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Utilization of Enzyme Supplemented Cowpea Testa Meal by Broiler Chickens 1: Effect on Growth Performance and Cost of Production

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Authors' contributions

This work was carried out in collaboration between all authors. Author RJW designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors LIT and RJW performed the statistical analysis and managed the analyses of the study. Authors UA and MIH coordinated data collection and managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To evaluate the utilization of cowpea testa meal supplemented with or without enzyme maxigrain® on broiler chicken growth performance.
Study Design: Completely randomized design.
Place and Duration of Study: The study was conducted at a Commercial Poultry Farm in Yola, Nigeria between the months of October and December 2016.
Methodology: Experimental diets were compounded using Cowpea testa meal (CTM). The CTM replaced wheat offal at 0, 25, 50, 70 and 100%. 0.20 g/kg enzyme maxigrain® was supplemented

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at two levels (with and without). Four hundred (400) unsexed day old *Anak 2000* were used, the birds were brooded for two weeks on commercial starter diet and then randomly assigned to dietary treatments of four replicates with ten birds per replicate in a 5 x 2 factorial arrangement in a completely randomized design. Each replicate was housed in 3 × 3m deep litter pens fitted with wood shavings, feeders and drinkers.

Results: Birds fed replacement levels of CTM without enzyme supplementation showed significantly decrease ($P<0.05$) in average final body weight and daily weight gain as the levels of replacement in the diets, while average daily feed intake, feed conversion ratio, feed cost and feed cost per kg weight gain increased. Enzyme supplemented CTM showed significant ($P<0.05$) improvement in average daily weight gain, final body weight gain and a decrease in feed intake, feed cost and feed cost per kg weight gain over non-supplemented birds.

Conclusion: It was concluded that CTM can replace wheat offal 100% with 0.20g/kg Maxagrain® in broiler chicken diets.

Keywords: Broiler; cowpea testa meal; growth performance; maxigrain®.

1. INTRODUCTION

The high cost of feed has been identified as the major challenge of the poultry industry in most developing countries [1,2]. This has affected the expansion of the industry as well causing a shortfall in animal protein intake among the populace [3,4] and [5]. Recently, studies have been intensified into the use of agro-industrial by-products and waste in poultry ration at various levels to determine its utilization and cost of feeding [6,7] and [8]. However, the use of agro-industrial by-products is limited due to high fibre content which is the most impeding factor to its utilization in monogastric animals [9] and [10]. Poultry, especially broilers cannot efficiently utilize high dietary fibre completely due to an absence of digestive framework [6]. Agro-industrial by-product considered in this study is Cowpea (*Vigina unguiculata*) testa. It is a by-product obtained after cowpea processing. It contains 22.06 % crude protein, 50.20% nitrogen-free extracts and 13.60% crude fibre on a dry matter basis [11,12]. However, cowpea has high dietary fibre which limits its usage in monogastric animals [13]. Crude fibre has been reported to depressed nutrient digestibility, absorption, availability in intestinal mucosa of monogastric animals [14,15]. Therefore, in order to improve the nutrient absorption and utilization of cowpea testa meal, its carbohydrate and crude protein structural component must be broken down into simpler digestible units. The use of enzyme to improve the nutritional value of feed especially in poultry is well documented [6,8] and [16]. An enzyme has shown to improve growth performance, increase the effectiveness of nutrient utilization and increase apparent metabolizable energy [7,17]. The study was therefore conducted to evaluate the utilization of cowpea testa meal supplemented with or without enzyme maxigrain® on broiler chicken growth performance.

2. MATERIALS AND METHODS

The study was conducted at a Commercial Poultry Farm in Yola, Nigeria located between latitude 7^{o} and 11^{o}N and longitude 11^{o} and 14^{o}E. The area is characterized by two seasons (dry and rainy) and has maximum temperature up to 40^{o}C particularly in the month of April and minimum temperature as low as 18^{o}C between December and January [18].

Cowpea testa was procured from agro- by product market in Yola then milled using milling machine. Experimental diets were compounded using Cowpea testa meal (CTM). The CTM replaced wheat offal at 0, 25, 50, 70 and 100%. The diets were supplemented with 0.20 g/kg maxigrain® at two levels (with and without) as shown in Tables 1 and 2 for both starter and finisher diets. Four hundred (400) unsexed day old *Anak 2000* procured from AgriTED Farms Ltd, along Mayo-Belwa road Adamawa State, Nigeria. The birds were brooded for two weeks on commercial starter diet, and then randomly assigned to ten dietary treatments of four replicates with ten birds per replicate in a 5 x 2 factorial arrangement in a completely randomized design. Each replicate was housed in 3 × 3 m deep litter pens fitted with wood shavings, feeders and nipple drinkers.

