EVALUATION OF GROWTH RESPONSE AND NUTRIENT DIGESTIBILITY OF BROILER BIRDS FED DIETS SUPPLEMENTED WITH ENZYME-TREATED BOILED AERIAL YAM (D*IOSCOREA BULBIFERA*) MEAL.

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ABSTRACT

This study investigates broiler chickens' growth response and nutrient digestibility over a four-week feeding trial utilizing diets supplemented with enzyme-treated boiled aerial yam (Dioscorea bulbifera) meal. The aerial yam was processed by peeling, boiling at 100 °C, milling, and incorporated into diet formulations. Five diets were formulated: Treatments 1 (T1) and 2 (T2) contained maize as the primary energy source, acting as positive and negative control groups, respectively. Treatment 2 was further supplemented with 0.2% enzyme. Treatments 3 (T3), 4 (T4), and 5 (T5) had a progressive replacement of maize with 20%, 40%, and 60% aerial yam meal, respectively, and each of these treatments was additionally supplemented with 0.2% of the multi-grade enzyme Rozayme-2G. A total of 150 Ross 308-day-old broiler chicks, with an average initial weight of 40.72 ± 10 g per bird, were randomly allotted into the five treatment groups, employing a completely randomized design (CRD) with 30 birds assigned to each group. Three birds per treatment were selected, weighed, and placed in metabolic cages for a digestibility trial. The results revealed that broiler chickens fed the T4 diet exhibited the highest average daily weight gain, measured at 59.87 g, alongside a superior feed conversion ratio (FCR) of 3.36. Furthermore, the treatments displayed varying degrees of nutrient digestibility; T5 recorded the highest digestibility of crude fat at 98.82%, T4 exhibited the highest digestibility of crude fiber at 86.72%, and T3 demonstrated the highest gross energy digestibility at 98.32 kcal/kg. In conclusion, the incorporation of the Rozayme-2G enzyme at a level of 0.2% facilitates the replacement of up to 60% of maize with boiled aerial yam meal in the diets of broiler chickens, supporting optimal growth and health outcomes.

Keywords: Aerial yam, Enzymatic supplementation, Performance metrics.

INTRODUCTION

Poultry farming in tropical regions encounters numerous challenges, the most significant of which is the high cost of feed ingredients, including maize, sorghum, millet, and wheat (Nortey *et al*., 2015). As a staple food for humans, maize plays a crucial role not only in animal feed and the agro-food industry but also in biofuel production in certain countries. This dependency results in considerable fluctuations in both price and availability (Kana *et al.,* 2015). As a response, there has been an intensified interest in identifying alternative feed resources that are locally accessible, economically viable, non-competitive with human food sources, and nutritionally sufficient to replace these costly ingredients. Aerial yam (*Dioscorea bulbifera*) meal has emerged as a potential substitute for incorporation into the diets of broiler chickens. *D. bulbifera* is acknowledged for its nutritional benefits and its capacity to serve as a source of energy that enhances human health (Anano *et al*., 2018). According to Abara (2011), the proximate composition of aerial yam consists of 2.89% crude fibre, 6.35% crude protein, 0.49% fat, 82.50% carbohydrates, and 2.77% ash. As such, it is imperative to explore methods for inactivating these anti-nutrients to facilitate nutrient availability. The supplementation of exogenous enzymes has been proposed as a viable strategy to achieve this objective. Enzymes can enhance the digestibility and utilization of nutrients, consequently mitigating waste outputs and reducing nutrient excretion (Moghaddam *et al*., 2012). Given that poultry may not produce sufficient quantities of these enzymes, it is recommended that they be supplemented within the diet. Nevertheless, there is a notable lack of literature addressing the effects of enzymatic supplementation on the utilization of *D. bulbifera* and its implications for the growth performance and nutrient digestibility of broiler chickens.

Therefore, this study aims to investigate the influence of enzyme supplementation on these variables for broiler chickens fed diets containing boiled *D. bulbifera* meal.

