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Growth Performance of Albino Rats Fed Graded Levels of Baobab (*Adansonia digitata*) Leaf Meal

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Authors' contributions

This work was carried out in collaboration between all authors. Author ARSS designed the study, wrote the protocol and wrote the first draft of the manuscript. Author AA managed the analyses of the study and the literature searches. Author JKL managed the collection and processing of the test materials and the experimental process. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aims: The study was conducted to determine the possible use of baobab leaf meal (BLM) as a feed ingredient in livestock feeding and its effects on growth performance of the animals.
Study Design: Completely Randomized Design (CRD) was used for the study.
Place and Duration of Study: Department of Ecological Agriculture, Bolgatanga Polytechnic, Bolgatanga. The experiment lasted for four weeks.
Methodology: Sixteen individually-housed albino weanling rats of about six weeks old were fed with four levels of BLM inclusion in the diet. The four levels of BLM in the diets were the control (0%), 10%, 15% and 20% for T0, T1, T2 and T3 respectively. Each treatment was replicated four times, with a rat representing a replicate. Feed and water were given ad-libitum and growth performance monitored during the four-week period. The data were analyzed using the General

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Analysis of Variance. Least significant difference was also used to separate treatment means at 5%.

Results: The results showed significant differences (*P*=.05) between levels of BLM in diet on rats weight gain, feed intake and feed conversion efficiency. The rats fed on the control (T0) diet significantly (*P*=.05) grew better, compared to those fed with BLM-based diets (T1, T2 and T3). The values for mean weight gain were 59.7, 42.3, 33.3 and 33.3 g for T0, T1, T2 and T3 respectively. In respect to feed intake, the mean total feed intake values were 399.0, 314.0, 327.0, and 313.0 g with corresponding mean daily feed intake of 14.24, 11.21, 11.69 and 11.19 g for T0, T1, T2 and T3 respectively. The mean feed conversion efficiency was better compared to test diets (T1-T3). For the carcass parameters, the mean weights of viscera, respiratory tract, full stomach, heart, kidney, spleen, liver and full gastrointestinal tract were not influenced (*P* = .05) by the dietary treatments.

Conclusion: The inclusion of baobab leaf meal in rat diet could negatively affect their growth performance, especially with regard to their weight gain. In places where other plant-based feed sources are scarce, very low inclusion rates of not more than 10% of BLM in diets may be considered, provided animal weight gain is not the primary objective of the farmer.

Keywords: Growth performance; albino rats; Adansonia digitata; baobab leaf meal.

1. INTRODUCTION

Nutrition has been recognized as a major constraint to livestock production in Ghana and elsewhere [1,2]. Research has shown that feed cost accounts for 70-80% of total production cost [3] and protein is likely to be the first limiting factor in poultry diets at the level of small scale farmers. The feed cost in Ghana, just as any other developing countries of the world, is quite expensive, and is often beyond the reach of ordinary farmer. There is the need for research to determine the suitability of utilizing locally available feed resources, particularly leaves from multi-purpose trees to replace some of these expensive feed ingredients while increasing the protein content of the diet. It is a common practice by small holder farmers in the Upper East Region of Ghana to offer small amounts of green feed to their animals to reduce cost while protecting them against possible vitamin and protein deficiencies.

The multi-purpose tree, the baobab (*Adansonia digitata*), is a perennial tree plant species well adapted to the tropical climate, and widely distributed in the hot savannah regions of Sub-Saharan. Every part of the baobab tree is useful for either food, fodder, medicine or shelter [4]. The leaves of baobab tree are staple food for many populations in Africa, the tender leaves are harvested and eaten fresh and also dried for domestic use. They are used in the preparation of soup commonly called “tukara” in Mamprulli (Northern Ghana), “kuka” in Hausa and “luru” in Yoruba (Nigeria). The baobab leaves crude protein content vary from 13-18% in dry matter [5,6,7] and contain reasonable amounts of minerals especially magnesium and manganese [8]. The leaves also have high iron content compared to numerous other wild-gathered foods, and are rich sources of calcium, zinc and phosphorus [9].

In spite of the above nutritional value of the baobab leaves, there is a dearth of information on the possible use of BLM in livestock feeding and its effects on growth performance of the animals in Ghana. Therefore, this study is aimed at determining the effects of inclusion of BLM on growth performance of albino rats.

