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Research Article

PERFORMANCE, DIGESTIBILITY, CARCASS AND BLOOD PROFILE OF GROWER RABBITS FED BAOBAB (*ADANSONIA DIGITATA*) PULP AND SEED MEAL

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ABSTRACT
An eight week study was conducted to evaluate the effects of inclusion of baobab (*Adansonia digitata*) pulp and seed meal (BPSM) in the diets of weaner rabbits. One hundred mixed sex crossbred (Chincilla× New Zealand White) rabbits average 852±4g were divided into four groups of 25 rabbits each on equal weight basis and the groups randomly allotted to four diets that contained either 0% or 5% or 10% or 15% BPSM in a completely randomized design. Data were collected on performance, production cost, digestibility, carcass and blood composition. Data were analyzed by one-way analysis of variance. Results revealed that weight gain, feed intake, feed conversion ratio, mortality, nutrient digestibility, carcass, visceral organ weights, haemoglobin concentration, white blood cell, mean cell haemoglobin concentration and blood serum composition were not affected by inclusion of BPSM in the diets. Packed cell volume and Red blood cell were higher in the rabbits fed 10% and 15% BPSM. Feed cost and feed cost per kilogram weight gain reduced with increase BPSM in the diets. It was concluded that BPSM can be included up to 15% in the diets of grower rabbits without compromising the growth, health status and also to reduce production cost.

Keywords: *Carcass characteristics; digestibility; Feed intake; Feed conversion ratio; haematology; Serum chemistry; Weight gain*

INTRODUCTION
The high cost of animal products that is being witnessed in Nigeria and most African countries can be attributed to high cost of livestock feed which generally accounts for 60 – 70 percent of the total cost of production (Lawrence *et al.,* 2008). This is because the conventional feeds that are used to supply energy and protein such as maize, soybean meal and groundnut cake are becoming more expensive due to competition between man and livestock animals.

Although rabbits can subsist on forage, the present day breed of rabbits cannot attain their full genetic potential on sole forage diet. The use of concentrate feed for rabbit and the rapid increase in rabbit production in the last one decade is already creating feed/food crisis that is being witnessed in poultry and swine production. This calls for the use of less utilized but readily available unconventional feed resources such as forestry trees that abound in most African countries. Baobab (*Adansonia digitata*) tree is a deciduous, drought and fire tolerant tree that is widely distributed in most African countries. The tree is massive and may be up to 20-30 meter high with a lifespan of several hundred years (Heuze *et al.*, 2013). Baobab tree begins to bear fruit at the age of 8 years and can produce for 30 years.

It has been reported that baobab seed meal is rich in nutrients with protein content of 12.7-37.6%, energy content of 22.2MJ/KgDM and 16.5-26.5% crude fibre. The protein content of the fruit pulp was reported to be 11.2%, 19.9MJ/KgDM gross energy and 26.4% crude fibre). Anti-nutritional factors that have been detected in baobab seed meal include oxalate (10%), Phytate (2%), and saponin (3-7%), trypsin inhibitors (Osman, 2004; Belewu, 2008), amylase inhibitors and tannin (Igboeli *et al.*, 1997; Osman 2004).

A lot of studies have been carried out on the use of baobab oil seed meal as feed for different species of animals with various degree of success. While it was reported that guinea fowl keets were able to tolerate 5% (Mwale *et al.*, 2008), broiler chicken was reported to show consistent growth depression at all levels of inclusion (Anjos, 2005; Chimvuramahwe *et al.*, 2011). However, information on the use of baobab

pulp and seed meal in livestock feed is scanty most especially for rabbit. The present study was therefore conducted to bridge this gap.

MATERIALS AND METHODS

Experimental Site

The study was conducted at the rabbitary unit of the Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. The study site fall within latitudes $8^0$07'N and $8^0$12'N and longitudes $4^0$04'E and $4^0$15'E. The mean annual rainfall is 1247mm with relative humidity of between 75 and 95%. The location is situated at about 500m above the sea level with a mean annual temperature of 26.2^0C.