MATERIALS AND METHODS

The research took place at the Poultry Unit of the Teaching and Research Farm, Department of Animal Science, Faculty of Agriculture, University of Calabar, Calabar, Cross River State, Nigeria. The *D. bulbifera* utilized in this study was procured from open markets in Afikpo South, Local Government Area of Ebonyi State, Nigeria. The enzyme, Roxazyme 2G® which encompasses the activities of cellulase (endo-1,4–beta-glucanase; EC 3.2.1.4), endo-1,3(4)-beta-glucanase (EC 3.2.1.6), and endo-1,4-beta-xylanase; EC 3.2.1.8) was sourced from the Agricultural Technology Company in Lagos, Nigeria.

Upon acquisition, the *D. bulbifera* underwent thorough washing with potable water, was peeled, sliced, and boiled at 100°C. Thereafter, it was drained, sun-dried, and oven-dried at 60°C, measuring weight at intervals

until a consistent weight was obtained. The dried samples were milled using a grinder with a 0.20 mm screen, after which the resulting flour was stored in an airtight container pending the formulation of experimental diets. Five (5) diets were formulated for the finisher, as shown in Table 1. Diet T1 consisted of maize without any added enzyme. Diet T2 included maize supplemented with 0.2% multi-grade enzyme. Diets T3, T4, and T5 incorporated 20%, 40%, and 60% boiled *D. bulbifera* meal, respectively, along with 0.2% multi-grade enzyme. One hundred and fifty (150) day-old unsexed Ross broiler chicks were procured from the Agrited hatchery located in Ibadan, Oyo State, Nigeria, for this experiment. The chicks were weighed and were evenly allocated into five groups of thirty (30) chicks each, based on weight equalization. Each group was further subdivided into three replicates of ten (10) chicks, and the groups were subsequently assigned randomly to the five experimental diets. The experimental design utilized for this study was a Completely Randomized Design (CRD). The birds were housed under a deep litter management system for four weeks, ensuring adequate spacing, ventilation, and strict adherence to established routine management practices.

Table 1 Contents of the finisher broiler feed

Ingredient	Treatments				
	Control Maize T1	Maize + 0.2 % Enzyme T2	20 % AYM + 0.2% enzyme T3	40 %AYM +0.2% enzyme T4	60 %AYM + 0.2% enzyme T5
Maize	59.1	59.1	47.3	35.5	23.6
D. Bulbifera	0.0	0.0	11.8	23.6	35.5
Soybean meal	24.5	24.5	24.5	24.5	24.5
Fish meal	2.0	2.0	2.0	2.0	2.0
Wheat offal	10.4	10.4	10.4	10.4	10.4
Dicalcium phosphate	3.0	3.0	3.0	3.0	3.0
Salt	0.3	0.3	0.3	0.3	0.3
Methionine	0.2	0.2	0.2	0.2	0.2
Lysine	0.2	0.2	0.2	0.2	0.2
Vitamin/mineral premix	0.3	0.3	0.3	0.3	0.3
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Crude protein (%)	19.7	20.2	19.9	20.7	20.8
Crude fibre (%)	3.8	3.9	5.3	5.6	5.7
Metabolizable energy (kcal/kg ME)	3052.7	3043.8	2985.1	2963.7	2960.8
Ether extract					
Calcium	0.41	0.41	2.10	2.13	2.15
Ash	3.71	3.71	4.11	4.14	4.18
Phosphorus		0.06	0.07	0.09	0.10
	0.06				
Methionine	0.29	0.29	0.31	0.33	0.35
Lysine	0.31	0.31	0.34	0.39	0.40

Data Collection and Analysis

The initial body weight of the birds was recorded at the beginning of the experiment and subsequently measured weekly until the end of the feeding trial. The average daily feed intake was calculated by subtracting the leftover feed from the initial quantity supplied, 24 hours after feeding. The feed conversion ratio was computed by dividing the average weekly feed intake by the average weight gain.

At the end of the feeding trial, nutrient digestibility was assessed by randomly selecting three birds per treatment, based on their weight. These selected birds were placed in individual metabolic cages and fed 200 g of the experimental diets. Faecal samples were collected consecutively for five days and were oven-dried at 60°C to a constant weight daily to prevent nutrient loss. The dried faecal samples were then pooled according to treatment groups for chemical analysis. The proximate composition, non-starch polysaccharides, minerals, and gross energy contents of both the feed and faecal samples were evaluated. Nutrient digestibility was calculated using the appropriate formula: Apparent digestibility = [(% Nutrients in feed × FI) – (% Nutrients in faeces × FO)] / (% Nutrients in feed × FI) × 100, where FI represents feed intake and FO represents faecal output.

