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EFFECTS OF ENZYME SUPPLEMENTATION OF CASSAVA FLOUR-BASED DIETS ON PERFORMANCE AND ECONOMIC EFFICIENCY OF BROILER CHICKEN

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Abstract

Two hundred and forty three day-old early strain (Abor acre) broiler chicks were randomly assigned to nine treatment diets, replicated thrice in a Completely Randomized Design (CRD) to evaluate the substitutional effects of enzymes supplemented and non-supplemented dietary cassava flour for maize in broiler nutrition. The experiment lasted 49days (7weeks). Growth performance, feed and economic efficiency, carcass and organ proportions, serum chemistry and hematological parameters were significantly (P<0.05) influenced. Birds fed diet 1 gave a superior (P<0.05) performance over and above all the other diets in terms of the mean final weight (1885.18g), body weight gain (1,834.19g), revenue (₦1,100.20) and gross margin (₦125.33) realizable, hematology and serum chemistry values. This was closely followed by birds fed diets 2, 3, 4 and 5. The results further showed that substitution of maize with enzymes supplemented and non-supplemented cassava flour beyond 50% in the broiler diets reduced revenue (₦) realizable and gross margin (₦), an indication that the diets did not optimize economic returns nor enhance biological values. In conclusion, diets 1 on one hand and 2, 3, 4 and 5 on the other are hereby recommended for optimal performance and economic returns.

Keywords: *cassava flour, enzyme, performance, economics and broiler chicken*

INTRODUCTION

There is the need for food production to increase as the human population increases. This becomes necessary because the economy of the nation is inextricably linked to the health of his populace. A healthy and well-motivated populace is the bedrock of wealth creation. Among the various food nutrients required by man, animal protein is the most important, followed by energy. Poultry provides the easiest, fastest and cheapest means of meeting such demand. Despite its potentiality in bridging the protein intake gaps of the nation, it is bedeviled with diverse problems which affect its population in diverse ways. Among such is the ever-increasing cost of grains, inadequate production, unavailability and stiff competition between man, animal and the industry for these grains and unstable Government policies. Inclusion of maize, a major conventional dietary energy source in poultry ration ranged from 60% to 70% of the cost of the feed [22]. The demand pressure for maize has not abated despite efforts made over the years to stem the trend. There is therefore the need to look for locally available and cheaper sources of alternative dietary energy for poultry if human demand for animal protein would be met at affordable cost. According to [11] cassava flour and cassava by-products (fiber, peels, chips) have proven to be very appropriate for this purpose. Cassava floor has 80-90% carbohydrate content which consists of starch, sugar, small amounts of pectins, hemicelluloses and cellulose [12]. Cassava production, food and job security, rural household income and foreign exchange earnings are inter related. In addition, investment in cassava research for livestock is an imperative that must now be given serious attention. Efforts had been made in the past to replace cereals with cassava in poultry diets [11, 16] with attendant wide variability of results. Diverse processing methods had also been engaged to enhance the nutritive value of cassava products, while enzyme supplementation was used to mitigate the limitation placed on cassava products by the high fiber content [19].

The objective of this study therefore is to evaluate the efficiency of cassava flour with or without enzyme supplementation on the performance, organ and carcass characteristics, hematology and serum chemistry and cost efficiency of broiler chicken reared in a warm humid tropical condition.

MATERIALS AND METHODS

Experimental site

This study was carried out at the poultry unit of the Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike; Abia State, Nigeria. Umudike is located at $05^{0}29$ and $07^{0}33$ which is approximately 122m above the sea level and has maximum and minimum temperature of $36^{0}C$ and $27^{0}C$ respectively, with a relative humidity of 57-91%.

Test Material

The test material (cassava root) was obtained from a local market in Nigeria. It was peeled, washed, grated, milled, dried and grounded into a gritty form, which was generally referred to as the "cassava flour". Smart choice enzyme respectively produced and distributed by smart choice Agriculture INC, USA and Farm Associates, Nig. LTD, Enugu State, Nigeria was used for the supplementation of some of the cassava-based flour diets. The enzyme is of multiple origin which includes bacterial, yeast and fungal.