Collection and Processing of the Test Ingredient

Baobab fruits used for this study were harvested from baobab trees around Ayete town in Ibarapa Local Government area of Oyo State, Nigeria. The fruits were harvested at mature stage which was indicated by the hard brown colour of the ectoderm. The hard leathery cover was scraped off with the knife and the seeds and pulp dried on concrete slab for 5 days to attain the moisture content of about 12%. The dried product was milled using hammer mill to obtain what was called Baobab Pulp and Seed Meal (BPSM).

Preparation of Experimental Diets

Four experimental rabbit diets were formulated. Diet 1 which served as the control contained no baobab pulp and seed meal, diets 2, 3, and 4 contained 5%, 10% and 15% baobab pulp and seed meal respectively. The diets were balanced as much as possible for crude protein and energy. The gross composition of the diets is shown in Table 1.

Table 1: Gross composition of experimental diets

Level of baobab pulp and seed meal (%)				
Ingredient (%)	0 (diet 1)	5% (diet 2)	10% (diet 3)	15% (diet 3)
Corn	10.0	9.0	9.0	8.0
Corn bran	18.0	17.0	16.0	14.0
Wheat offal	28.0	26.0	26.0	26.00
Palm kernel cake	23.8	23.8	22.3	22.3
Soy bean meal	3.0	2.0	2.0	1.0
BPSM	0.0	5.0	100-	15.0
Blood meal	2.0	2.0	2.0	2.0
Rice bran	12.0	12.0	9.5	8.5
Common salt	0.2	0.2	0.2	0.2
Oyster shell	3.0	3.0	3.0	3.00
Total	100	100	100	100
Crude protein (%)	16.0	15.93	15.90	15.85
Crude fibre (%)	10.2	10.72	11.13	11.51
[1]Digestible energy	2261.75	2256.1	2246.1	2216

[1] *Calculated value*

Animals and Management

One hundred crossbred (Chincilla×California White) mixed sex weaner rabbits average 852±4g were used for the study. The rabbits were purchased from a commercial rabbit breeder in Osogbo, Osun State, Nigeria. The rabbits were immediately treated for ecto-and endo-parasites, housed individually in rabbit hutches measuring 60×50×45cm and allowed to acclimatized for 3 weeks during which they received commercial rabbit pellets and have access to water *ad libitum*.

At the beginning of the experiment, the rabbits were divided into four equal groups of 25 rabbits with the groups balanced for weight. Each of the group was randomly assigned to any of the four diets in a completely randomized design (CRD). Each rabbit which constituted a replicate was housed individually

in a hutch and have unrestricted access to feed and water throughout the duration of the study. Feeds and water were supplied using heavy clay containers with flat bottom to avoid tip over and wastage of feed and spillage of water. The study lasted for eight weeks.

Data collection

Feed intake: A known quantity of feed was supplied in the morning and left-over weighed the following morning. The actual feed intake was then determined as the difference between the two weights.

Feed Intake = Feed supplied- Feed rejected

Weight gain: The rabbits were weighed individually at the beginning of the experiment using weighing scale and thereafter weekly to monitor the growth of the animals. Weight gain was then calculated as the difference in weight in two successive weeks.

Weight gain = Weight in the present week – Weight in the previous week

Feed: gain ratio: This was calculated from the data collected on feed intake and weight gain. It was determined as the feed consumed per unit body weight gain

Feed: gain ratio = Feed intake/Weight gain

Mortality: This was determined from the record of mortality collected from the beginning of the experiment to the end. The number of animals that died in each treatment was expressed as the percentage of the total animals in each treatment at the beginning of the study.

Economic analysis: Feed cost was calculated from the cost per kilogram of various ingredients used in feed preparation. Cost of baobab pulp and seed meal was determined from the cost of harvesting, transportation and processing. Records of cost of feed and feed: gain ratio was used to determine feed cost per kilogram weight gain.

Digestibility trial: Digestibility study was conducted to evaluate the effects of inclusion of baobab pulp and seed meal in the diets on the digestibility. The study that was conducted during the last week of the experiment involved the use of ten rabbits from each treatment. The hutches were fixed with collection tray underneath. Feed intake was measured daily using total collection method for the five days duration of the trial. The faeces collected from each replicate each day was oven-dried at 65^0C for 24 hours. Faeces from each replicate was bulk, milled and samples analyzed. The results obtained were then used for the calculation of nutrient digestibility.

