observed in this study. The similarity in values between pearl millet diets and the control may be as a result of solubilizing of cell walls by exogenous enzymes [39,40] thus enabling the birds on such diets to utilize the nutrients effectively.

Haematological indices (Table 4) such as red blood cell (RBC $x10^{12}$/l) varied between 1.27 (B) to 2.11 (diet D) but did not differ significantly (P=0.69).

White blood cell (WBC$x10^{9}$/l) was lower for diet B (2.68) and higher for diet D (5.63) but was statistically similar (P=0.65), packed cell volume (PCV%) was lowest, 18.33 (diet B) and highest 30.50 for (diet C) but the differences were not

statistically significant (P=0.70). and haemoglobin concentration (Hbg/l) differed from 6.10 (diet B) to 10.17g/l (diet C) and did not vary significantly (P=0.70). Other blood parameters measured MCV (mean corpuscular volume) from 94.34 (diet E) to 160.52fl (diet C) were statistically similar (P=0.73). MCH (mean corpuscular haemoglonin) dropped from 53.5 (C) to as low as 31.47pg (E) but were statistically similar and MCHC (mean corpuscular haemoglobin concentration) increased from 22.18 (diet B) up to 33.34 g/l (diet C) but were not significantly affected by the diets. This differed from the report of some authors [36] where they recorded significant (P=0.74) effect of the test diets on haematological parameters. This is probably because they used whole millet in their study as against ground pearl millet used in this study. The normal haemoglobin concentration (Hb) and packed cell volume (PCV) was between 7-13g/dl and 24-45% respectively as reported by [41]. The Hb and PCV values reported in this study fall within these extremes signifying that the health of the birds was not compromised. Values for WBC obtained in this study are lower than the range (15.25-16.77 $x10^9$/l) for broilers as reported [42] but this and other blood values reported are within the range reported for chicken [43]. This report is also supported by some [44] who fed different energy sources including pearl millet supplemented with enzyme to broilers and noted that haematological parameters were within normal range for healthy chicken.

Table 3. Carcass characteristics of broilers fed different levels of pearl millet

Parameters	A	B	C	D	E	SEM	P-value	LOS
Live weight (kg)	2.20	2.20	2.00	2.23	2.05	0.20	0.527	NS
Bled weight (kg)	2.00	2.13	1.87	2.00	1.87	0.16	0.292	NS
Plucked weight (kg)	1.87	1.95	1.70	1.83	1.83	0.17	0.538	NS
Carcass weight (kg)	1.70	1.73	1.58	1.60	1.53	0.16	0.556	NS
Dressed (%)	68.37	71.31	72.02	67.37	65.49	5.71	0.617	NS
Breast (%)	24.29	27.42	23.37	22.03	23.07	4.29	0.614	NS
Back (%)	13.72	20.10	16.83	11.68	19.55	6.08	0.416	NS
Thigh (%)	13.78	15.30	15.07	11.94	14.79	2.34	0.422	NS
Drumstick (%)	10.58^{a}	15.38^{ab}	16.59^{a}	9.01^{c}	14.79^{ab}	2.16	0.006	*
Wings (%)	9.19	12.05	11.80	9.01	11.45	2.21	0.320	NS
Relative organ weight expressed as a percentage of live weight								
Heart	1.27	1.51	2.16	1.48	1.65	0.49	0.294	NS
Gizzard	2.79	1.73	1.73	2.73	2.94	1.34	0.665	NS
Liver	2.82	1.73	1.73	2.73	2.94	1.33	0.656	NS
Intestine	0.92	1.19	1.00	1.06	1.14	0.27	0.729	NS

a, b, c, means with similar superscript letters within rows are not significantly different (P>0.05)
** Significant difference, NS= not significant, LOS= level of significance*

Table 4. Haematological values of broilers fed diets containing varying levels of pearl millet

Parameters	A	B	C	D	E	SEM	P-value	LOS
RBC ($x10^{12}$/l)	1.30	1.27	1.93	2.11	1.37	0.91	0.689	NS
WBC ($x10^9$/l)	2.68	3.48	4.40	5.63	2.97	2.32	0.653	NS
PCV (%)	20.00	18.33	30.50	20.00	19.33	13.00	0.700	NS
Hb, (g/l)	6.67	6.10	10.17	9.30	6.45	4.32	0.702	NS
MCV (fl)	108.33	96.46	160.52	136.15	94.34	69.42	0.733	NS
MCH (pg)	36.11	32.10	53.50	44.63	31.47	23.13	0.740	NS
MCHC (g/l)	22.22	22.18	33.34	33.10	22.24	14.90	0.741	NS

Key: SEM = standard error of mean, N.S = not significant, Diet A=control (no pearl millet) B=Diet with 25% pearl millet, C=Diet with 50% pearl millet, D=Diet with 75% pearl millet, E=Diet with 100% pearl millet. PCV=packed cell volume, WBC= white blood cells, RBC=red blood cells, Hb= haemoglobin concentration, MCV= mean corpuscular volume, MCH=mean corpuscular haemoglobin, MCHC=mean corpuscular haemoglobin concentration, LOS= level of significance

4. CONCLUSION

The results from this study showed that with the exception of drumstick, all other parameters measured did not differ significantly from the control diet. Therefore, pearl millet as a potential feed resource in broiler diets can completely (100%) replace maize when supplemented with enzymes without adverse effect on carcass and haematological parameters.

ETHICAL APPROVAL

All experimental procedures involving animals were in compliance with the recommended protocol approved by the institutional animal ethics committee of The Federal College of Animal Health and Production Technology, National Veterinary Research Institute, Vom (Protocol No. nvriAUCC F001/15) and in compliance with the Nigerian Animal Diseases (Control) Act. Cap A17 LFN, 2004 and the Veterinary Surgeon Act. Cap V3 LFN 2004.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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