Experiment diets

A total of nine experimental diets were formulated with diets 1 serving as the control. The diets were divided into two different groups namely 1, which consists of diets 2, 4, 6 and 8 which had their maize substituted for cassava flour at 25%, 50%, 75% and 100% respectively without enzyme supplementation. The second group consists of diets 3, 5, 7, and 9 which had their maize substituted for cassava flour at 25%, 50%, 75% and 100% respectively but supplemented with enzyme at 0.10% (Table 1).

Table 1. Composition of experimental Diets fed broiler chickens from (0-7 weeks)

INGREDIENT	DIET 1	DIET 2	DIET 3	DIET 4	DIET 5	DIET 6	DIET 7	DIET 8	DIET 8
Maize	60.30	45.23	45.23	30.15	30.15	15.08	15.08	-	-
Soybean meal	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30,00	30,00
Cassava flour	-	15.08	15.08	30.15	30.15	45.23	45.23	60.30	60.30
Fishmeal (imported)	5.00	5.00	5.00	5.00	5.00	5.00	5,00	5.00	5.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Oyster shell	1.0	1.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Vit. Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.1	0.10	0.10	0.10	0.10	0.10	0.10	0.10
- /+enzyme	-	-	0.10	-	0.10	-	0.10	-	0.10
Total	100	100	100	100	100	100	100	100	100
Calculated composition:									
Crude protein	22.03	21.12	21.12	20.22	20.22	19.49	19.49	18.40	18.40
ME (kcal/kg)	2,907.13	2,864.92	2,864.92	2,822.71	2,822.71	2,788.94	2,788.94	2,738.29	2,738.29
Calorie: Protein ratio	1:132	1:136	1:136	1:140	1:140	1:143	1:143	1:149	1:149

Vit. Premix Composition: Vit A,10000 IU; Vit D,28000 IU; Vit E, 35000 IU; Vit K,1900 mg;VitB_{12} 19$_{mg}$; Riboflavin, 7000 mg; Pyridoxine, 3800 mg; Thiamine, 2200 mg; D-Pantothenic acid, 11000 mg; Folic acid, 1400 mg; Biotin,113 mg; Cu, 8000 mg; M, 64000 mg; Choline, 475000 mg; Methionine, 50000 mg; BHT, 5000 mg; Spiramyin, 5000 MG

Experimental animal, management and experimental design

Two hundred and forty three (243) day-old early strain (Abor acre) broiler chicks were individually weighed and randomly assigned to nine (9) dietary treatments replicated thrice. Each treatment comprised of twenty seven (27) birds, with nine birds per replicate in a Completely Randomized Design (CRD). The birds were fed and watered ad libitum, while routine health management were religiously and appropriately observed according to standard and internationally acceptable procedures. The birds were weighed weekly, and data on feed intake, weight changes, and feed-to-gain ratio were obtained and or calculated. The cost efficiency was also evaluated according to the procedure of [5].

Evaluation of carcass characteristics

At the end of the experimental period, a total of 27 birds closest to the mean in each group, with three from each treatment were randomly selected, fasted of feed overnight to empty their crops, slaughtered by complete severing of the head, defeathered with hot water (60^0C) and then eviscerated according to the procedure of [20].

Evaluation of the blood parameters

The blood were collected through the jugular vein and taken to the laboratory for analysis. The parameters considered include the red blood cell count (RBC), white blood cells count (WBC), packed cell volume (PVC) and hemoglobin (HB).

Serum chemistry of the blood collected was also evaluated such include total protein, Globulin, glucose, albumin, serum aspartate amino transferase, alanine amino transferase, creatinine and alkaline phosphate.

Statistical analysis

Data collected were statistically evaluated using the analysis of variance (ANOVA) according to [12]. Duncan Multiple Range Test (8) was used to detect differences among means.

RESULTS AND DISCUSSIONS

Table 2 presents the performance characteristics of broiler chickens fed varying levels of cassava flour meal with or without enzyme supplementation. The mean final body weight, body weight gain, total feed intake and feed-to-gain ratio were significantly (P<0.05) influenced.