2. MATERIALS AND METHODS

2.1 Location and Duration of the Study

The study was conducted at the Department of Ecological Agriculture of the Bolgatanga Polytechnic in Ghana. The experiment was a feeding trial for a period of four (4) weeks.

2.2 Baobab Leaves Collection and Processing

The fresh green tender baobab leaves were harvested from readily available trees within Sumbrungu community in the Bolgatanga Municipality of the Upper East Region of Ghana. The leaves were shade dried for two weeks, and further processed by pounding using pestle and mortar, into fine baobab leaf meal (BLM).

2.3 Experimental Rats and Design

Sixteen male rats of an average age of six weeks were obtained from the SAS Farms Ltd in Nalerigu, Ghana, for the experiment. The rats were caged and completely Randomized in 4 replicates per treatment. The rats were randomly allotted to four experimental diets containing BLM of 0% (control), 10%, 15%, and 20% as replacement of maize. This BLM based diets which respectively constitute treatments 0 (control), 1, 2, and 3, were compounded with the addition of other ingredients as shown in Table 1.

2.4 Housing and Feeding

The rats were individually housed in transparent plastic containers measuring 30 x 19x 16 cm. The plastic containers had covers made of welded mesh to enhance ventilation. Empty tomato paste tins were fitted to the corners of the cages to serve as feed troughs and drinkers. The rats had free access to feed and water throughout the experimental period.

2.5 Parameters Measured

In the course of the experiment, weekly feed intake and weekly weight gains were recorded and corresponding average daily feed intake, average daily weight gain and feed conversion efficiency were calculated. At the end of the experiment, the rats were chloroformed for 5 minutes, dissected and the viscera removed and weighed with an electronic scale. The liver, spleen, kidneys, stomach, respiratory tract and full gastro-intestinal tract (GIT) were also individually weighed after separation.

2.6 Chemical and Statistical Analyses

The proximate compositions of the four diets and the baobab leaves were determined using procedures outlined by [10]. All data collected were subjected to analysis of variance using GenStat (Discovery Edition 4) and means were separated by least significant difference (LSD) at 5%.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Dried Baobab Leaf Meal

The results of the proximate composition are shown in Table 2. The protein content of 18.47% recorded for baobab leaf meal (BLM) in this present study is higher than those reported by other studies [5,7,11,12,13] but similar to the value reported by [14] for dried moringa leaves. The ether extract value of 7.69% is also higher than those reported by earlier researchers [5,7,11,12,13] but in agreement with the value of 7.22% reported for moringa leaves [14].

Table 1. Percentage composition of the experimental diets

Ingredient	Dietary treatments			
	$T_0$0%	**$T_1$10%**	**$T_2$15%**	**$T_3$20%**
Maize	60	50	45	40
Baobab leaf meal (BLM)	-	10	15	20
Fishmeal	10	10	10	10
Soyabean meal	15	15	15	15
Rice bran	13.5	13.5	13.5	13.5
Oyster shell	0.5	0.5	0.5	0.5
Common salt	0.50	0.50	0.50	0.50
Vitamin-traced mineral premix**	0.50	0.50	0.50	0.50
Total	100	100	100	100
Analyzed composition				
Crude protein	13.3	17.83	19.77	19.83
Ether extract	7.00	7.33	9.33	7.00
Crude fibre	2.05	4.66	5.18	5.51
Moisture	10.50	11.17	12.50	12.00
Ash Content	16.50	8.17	8.67	10.17
Dry Matter	89.50	88.83	87.50	88.00

***Vitamin Trace Mineral Premix: Inclusion rate is 2.5 g/kg to supply Vit. A = 8000 IU, Vit. D = 500 IU, Vit. E = 2.5 mg, Vit. K3 = 1mg, Vit. B2 = 2 mg, Vit. B12 = 0.005 mg, Folic Acid = 0.5 mg, Nicotinic Acid = 8 mg, Calcium Panthotenate = 2 mg, Choline Chloride = 50 mg, Manganese = 50 mg, Zinc = 4 mg, Copper = 4.5 mg, Cobalt = 0.1 mg, Iodine = 1 mg, Selenium = 0.1 mg*

The crude fibre (CF) content is inconsistent with the earlier reports [13], who recorded lower values averaging 2.10% and 2.45% respectively. The CF reported herein is lower than those of [5,11,12]. The average ash content of the BLM was 6.50%. The results are higher than other reports [13] for fresh baobab leaves. The ash content was lower than those in some reports for baobab leaves [7,12] and for moringa leaves [14]. The moderate ash content of the BLM may be good source of minerals for farm animals.