Feed and water were supplied *ad libitum.* On the first day of birds' collection, vitalyte soluble powder was administered to prevent stress while on the second day; birds were vaccinated using New Castle Disease Vaccine (I/O). Similarly, on day 7 and 14, birds were orally immunized

Table 1. Ingredient composition of broiler starter diets

Ingredients	Replacement levels of cowpea testa meal									
	T1 (0%)	T2 (0%)	T3 (25%)	T4 (25%)	T5 (50%)	T6 (50%)	T7 (75%)	T8 (75%)	T9 (100)	T10 (100%)
Maize	38.65	38.65	38.65	38.65	38.65	38.65	38.65	38.65	38.65	38.65
Flour milling waste	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Soybean meal	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00
Fish meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Wheat offal	17.00	17.00	12.75	12.75	8.50	8.50	4.25	4.25	0.00	0.00
CTM	0.00	0.00	4.25	4.25	8.50	8.50	12.75	12.75	17.00	17.00
*Enzyme	-	+	-	+	-	+	-	+	-	+
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Limestone	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Salt	0.25	0.25	0.25	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	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100	100	100
Proximate composition										
Crude protein	22.01	22.01	22.00	22.00	22.03	22.03	22.00	22.00	22.01	22.01
Crude fiber	3.66	3.66	4.05	4.05	4.46	4.46	4.65	4.65	4.89	4.89
Ether extracts	3.66	3.66	3.55	3.55	3.42	3.42	3.29	3.29	3.17	3.17
Ash	4.09	4.09	4.07	4.07	4.10	4.10	4.07	4.07	4.09	4.09
Ca	1.08	1.08	1.06	1.06	1.09	1.09	1.06	1.06	1.07	1.07
P	0.73	0.73	0.71	0.71	0.74	0.74	0.72	0.72	0.73	0.73
Methionine	0.62	0.62	0.61	0.61	0.62	0.62	0.61	0.61	0.61	0.61
Lysine	0.95	0.95	0.93	0.93	0.98	0.98	0.93	0.93	0.95	0.95
ME kcal/kg	3075.01	3075.01	3079.67	3079.67	3083.59	3083.59	3079.93	3079.93	3075.15	3075.15

***Vitamin Premix (2.5 kg/1000 kg): vitamin A 15,000 U.I; vitamin D33,000.000 I.U and vitamin E 30,000 I.U, vitamin k 2,500 I.U, Thiamin B, 2,000 mg, Riboflavin B2 6,000 mg. Pyridoxine B0 4000 mg, Niacin 40,000 mg, vitamin B12 20 mg, pantothenic B6 10,000 mg, folic acid 1,000 mg, Biotin 80 mg, chlorine chloride 500 mg, antioxidant 12 g, manganese 96 g, zinc 60 g, iron 24 g, copper 69, iodine 1.4 g, selenium 24 g and cobalt 12 g .*Maxigrain Enzyme 0.20 g/kg*

Table 2. Ingredient composition of broiler finisher diets

Ingredients	Replacement levels of cowpea testa meal									
	T1 (0%)	T2 (0%)	T3 (25%)	T4 (25%)	T5 (50%)	T6 (50%)	T7 (75%)	T8 (75%)	T9 (100)	T10 (100%)
Maize	47.65	47.65	47.65	47.65	47.65	47.65	47.65	47.65	47.65	47.65
Flour milling waste	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Soybean meal	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Fish meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Wheat offal	17.00	17.00	12.75	12.75	8.50	8.50	4.25	4.25	0.00	0.00
CTM	0.00	0.00	4.25	4.25	8.50	8.50	12.75	12.75	17.00	17.00
Enzyme	-	+	-	+	-	+	-	+	-	+
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Limestone	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Salt	0.25	0.25	0.25	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	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100	100	100
Proximate composition										
Crude protein	19.51	19.51	19.50	19.50	19.52	19.52	19.50	19.50	19.51	19.51
Crude fiber	3.03	3.03	4.42	4.42	4.58	4.58	4.75	4.75	4.87	4.87
Ether extracts	3.57	3.57	3.56	3.56	3.58	3.58	3.56	3.56	3.57	3.57
Ash	3.09	3.09	3.08	3.08	3.10	3.10	3.08	3.08	3.09	3.09
Ca	1.06	1.06	1.07	1.07	1.07	1.07	1.08	1.08	1.08	1.08
P	0.75	0.75	0.75	0.75	0.76	0.76	0.77	0.77	0.77	0.77
Methionine	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
Lysine	0.78	0.78	0.79	0.79	0.80	0.80	0.82	0.82	0.84	0.84
ME kcal/kg	3165.58	3165.58	3170.74	3170.74	3175.62	3175.62	3180.65	3180.65	3185.475	3185.475