Nevertheless, the difference observed followed no definite pattern, though growth and feed intake were depressed as the level of cassava substitution for maize increased with or without enzyme supplementation. The mean daily weight gain for birds fed diets 1, 2, 3 and 5 were comparable and ranged from 32.21 (D5) to 37.80 (D1).

Table 2. The Performance characteristics of Broiler chickens fed varying levels of cassava flour meal with or without enzyme supplementation

Parameters	Tx1	Tx2	Tx3	Tx4	Tx5	Tx6	Tx7	Tx8	Tx9	SEM
Initial body weight (g)	51.00	51.33	51.67	50.67	51.67	52.00	50.67	53.67	50.667	1.111
Final body weight (g)	1885.18^b	1688.89^b	1666.66^b	1355.55^a	1629.63^b	1255.55^a	1203.70^a	1133.33^a	1231.48^a	90.79
Average body weight gain (g)	1834.19^b	1639.5^b	1615.00^b	1304.89^a	1578.30^b	1203.55^a	1153.04^a	1082.66^a	1180.66^a	90.62
Daily body weight gain (g)	37.80^b	33.42^b	32.96^b	26.63^a	32.21^b	24.56^a	23.53^a	22.10^a	24.10^a	1.85
Total feed intake (g)	1134.98^d	961.83^{bc}	939.53^{bc}	1079.36^{cd}	1064.25^{cd}	915.34^{bc}	694.63^a	789.12^{ab}	720.33^a	43.58
Daily feed intake (g)	23.16^f	19.53^{de}	19.18^{cd}	22.03^{ef}	21.54^{def}	18.68^{bc}	14.17^a	16.10^{ab}	14.70^a	0.87
Feed conversion ratio	1.62^{bc}	1.73^c	1.73^c	1.21^a	1.49^{abc}	1.32^{ab}	1.64^{bc}	1.38^{abc}	1.64^{bc}	0.12

^{abcd} Mean values in a row with different superscripts are significantly different (P<0.05). SEM-standard error of mean.

They are also significantly (P<0.05) higher than those fed diets 4, 6, 7, 8 and 9 which are also comparable and ranged from 22.09g (Diet 8) to 26.63g (Diet 4). The mean final body weight and body weight gain exhibited same response as the mean daily weight gain.

The result obtained in this trial does not agree with the findings of [3] and [11] which stated that enzyme supplementation brings about better growth and improved nutrient utilization. But according to [18, 19, 14], the inclusion of exogenous enzymes in broilers chicks diet do not necessarily translate to improved body weight and or feed efficiency. This is in agreement with the findings obtained in this trial. This may be due to the increasing bulkiness fiber content and lowering of nutrient concentration of the diets as the level of dietary cassava flour increased in the diets. The inability of the birds to efficiently digest the fiber, which would then create a gut fill sensation and subsequent depression of appetite is also a possibility [7]. The ambient temperature, breeds of chickens used for the experiment and other intrinsic factors could have influenced the results obtained in the trial.

Table 3 shows the economics of production of broiler chickens fed varying levels of cassava flour meal with or without enzyme supplementation. The result shows that cost per weight gain (₦), cost of production (₦), revenue (₦) and gross margin (₦) were significantly (P<0.05) depressed as the levels of maize substituted with cassava flour increased, with or without enzyme supplementation. Birds fed diets 1 proved superior to others because energy from dietary maize has better nutrient and energy availability when compared with cassava products [17]. The dietary substitution of maize with cassava flour beyond 50% did not optimized monetary returns with or without enzyme supplementation. This is in agreement with the findings of [11] and [16]. The reductions of growth due to a lower density of digestible nutrients in cassava products compared to maize may be related to the depression of productive performance of the broiler chickens as the level of maize substitution for cassava increased. This also effects the possible economic gain. Therefore, this goes to prove the fact that inclusion of a particular nutrient in the diet of an animal must not only be considered on the basis of its nutritive content, cheapness and availability alone but also on the economic efficiency.