Data generated from the study were subjected to a one-way analysis of variance at a 5% level of significance, and significant means were separated using Duncan's Multiple Range Test (DMRT) (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The growth response results for broiler chickens fed diets containing varying levels of enzyme-supplemented boiled *D. bulbifera* meal (Table 2) indicated that the average daily weight gain differed significantly ($p < 0.05$) among treatment groups. Chickens fed the T4 diet (40% AYM + 0.2% enzyme) achieved the highest average daily weight gain at 59.87 g/bird, while those on the control diet (T1) had the lowest gain at 48.03 g/bird. Additionally, the average daily weight gain of 54.26 g/bird for chickens fed diet T2 (maize + 0.2% enzyme) was

similar ($p > 0.05$) to the gains of 51.63 g/bird for T3 (20% AYM + 0.2% enzyme) and 56.42 g/bird for T5 (60% AYM + 0.2% enzyme).

The significant ($p < 0.05$) improvement in average daily weight gain among chickens fed enzyme-supplemented *D. bulbifera* meal compared to those on a maize-based diet without enzyme supplementation highlights the importance of dietary enzyme supplementation. The enzymes break down fibrous materials in boiled *D. bulbifera* meal, allowing the birds to absorb more nutrients from the feed, which are then deposited as body tissue. This study suggests that broiler chickens perform optimally when fed a diet with up to 40% enzyme-supplemented *D. bulbifera* meal. Goli and Shahryar (2015) also reported improvements in average body weight gain following dietary enzyme supplementation.

The Feed conversion ratio (FCR) also differed significantly ($p < 0.05$) among treatment groups, with broiler chickens on the T4 (40% AYM + 0.2% enzyme) diet exhibiting a superior FCR value of 3.36, while those on the T1 diet had the lowest FCR value of 4.12. Notably, no mortalities were recorded among the treatment groups throughout the feeding trial. The non-significant ($p > 0.05$) difference in average daily feed intake between chickens fed the control diet and those on enzyme-supplemented *D. bulbifera* diets suggests that the treatment diets did not contain substances that would adversely affect feed utilization. The dietary enzymes may have contributed to improved feed efficiency.

The superior FCR observed in broiler chickens fed an enzyme-supplemented *D. bulbifera* diet, particularly with the 40% replacement level, compared to those fed a control (maize) diet without enzyme supplementation indicates that the enzymes enhanced the effective utilization of the feed, converting it into body mass. Kalantar *et al*. (2015) found that supplementing wheat and barley diets with multi-enzymes significantly reduced ($p < 0.05$) the feed conversion ratio compared to diets without enzymes. Additionally, Attia *et al*. (2012) noted that multi-enzyme dietary applications increased growth by 10%, improved the FCR by 10.8%, and enhanced the production index and economic efficiency by 26.1% and 31.5%, respectively. Giacobbo *et al*. (2021) reported a 5% improvement in body weight and an 8% enhancement in FCR for broiler chickens fed enzyme-supplemented diets formulated with different corn hybrids dried at various temperatures. The absence of mortality in the treatment group confirms that the experimental diets did not adversely affect the broiler chickens.

Table 2: Growth responses of broiler chickens fed diets with varying levels of enzyme-supplemented *D. bulbifera* meal.

Parameter	Treatments					±SEM
	Control Maize T1	Maize + 0.2% Enzyme T2	20 AYM + 0.2% Enzyme T3	40AYM +0.2% Enzyme T4	60AYM + 0.2% Enzyme T5	
Initial weight (g/bird)	41.43	40.54	40.67	40.51	40.47	0.10
Final weight (g/bird)	2730.95	3079.36	2931.74	3393.25	3199.99	83.44
Total weight gain (g/bird)	2689.52^{b}	3038.82^{ab}	2891.07^{ab}	3352.74^{a}	3159.52^{ab}	83.50
Average daily weight gain (g/bird)	48.03^{b}	54.26^{ab}	51.63^{ab}	59.87^{a}	56.42^{ab}	1.49
Average daily feed intake (g/bird/day)	197.88	194.07	197.18	199.05	198.39	1.23
Feed conversion ratio	4.12^{a}	3.59^{b}	3.81^{ab}	3.36^{b}	3.52^{b}	0.09
Mortality	0.00	0.00	0.00	0.00	0.00	0.00