The results of nitrogen free extract (NFE) in this present study are at the same levels as in other reports [5,7]. The NFE was lower than that of [11] reported for baobab leaves. The dry matter content reported in this work is higher than those in other reports [11].

In fact, the discrepancies in reported values could be explained by the analytical method used [13] species, maturity state of the plant, genetic variances [7,13] soil and climatic conditions [7,11,13] and seasonal variations [6].

Table 2. Proximate composition of dried baobab leaf meal (BLM)

Parameter	Percentage (%)
Crude protein	18.47
Ether extract	7.67
Crude fibre	7.69
Ash content	6.50
Nitrogen free extract	59.67
Moisture	12.67
Dry matter	87.33

Values are means of triplicate determinations

3.2 Growth Performance

The growth performance of the rats in terms of weight gain, average daily weight gain, feed intake and average daily feed intake is presented in Table 3.

The initial weights of the rats on average ranged between 94-94.7 g with T0 and T1 recording the highest. The mean final weights were 154.3, 137.0, 127.3 and 124.7 g with corresponding mean weight gains of 59.7, 42.3, 33.3 and 33.3 g for the T0, T1, T2 and T3 diets respectively (Table 3). There were significant differences (*P*=.05) in mean values of measured parameters across treatments. It was observed that the mean values of T0 diet were higher than the other diets. The relatively low weight gain in the other diets compared to the control may due to poor utilization of the nutrients by the rats. It is also worth noting that as the level of BLM increased in the diet, there was corresponding decrease in weight gain in the rats. This is in agreement with [15] in their determination of nutritive value of tropical biomass products as dietary ingredients for monogastrics using rats as model animals. They indicated that, when the inclusion level was increased from 25% to 50%, there was corresponding decrease in weight gains of the rats in all the plant species under investigation. Similarly, [16] reported that at lower level of inclusions (0.15 and 0.30%) there were improvements in weight gain in rabbits but decrease when 0.45% of *Moringa oleifera* leaf meal (MOLM) was added. The decrease in rats' body weight with increase in level of inclusion of BLM could be attributed to decrease in feed intake, high crude fibre content in the test diets (T1-T3) and the possibly inherent anti-nutritional factors (protease inhibitors, tannins, phytates and gums) which are present in baobab leaves [17].

These tannins are known to reduce the availability of proteins, carbohydrates and minerals by forming indigestible complexes with the nutrients [18], thereby reducing intestinal absorption of nutrients, suppressing growth, decreased animal food intake, final weight gain and reproductive performance [19, 20].

Contrary to the above, [21] reported increased body weight gains of 954.98, 1274.52, 1373.34 and 1107.46 g of broilers fed with MOLM on inclusion levels of 0, 1, 2 and 3% respectively. The improvement observed may be due to the low levels of inclusion of the MOLM and enhanced protein quality in the diets. In other studies on rabbits by [22] with inclusion of 5% *Icacina oliviformis* leaves and broilers by [23] with the inclusion of 5% *Leucaena leucocephala* leaf meal, there were no adverse effect on the growth performance of the experimental animals. They concluded that feeding at 5% inclusion level improved feed intake, digestibility and weight gains.

The mean daily weight gains were significantly (*P*=.05) different. The values were 2.13, 1.51, 1.19 and 1.19 g for the T0, T1, T2 and T3 diets respectively. The T0 diet recorded the highest mean daily weight gain than the other diets (Table 3). The T2 and T3 diets recorded the lowest values. The decrease mean daily weight gain as the level of inclusion of baobab leaf increased in the experimental diets is consistent with the findings of [24]. They reported similar decreasing trend in weight of broilers when fed with raw baobab seed meal, but added that, the weight decrease was more severe in broiler group fed 20% level of raw baobab seed. [25] also reported that, rabbits fed diets containing 0, 5, 10 and 15% MOLM showed sharp decrease of average daily gain with increasing MOLM replacement level. Similar trends were reported in juveniles of *Clarias gariepinus* fed baobab seed meal as a protein source [26]. [22,23,27] concluded that the poor performance of the experimental animals may be attributed to high fibre and the presence of anti-nutritional factors in the test diets resulting in low dry matter digestibility and therefore affect weight gain.