Table 3.Economics of Production of Broiler chickens fed varying levels of cassava flour meal with or without enzyme supplementation

Parameter	Tx1	Tx2	Tx3	Tx4	Tx5	Tx6	Tx7	Tx8	Tx9	SEM
Cost/kg feed (N)	110.26	108.46	111.26	106.64	109.44	104.84	107.64	103.02	105.82	13.09
cost of wt gain (N)	178.95^{bc}	188.01^{c}	192.47^{c}	130.33^{a}	162.68^{ab}	138.04^{ab}	176.89^{bc}	142.17^{ab}	173.19^{ab}	5.67
Cost of production(N)	280.24^{cd}	273.30^{cd}	274.40^{cd}	285.17^{d}	286.41^{d}	265.89^{bc}	244.74	251.25^{ab}	246.19^{a}	600.00
Revenue (N)	1100.20^{b}	982.40^{b}	969.00^{b}	783.00^{a}	947.00^{b}	722.00^{a}	691.70^{a}	649.57^{a}	708.50^{a}	54.349
Gross margin (N)	125.33^{d}	104.30^{bc}	104.40^{bc}	115.17^{bc}	116.41^{cd}	95.89^{b}	74.74^{a}	81.25^{a}	76.19^{a}	4.718

^{abcd} Mean values in a row with different superscripts are significantly different (P<0.05). SEM-standard error of mean

The percent dressed weight (Table 3) was significantly (P<0.05) influenced by the dietary treatments. The values ranged from 43.16 (D6) to 67.59 (D9). The drumstick, neck and back-cut showed no significant (P<0.05) difference and followed no definite pattern that could be attributed to either the increasing substitutional level of cassava flour for maize nor enzyme supplementation of the diets. The percent gizzard, proventriculus, spleen, crop, kidney, large and small intestine were significantly (P<0.05) influenced but the lungs were not. The result showed that some of the cut-parts bore a relationship with the carcass weight, supporting the view of [16] that weight, volumes and dimensions of broiler parts were directly related to the carcass weight.

Among the hematological parameters considered, only the mean packed cell volume was significantly (P<0.05) influenced, and the values ranged from 23.33 (D5) to 29.67 (Diet 1). The mean hemoglobin concentration, red blood cell and corpuscular volume respectively ranged from 8.28 (D3) to 9.72 (D8), 1.57 (D5) to 2.83 (D1) and 125.16 (D8) to 169.86 (D4). The birds fed diet 7 and 5 respectively gave the least (30.33) and highest (39.40) mean corpuscular hemoglobin concentration values while mean corpuscular hemoglobin and white blood cells respectively ranged from 3635 (D1) to 60.85 (D5) and 8.68 (D7) to 9.67 (D2). The various values obtained in this trial are generally higher than range of values presented by [6, 9, 15]. This could be due to the balancing for dietary protein deficiencies associated with cassava products with fish meal (72% cp), synthetic methionine and lysine. The place of enzyme in improving nutrient utilization should also not be downplayed in a situation like this.

The mean total protein, globulin, glucose, albumin and creatinine showed significant (P<0.05) difference, while serum aspartate amino transferase, alanine amino transferase, and alkaline phosphate were not. The various values obtained in this trial are generally lower than the range of standard values presented by [4, 6, 13]. From the foregoing, it is possible that the hydrogen cyanide and some other anti-nutritional factors that are generally associated with cassava products had not been completely eliminated by the processing method used in this trial thus, leading to lowering of serum metabolites. The serum aspartate, amino transferase, alanine amino transferase and alkaline phosphate showed positive correlation with the quality of diet and the form of feed [1, 2].

CONCLUSIONS

Birds fed diet 1 gave a superior performance over and above all the other 8 diets in terms of the mean final weight gain, percent dressed carcass, serum chemistry and hematological values. This was closely followed by birds fed diets 2, 3, 4, and 5. Substitution of maize with enzyme supplemented and non-supplemented dietary cassava flour should not exceed 50% in the broiler diet. This is because, as the levels of dietary cassava flour substitution for maize increased from 50% to 100%, revenue realizable and gross margin (₦) values also dropped, an indication that the diets (6, 7, 8 and 9) did not optimize economic returns nor enhanced biological performance.