***Vitamin Premix (2.5 kg/1000 kg): vitamin A 15,000 U.I; vitamin D33,000.000 I.U and vitamin E 30,000 I.U, vitamin k 2,500 I.U, Thiamin B, 2,000 mg, Riboflavin B2 6,000 mg. Pyridoxine B0 4000 mg, Niacin 40,000 mg, vitamin B12 20 mg, panthothenic B6 10,000 mg, folic acid 1,000 mg, Biotin 80 mg, chlorine chloride 500 mg, antioxidant 12 g, manganese 96 g, zinc 60 g, iron 24 g, copper 69, iodine 1.4 g, selenium 24 g and cobalt 12 g .*Maxigrain Enzyme 0.20 g/kg*

against New Castle Disease (Lasota) and Infectious Bursal Disease (Gumboro), respectively by dissolving 200 doses of each vaccine in 2 litres of chlorine-free water. The birds were also given prophylactic treatment against bacterial infection in the second week using Terramycin (chick formula) soluble powder (50 g in 60 litres H_2O) and against coccidiosis using Embazin forte at 30 g per 50 litres water on the 18th day. The experiment lasted for a period of 49 days during which feed intake, weight gain, feed conversion ratio were monitored. Feed intake was determined daily by the weigh back technique according to [19]. Live body weights were recorded on weekly basis for each bird. Feed conversion ratio was then calculated as the index of feed consumed per unit (grams) weight gained over the same period.

Experimental diets and cowpea testa meal were analysed for proximate composition using the methods described by [20].

Data generated were subjected to analysis of variance test using the General Linear Model (GLM) procedure according to [21]. Means were separated using Duncan's multiple range test of the same statistical software.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Cowpea Testa Meal

The proximate composition of the cowpea testa meal is shown in Table 3. The crude protein of the cowpea testa meal is lower than the value 22.06 reported by [11] but similar to 18.0% reported by [12]. However, the crude fibre content is higher than 10.07% reported by [11] but comparable to 13.6% reported by [12] The values of ether extract and ash content recorded were similar to the values reported by [11] who analyzed cowpea testa. The values of nitrogen-free extracts and metabolizable energy were 49.74% and 2946.05 kcal/kg. The differences observed in the proximate composition could be attributed to different methods of processing cowpea testa meal and laboratory analysis [11] and [22].

3.2 Growth Performance of Broiler Chicken Fed Replacement Levels of Cowpea Testa Meals

The effect of feeding replacement levels of cowpea testa meal (CTM) in broiler chicken diets is shown in Table 4. Birds fed 0% CTM had significantly (P<0.05) higher average final body weight (AFBW) and feed cost ₦/kg (2250.56g/bird and 145.34). However, AFBW, average daily weight gain (ADWG) and feed cost ₦/kg decreased as the replacement levels of CTM in broiler diet increased. Birds fed 25% and 50% CTM had similar AFBW and higher than those fed 75% and 100% CTM. Conversely, average daily feed intake (ADFI) and feed conversion ratio showed a reverse trend. Higher (P<0.05) ADFI was recorded on birds fed with 100% replacement level of CTM than the other levels. Better feed conversion ratio was observed in birds fed 0% CTM. Replacement levels of CTM with Wheat offal in broiler diets in this study showed depressed in growth performance. This is contrary to the report of [11] who observed increased in growth performance of weaner rabbits fed levels of wheat offal replace with cowpea testa meal. The difference in performance could be attributed to digestion and assimilation of nutrients by the animals. The AFBW recorded in this study were within the range of 1695.00- 2450.00g reported by [8] for broiler chicken fed graded levels of wheat offal base diets. The ADWG recorded were within range of 26.58-48.35g reported by [8] and [24] for broiler raised under tropical conditions. Decreased in growth performance observed in the study could be attributed to poor utilization of CTM as a result of high fibre content of the diets. [14] reported that crude fibre depresses nutrient digestibility, absorption, availability and utilization in monogastric animals. However, decreased in feed cost (₦/kg) as the replacement level of CTM increases could be attributed to the variation in the prices of CTM (₦35/kg) and wheat offal (₦60/kg). Several studies have shown that increasing the levels of non - conventional feedstuff in broiler chicken diets led to reduction in feed cost [25] and [26]. This is because non–conventional feedstuff are cheaper than the conventional feedstuff.