Carcass Analysis: Ten (10) rabbits that had their weights close to the mean for their treatments were selected for carcass evaluation. The rabbits were fasted for 24 hours, weighed using electronic weighing balance, stunned and bled. The carcass were skinned, dressed and weighed. The visceral organs (kidneys, liver, heart, spleen and lung) of the animals were carefully excised, cleaned of the blood and weighed. The weights of the carcass and the organs were then expressed as the percentage of the live weight.

Blood Collection and Analytical Methods

Blood collection: Blood was collected from each rabbit into two vacutainer bottles through the ear vein with the aid of needle and syringe. One of the bottles contained ethylene diamine tetra acetic acid (EDTA) while the other bottle was plain without anti-coagulant. Blood collected into plain bottles were covered and centrifuged at 3000rpm for 10 minutes and the serum decanted and stored at -20^0C in the freezer for serum biochemical analysis.

Analysis of haematology and biochemical parameters: Packed cell (PCV) was determined using micro-haematocrit capillary tube method as described by Jain (1986). Haemoglobin concentration (Hb) was determined by a cyanmethaemoglobin concentration method using Drabkins solution as diluents (Jain, 1986). Red blood cells (RBC) were estimated using haemocytometer method as described by Jain (1986). White blood cells were determined using Neubauer haemocytometer after appropriate dilution. Mean cell haemoglobin concentration (MCHC) was calculated according to the formula of Jain (1986).

Serum alanine aminotransferase (ALT) and aspartate amino transferase (AST) activities were determined using spectrophotometric methods as described by Rej and Hoder (1983). Total protein was determined using biuret method as described by Kohn and Allen (1995). Serum albumin was determined using bromocresol green method as described by Peter *et al.*, (1982). Glucose and creatinine were measured spectrophotometrically following the procedure defined in the commercial test kits (Biolabo, France).

Analysis of feeds and faeces: Feeds, faeces and baobab pulp and seed meal were subjected to proximate analysis using the methods of AOAC (1990). Gross energy of the baobab pulp and seed meal was carried out using adiabatic bomb calorimeter.

Statistical analysis: Data generated were analyzed by one-way analysis of variance using SAS (1998) software package. Significance was determined at P<0.05) and where significance were indicated, Duncan's option of the same package was used to separate the means.

RESULTS AND DISCUSSION

The chemical composition of BPSM used in this study is shown in Table 2.

Table 2: Chemical composition of baobab pulp and seed meal

Component	% (Dry matter basis)
Dry matter	89.30
Crude protein	11.7
Crude fibre	20.52
Ether extract	9.67
Ash	6.03
NFE	52.08
[1]Gross energy	4332

NFE=Nitrogen free extract; [1]Kilocal/Kg

The content of crude protein, crude fibre, ether extract, ash and nitrogen free extract were 11.7%, 20.52%, 9.67%, 6.03% and 52.08% respectively. The gross energy was 4332Kcal/kg.

The performance and economy of feeding BPSM to grower rabbits is shown in Table 3.

Table 3: Performance and economic implication of feeding baobab pulp and seed meal to grower rabbits

Level of baobab pulp and seed meal (%)					
Parameter	0 (diet 1)	5 (diet 2)	10 (diet 3)	15 (diet 4)	SEM
Initial wt (g)	850	853	852	855	-
Final wt(g)	1759.9	1766.5	1793.2	1798.6	40.0
Total weight gain (g)	909.9	913.5	941.2	943.6	40.0
A D G (g)	16.24	16.31	16.81	16.85	1.5
Feed intake (g)	97.3	98.2	100	101	12
FCR	5.99	6.02	5.94	5.98	0.6
Mortality (%)	5.0	5.0	5.0	5.0	0.7
Feed cost (N/Kg)	85.3^{a}	82.1^{b}	81.1^{c}	76.0^{d}	0.5
Cost/kg wt gain (N)	510^{a}	494^{b}	482^{c}	454^{d}	4.5

abcd: Means bearing different superscripts along the same row are significantly different (P<0.05); N = Nigerian Naira; ADG= average daily gain; FCR= Feed conversion ratio; Wt = Weight.