Table 4. Carcass Characteristics of the Broiler chickens fed varying levels of cassava flour meal with or without enzyme supplementation

Parameters	Tx1	Tx2	Tx3	Tx4	Tx5	Tx6	Tx7	Tx8	Tx9	SEM
Live wt (g)	1846.67^{d}	1673.33^{cd}	1666.67^{cd}	1243.33^{ab}	1400.00^{bc}	1233.33^{ab}	1226.67^{ab}	1046.67^{a}	1333.33^{ab}	89.66
Dressed wt carcass)%	86.45^{b}	88.16^{b}	87.76^{b}	88.01^{b}	87.69^{b}	75.73^{a}	87.97^{b}	85.84^{b}	84.31^{b}	2.59
Dressed wt (%)	62.08^{cd}	63.33^{cd}	61.16^{cd}	63.52^{cd}	59.40^{c}	43.16^{a}	51.79^{b}	59.41^{c}	67.59^{d}	2.22
Thigh %	16.84^{ab}	16.99^{ab}	17.60^{ab}	15.62^{a}	15.67^{a}	19.39^{b}	18.35^{ab}	17.08^{ab}	16.18^{ab}	0.98
Breast muscle%	19.41^{ab}	25.49^{abcd}	26.62^{bcd}	23.55^{abcd}	27.41^{cd}	30.45^{d}	18.93^{a}	22.23^{abc}	29.17^{cd}	2.27
Drum stick %	14.46	15.40	15.82	14.68	15.18	19.01	15.52	15.62	15.30	1.34
Wings%	15.25^{a}	14.27^{a}	14.30^{a}	15.34^{a}	14.78^{a}	18.25^{b}	13.69^{a}	14.79^{a}	13.84^{a}	0.94
Heart%	0.63^{a}	0.62^{a}	0.59^{a}	0.61^{a}	1.19^{c}	0.93^{bc}	0.92^{bc}	1.09^{cd}	0.82^{ab}	0.09
Liver%	3.19^{a}	3.05^{a}	3.34^{a}	3.60^{a}	3.83^{ab}	4.487^{c}	3.88^{ab}	4.67^{bc}	3.45^{a}	0.31
Head%	3.80^{a}	4.07^{ab}	4.32^{ab}	4.38^{ab}	4.57^{ab}	6.81^{a}	4.87^{abc}	5.88^{cc}	5.25^{bc}	0.38
Neck %	7.56	7.59	7.17	7.20	7.49	8.82	7.51	8.17	7.40	0.64
Gizzard	2.79^{a}	3.71^{ab}	3.33^{ab}	2.97^{a}	3.32^{a}	4.03^{ab}	3.16^{a}	4.88^{b}	3.46	0.38
Shank	6.11^{a}	6.24^{a}	6.47^{a}	6.87^{a}	6.64^{a}	11.30^{c}	7.98^{ab}	9.22^{b}	8.08^{ab}	0.69
Back-cut	16.86	15.69	23.68	20.86	18.16	24.33	28.36	18.36	24.68	4.45
Proventriculus	0.54^{a}	0.58^{ab}	0.76^{bc}	0.59^{ab}	0.69^{abc}	0.85^{c}	0.72^{abc}	0.85^{c}	0.57^{ab}	0.06
Spleen	0.17a	0.25^{ab}	0.16^{a}	0.29^{ab}	0.22^{ab}	0.34^{b}	0.22^{ab}	0.15^{a}	0.20^{ab}	0.04
Crop	0.92^{ab}	0.84^{ab}	0.79^{ab}	0.69^{ab}	1.05^{ab}	1.30^{b}	0.78^{ab}	1.04^{ab}	0.48^{a}	0.19
Kidney	0.95^{ab}	1.06^{bc}	1.21^{bcd}	1.10^{bc}	1.2bc	1.54^{d}	1.33^{bcd}	1.37^{cd}	0.61^{a}	0.12
Hung	0.88	0.89	0.90	0.95	0.91	1.07	0.91	0.98	0.84	0.12
Large intestine	0.81^{a}	0.66^{a}	0.96^{a}	0.81^{a}	1.01^{a}	1.73^{b}	0.94^{a}	1.05^{a}	0.95^{a}	0.13
Small intestine	2.25^{a}	3.63^{ab}	4.36^{abc}	4.95^{abc}	5.14^{bc}	7.89^{d}	4.78^{abc}	5.53^{c}	3.58^{ab}	0.56