^{a,b,c} Means with different superscripts on the same row differ significantly ($p<0.05$)
±SEM= Standard Error of Means

The results of a study on nutrient digestibility in broiler chickens fed diets containing different levels of enzyme-supplemented boiled *D. bulbifera* meal are summarized in Table 3. The analysis showed that there was no significant difference ($p > 0.05$) between the control diet and the treatment diets in terms of the chickens' ability to digest non-starch polysaccharides (NSP) and protein. However, the digestibility of crude fat varied significantly ($p < 0.05$) among the treatment groups. The highest crude fat digestibility was observed in broiler chickens on the T5 diet (60% AYM + 0.2% enzyme), with a value of 98.92%. In contrast, the T1 diet had the lowest crude fat digestibility at 97.34%.

Notably, the crude fat digestibility for the T2 diet (maize + 0.2% enzyme) was similar to those recorded for the T3 (40% AYM + 0.2% enzyme) and T4 (60% AYM + 0.2% enzyme) diets, with values of 97.55%, 97.56%, and 97.63%, respectively. Furthermore, broiler chickens on the T4 diet demonstrated significantly higher crude fibre digestibility (86.72%) compared to those on the T1, T2, and T3 diets, which recorded 78.50%, 81.83%, and 86.50% digestibility, respectively. The crude fibre digestibility of 86.50% for chickens on the T3 diet was not significantly different ($p > 0.05$) from that of chickens on the T4 diet. The T5 group showed a crude fibre digestibility of 85.48%, which was comparable to the results for T2, T3, and T4. Energy utilization also differed significantly ($p < 0.05$) among the treatment groups, with the highest energy utilization of 98.32% found in broiler chickens on the T3 diet. The T5 diet had the lowest energy utilization, at 97.38 kcal/kg.

The results indicate that the application of enzymes allows for the replacement of maize with D. bulbifera at levels exceeding 20% in broiler chicken diets. According to Amerah (2016), using exogenous enzymes such as

amylase, xylanase, protease, and phytase enhances nutrient digestibility by facilitating better access of endogenous enzymes to cellular contents and hydrolyzing arabinoxylans in cell walls. Xylanases are particularly effective in broiler diets, as they reduce the anti-nutritional effects of NSP by decreasing digesta viscosity and breaking down arabinoxylans into lower molecular weight components. Lastly, Zhang et al. (2014) established that exogenous enzymes tend to increase both the ileal and total digestibility of crude protein and starch, which in turn improves the growth performance of broiler chickens.

Table 3 Nutrient digestibility of broiler chickens fed feeds with different levels of boiled *D. bulbifera* meal supplemented with enzyme.

Parameter (%)	Treatments					±SEM
	Control Maize T1	Maize + 0.2% enzyme T2	20 AYM + 0.2% enzyme T3	40AYM +0.2% enzyme T4	60AYM + 0.2% enzyme T5	
NSP	96.41	96.60	88.21	95.86	95.77	1.61
Calcium	71.05	72.85	81.68	74.15	69.50	1.84
Phosphorus	81.27^{b}	85.13^{ab}	89.96^{a}	82.47^{ab}	80.01^{b}	1.31
Sodium	81.75	83.04	84.52	84.14	82.34	0.51
Crude protein	97.07	97.57	97.33	97.63	98.72	0.24
Crude fat	97.34^{b}	97.55^{ab}	97.56^{ab}	97.63^{ab}	98.82^{a}	0.21
Crude fibre	78.50^{c}	81.83^{bc}	86.50^{a}	86.72^{a}	85.48^{ab}	0.99
Ash	87.92	88.89	89.30	89.47	87.69	0.31
Gross Energy (Kcal/kg)	97.46^{b}	97.72^{ab}	98.32^{a}	97.75^{ab}	97.38^{b}	0.11

^{a,b}= means with different superscripts on the same row differ significantly ($p<0.05$)
±SEM= Standard Error of Means

CONCLUSION AND RECOMMENDATIONS

The dietary supplementation of the multi-enzyme product Rozazyme 2G® significantly enhanced the utilization of boiled aerial yam meal. Furthermore, the inclusion of enzymes in broiler diets facilitated the replacement of maize with cooked aerial yam meal at a rate of 60% in the diets of broiler chickens.

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