Table 3. Proximate composition of cowpea testa meal

Parameter	% composition
Dry matter	91.03
Crude protein	18.02
Crude fibre	13.45
Ether extracts	6.34
Ash	12.45
Nitrogen-free extracts	49.74
*ME kcal/kg	2946.05

ME (kcal/kg) = 37 x % CP + 81 x % EE + 35.5 x % NFE. Calculated according to the formula of [23]

3.3 Growth Performance of Broiler Chicken Fed Cowpea Testa Meals Supplemented with or without Enzyme

The result of broiler chicken fed CTM supplemented with or without enzyme is presented in Table 5. AFBW and ADWG of broiler chicken fed enzyme supplemented CTM were significantly (p<0.05) higher than those fed without the enzyme. Enzyme supplementation resulted to decrease in ADFI, feed cost ₦/kg, cost of total feed intake (₦/kg), feed cost/kg (₦/gain) and better feed conversion ratio. The similar finding was reported by [8] when they fed enzyme supplemented wheat offal to broiler chicken. It has been reported that enzymes supplementation resulted in improved feed utilization, improve feed intake, body weight gain and feed conversion ratio as well as reduce the viscosity of ingesta in the intestine [27] and [28]. However, lower feed cost ₦/kg, cost of total feed intake (₦/kg), feed cost/kg (₦/gain) and better feed conversion ratio observed on birds fed enzyme supplemented CTM confirms earlier findings of [29] and [30] who reported similar result when they fed enzyme supplemented diets.

3.4 Interaction between Replacement Levels of CTM and Enzyme Supplementation on Growth Performance

The interaction between replacement levels of CTM and enzyme supplementation was significant (P<0.05) growth performance parameters (Table 6). Broilers chickens on enzyme supplemented diets had significantly (p<0.01) higher AFBW and ADWG than those without supplementation while those on 0, 25, 50% level of replacement of CTM without enzyme supplementation were higher than those on 75 and 100% CTM replacement levels. This could be as a result of higher levels of crude fibre in the diet which resulted in poor

Table 4. Growth performance of broiler chicken fed replacement levels of cowpea testa meals (2- 9 weeks)

Parameter	Replacement levels of cowpea testa meal					
	0%	25%	50%	75%	100%	SEM
Average initial body weight (g/bird)	155.02	155.01	155.02	155.00	155.01	0.15^{ns}
Average final body weight (g/bird)	2250.56^{a}	2010.00^{b}	1991.00^{b}	1986.30^{c}	1623.89^{c}	1.97*
Average daily weight gain (g/bird/day)	42.76^{a}	37.86^{b}	37.46^{b}	37.37^{b}	29.97^{c}	0.30*
Average daily feed intake (g/bird/day)	118.45^{d}	132.67^{c}	143.89^{b}	149.00^{b}	151.89^{a}	1.39*
Feed conversion ratio	2.77^{c}	3.50^{b}	3.84^{b}	3.98^{b}	5.06^{a}	0.23*
Feed cost ₦/kg	145.34^{a}	143.25^{a}	120.00^{b}	100.45^{c}	99.24^{d}	1.22*

Means on the same row with different subscripts are significantly different (p<0.05)
** = Significantly different (p<0.05), Ns= not significant (p>0.05), SEM = Standard error mean*

Table 5. Growth performance of broiler chicken fed cowpea testa meals supplemented with or without enzyme (2 -9 weeks)

Parameter	Enzyme supplementation		
	With	Without	SEM
Average initial body weight (g/bird)	155.02	155.01	0.15^{ns}
Average final body weight (g/bird/)	2122.00^{a}	1972.35^{b}	2.04*
Average daily weight gain (g/bird/day)	40.14^{a}	37.08^{b}	0.03*
Average daily feed intake (g/bird/day)	120.45^{b}	149.19^{a}	0.13*
Feed conversion ratio	3.00^{b}	4.02^{a}	0.04*
Feed cost ₦/kg	141.70^{b}	143.11^{a}	0.14*
Cost of total feed intake (₦/kg)	836.03^{b}	1046.13^{a}	9.41*
Feed cost/kg (₦/gain)	426.56^{b}	574.79^{a}	0.50*