^{abcd} Mean values in a row with different superscripts are significantly different (P<0.05). SEM-standard error of mean

Table 5. Haematology value of birds fed varying levels of cassava flour meal with or without enzyme supplementation

Parameters	Tx1	Tx2	Tx3	Tx4	Tx5	Tx6	Tx7	Tx8	Tx9	SEM
Haemoglobin concentration (g/dl)	9.10	9.32	8.28	9.69	9.18	8.30	8.35	9.72	8.80	0.28
Packed cell volume 1%	29.67^{b}	26.33^{ab}	25.33_{ab}	30.67^{b}	23.33^{a}	26.17^{ab}	27.50^{ab}	27.50^{ab}	27.33^{ab}	0.65
Red blood cell (x 106/ul)	2.83	2.54	1.98	2.03	1.57	2.12	1.70	2.65	1.90	0.16
Mean corpuscular volume (fl)	126.66	119.29	130.80	169.86	155.07	130.33	171.16	125.16	147.89	9.24
Mean corpuscular haemoglobin concentration (g/dl)	31.40	35.18	34.72	32.00	39.40	32.11	30.33	35.34	32.33	1.30
Mean corpuscular haemoglobin (pg)	36.35	41.52	46.73	51.39	60.85	40.65	51.69	40.88	47.96	2.83
White blood cell (x103/u)	9.31	9.67	8.88	9.41	9.31	8.81	8.68	9.75	8.92	0.30

^{abcd} Mean values in a row with different superscripts are significantly different (P<0.05). SEM-standard error of mean

Table 6. Serum Biochemistry of birds fed varying levels of cassava flour meal with or without enzyme supplementation

Parameters	Tx1	Tx2	Tx3	Tx4	Tx5	Tx6	Tx7	Tx8	Tx9	SEM
Total protein (g/dl)	2.69^{ab}	2.93^{b}	2.52^{ab}	2.20^{ab}	2.36^{ab}	2.12^{a}	2.60^{ab}	2.68^{ab}	2.36^{ab}	0.80
Globulin (mg/dl)	1.04^{ab}	1.45^{b}	1.13^{ab}	0.93^{ab}	1.23^{ab}	0.38^{a}	1.00^{ab}	1.12^{ab}	0.96^{ab}	0.93
Glucose (mg/dl)	232.65^{b}	148.30^{a}	164.63^{a}	238.10^{b}	194.56^{ab}	243.54^{a}	206.80^{ab}	187.76^{ab}	197.28^{ab}	8.00
Albumin (mg/dl)	1.65^{b}	1.48^{ab}	1.39^{ab}	1.27^{ab}	1.14_{a}	1.73^{b}	1.60^{ab}	1.56^{ab}	1.39^{ab}	0.05
Serum aspartate amino transferase (uld)	94.05	85.67	101.35	93.00	85.88	81.71	99.78	99.44	99.78	2.39
Alanine amino transferase (uld)	10.93	5.69	7.93	11.69	7.98	7.55	10.39	7.87	7.00	0.64
Creatinine (mg/dl)	0.27^{ab}	0.17^{a}	0.22^{ab}	0.44^{6}	0.27^{ab}	0.25^{ab}	0.37^{ab}	0.32^{ab}	0.36^{ab}	0.03
Alkaline phosphate	188.29	217.65	114.28	149.00	173.50	152.04	176.56	175.94	177.92	11.00

^{abcd} Mean values in a row with different superscripts are significantly different (P<0.05). SEM-standard error of mean

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