The mean total feed intake values ranged from 313-399 g, with the higher values occurring in T0 and T2 and these trends in treatments were similar to daily feed intake (Table 3). Even though, there were no significant (P=.05) differences among treatment means, it was noticed that feed intake decreased with increasing BLM. These results are in accordance with the findings of [23,24] who also reported inverse relationship between feed intake and increasing levels of leaf/seed meal in diets. However, [22,28] reported improved feed intake with increasing test material. So, the type of plant, level of inclusion and animals used could be accounted for the observed differences.

The mean feed conversion efficiency (FCE) was significantly different (P=.05) among treatments, with T2 recording the highest value of 9.81 followed by T3 (9.58) (Table 3). The T0 diet had a better FCE probably due to the absence of the BLM. These results compare favourably with [21-24). Increasing the level of inclusion of BLM means increase in the concentration of fibre and other anti-nutritional factors in the diet and this could impair digestibility of the diet.

3.3 Carcass Characteristics

The carcass parameters under consideration were the viscera, respiratory tract, full stomach, heart, kidney, spleen, liver, intestine weights. These are target organs of toxins when ingested especially the liver and kidney. The mean weights of all the organs investigated were not influenced (P=.05) by the dietary treatments (Table 3). This is in agreement with the report of [29]. They reported similar findings when maize was replaced with false yam seed meal at the inclusion rate of 15% for albino rats.

Table 3. Growth performance of rats on treatment diets

Parameter measured	**Dietary treatments**				**LSD**	**Sign.**
	T0	**T1**	**T2**	**T3**		
Mean Initial weight, g	94.7	94.7	94.0	94.0	22.35	NS
Mean Final weight, g	154.3	137.0	127.3	124.7	23.19	NS
Mean Weight gain, g	59.7^a	42.3^b	33.3^b	33.3^b	15.24	*
Mean daily gain, g	2.13^a	1.51^b	1.19^b	1.19^b	0.5508	*
Mean Total feed intake, g	399.0	314.0	327.0	313.0	72.00	NS
Mean daily feed intake,g	14.24	11.21	11.69	11.19	2.571	NS
Mean Feed conversion efficiency	6.89^a	7.42^a	9.81^b	9.58^b	1.982	*
Carcass characteristics						
Mean Viscera, g	17.00	17.67	17.00	15.67	2.927	NS
Mean Respiratory tract, g	1.497	1.297	1.333	1.423	0.3967	NS
Mean Full stomach, g	1.460	1.197	1.353	1.143	0.5422	NS
Mean Heart weight, g	0.463	0.373	0.380	0.370	0.1269	NS
Mean Kidney weight, g	1.133	0.860	0.887	0.977	0.2361	NS
Mean Spleen weight, g	0.777	0.630	0.473	0.507	0.3212	NS
Mean Liver weight, g	3.67	4.00	4.00	3.67	1.803	NS
Mean full GIT, g	7.33	9.00	9.00	9.00	3.564	NS

*Sign= Level of significance, NS= Not significant, *= Significant, ^{a,b} values in the same row with different letters are significantly different (P=.05)*

4. CONCLUSION

The inclusion of BLM in the diet of rats had negative effect on weight gain, feed intake and feed conversion efficiency (T1-T3) but not on carcass characteristics because no observable disease condition was noticed during visual examination. These are the key measurable parameters for determining the ability of an animal species to effectively maximized output from moderate levels of feed inclusions. Therefore, the inclusion of BLM based diets may not improve growth and carcass weight of animals and it may only be useful if the primary aim of production is not to increase animal weight for enhanced market value. Even where other feed sources are scarce, very low to moderate inclusion rates of BLM in diets could be considered, but may need careful monitoring of animal performance, especially if weight gain is the primary goal of the farmer.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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