Means on the same row with different subscripts are significantly different (P<0.05)
** = Significantly different (p<0.05), Ns= not significant (p>0.05), SEM = Standard error mean*

Table 6. Interactive Effect of Cowpea testa meal replacement Level and Enzyme Supplementation on Performance of Broiler Chicken (2-9 weeks)

	Replacement levels of cowpea testa meal										
	0		25		50		75		100		SEM
Enzyme	-	+	-	+	-	+	-	+	-	+	
AIBW (g/bird)	155.02	155.02	155.01	155.01	155.02	155.02	155.00	155.00	155.01	155.01	1.55^{ns}
AFIBW (g/bird)	2100.00^{ab}	2234.00^{a}	2099.35^{b}	2240.13^{a}	1923.89^{b}	2286.78^{a}	1703.78^{c}	2290.89^{a}	1689.89^{c}	2299.34^{a}	2.08*
ADWG (g/bird/day)	39.69^{b}	42.42^{a}	39.68^{b}	42.55^{a}	36.09^{b}	43.50^{a}	31.60^{c}	43.58^{a}	31.32^{c}	43.76^{a}	0.39*
ADFI (g/bird/day)	138.45^{d}	122.89^{e}	142.89^{c}	134.78^{d}	151.78^{b}	142.89^{c}	158.67^{b}	140.23^{c}	160.23^{a}	139.56^{d}	1.43*
FCR	3.48^{c}	2.89^{d}	3.60^{c}	3.16^{c}	4.20^{b}	3.28^{c}	5.02^{b}	3.21^{c}	5.11^{a}	3.18^{c}	0.03*

Means on the same row with different subscripts are significantly different (P<0.05)

** = Significantly different (p<0.05, Ns= not significant (p>0.05), SEM = Standard error mean, AIBW = Average initial body weight, AFIBW= Average final body weight, ADWG= Average daily weight gain (g/bird/day), ADFI = Average daily feed intake (g/bird/day), FCR= Feed conversion ratio*

utilization of nutrient in diets. However, ADFI and feed conversion ratio decreased with enzyme supplementation for all the CTM replacement levels. Enzyme supplemented CTM diet improved the growth performance. The result agreed with the report of [7] that final body weight and average daily weight gain increased with increase in level of cassava peel meal supplemented with Maxigrain enzyme and attributed the improvement in weight gain and feed utilization to enzyme supplementation in the diets. The finding also accords the reports of [6] and [8]. Studies have shown that poultry cannot utilize high fibre diet completely due to absence of a digestive framework that can digest large amounts of fibre [6]. Lower ADFI observed by birds on the enzyme supplemented CTM diets, it could be as a result of increase in dietary metabolisable energy and reduction in crude fibre content in the diets by the activity of the enzyme. [31] reported increased in dietary metabolizable energy and net energy gain of broiler diets supplemented with enzyme and concluded that enzyme supplementation improved the utilization of nutrients in broiler diets. The composition (Xylanase, Beta-glucanase, Cellulase and Phytase) of the enzyme used have energy-sparing properties, which acts by reducing the quantity of crude fibre. The reduction in crude fibre in the diets spared energy wastage from utilizing non-starch polysaccharides thereby allowing the birds to direct more energy to grow. Although this has not been investigated in our study. Maxagrain® enzyme supplementation, therefore, has led to a better usage of CTM with significant reductions in the quantities of wheat offal in broiler chicken diets.

4. CONCLUSION

The study has shown that replacement levels of CTM without enzyme supplementation did not show improvement in growth performance of broiler chicken while enzyme supplementation increased average body weight gain, decreased average daily feed intake and feed cost/kg gain thereby increasing income per naira investment as the replacement levels increased This study, therefore, recommended 100% cowpea testa meal with wheat offal supplemented with 0.20 g/kg Maxagrain® in broiler chicken diets.

ETHICAL APPROVAL

The study was conducted with permission from the Nigeria Institute of Animal Science welfare and ethics committee (Act No.26 of 2007).

COMPETING INTERESTS

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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