No significant effect of diets was observed in the final weight, total weight gain, average daily gain, feed intake, feed conversion ratio and mortality of the rabbits. Feed cost and feed cost per kilogram weight gain decreased linearly with increase level of BPSM in the diets.

Table 4 shows the nutrient digestibility of the rabbits fed diets that contained various levels of BPSM.

Table 4: Nutrient digestibility by rabbits fed baobab pulp and seed meal

Level of baobab pulp and seed meal (%) Parameter	0 (diet1)	5 (diet2)	10 (diet3)	15 (diet4)	SEM
Dry matter (%)	78.56	78.51	78.62	78.96	1.2NS
Crude protein (%)	73.84	73.68	73.90	73.98	1.1NS
Crude fibre (%)	55.73	55.34	56.12	56.21	2.8NS
Ether extract (%)	78.55	78.67	79.02	79.31	3.0NS
N F E (%)	81.45	81.63	82.43	82.66	3.0NS

NS= Not significant (P>0.05); NFE= Nitrogen free extract

Inclusion of BPSM in the diets had no significant effect on the digestibility of all the nutrients considered in this study.
The carcass and internal organ weights of the rabbits fed tested diets is shown in Table 5.

Table 5: Carcass and internal organ weights of rabbits fed baobab pulp and seed meal

Level of baobab pulp and seed meal (%) Parameter	0 (diet1)	5 (diet2)	10 (diet3)	15 (diet4)	SEM
Live wt (Kg)	1.73	1.70	1.77	1.78	0.2NS
Dressed weight (g)	975.6	984.7	991.9	998.8	30NS
Carcass yield (% live wt)	56.4	57.9	56.0	56.1	2.3NS
Kidneys (% live wt)	0.45	0.44	0.43	0.42	0.1NS
Liver (% live wt)	2.72	2.75	2.73	2.74	0.5NS
Heart (% live wt)	0.27	0.28	0.26	0.27	0.1NS
Spleen (% live wt)	0.71	0.70	0.71	0.69	0.69NS
Lung (% live wt)	0.54	0.56	0.53	0.57	0.08NS

NS= Not significant (P>0.05); Wt=weight

No significant effect of diets was observed in the live weight, dressed weight and carcass yield. The weights of visceral organs were also not affected by dietary treatments.
The haematological and blood serum biochemical indices of the rabbits fed BPSM are shown in Table 6.

Table 6: Haematological and blood serum biochemical indices of rabbits fed baobab pulp and seed meal

Level of baobab pulp and seed meal (%) Parameter	0 (diet 1)	5 (diet 2)	10 (diet 3)	15 (diet 4)	SEM
PCV (%)	55.6^{b}	56.4^{b}	58.6^{a}	58.8^{a}	1.1
RBC (%)	45.5^{b}	46.3^{b}	51.5^{a}	51.9^{a}	2.0
Hb (g/L)	130.4	131.2	132.8	132.6	3.5
WBC ($\times 10^3$/L)	10.2	10.1	11.3	11.5	2.2
MCHC (g/L)	321.8	323.2	322.3	321.7	3.8
Total protein (g/L)	68.2	68.9	69.1	68.7	3.0
Albumin (g/L)	31.2	31.5	33.3	32.9	4.0
Glucose (mmol/L)	6.2	6.4	6.3	6.1	1.5
Serum creatinine (mmol/L)	0.09	0.08	0.10	0.09	0.03
ALT (U/L)	7.5	7.4	7.1	7.0	0.8
AST (U/L)	10.5	10.6	10.4	10.3	0.9

ab: Means bearing different superscript along the same row are significantly different (P<0.05)

The PCV and RBC values of the rabbits that received diets that contained 10% and 15% BPSM were higher ($P<0.05$) than those fed 5% and control diet. No significant effect of diets was observed in Hb, WBC and MCHC. Dietary treatments also had no effect on serum composition as the values obtained for total protein, albumin, glucose, serum creatinine, ALT, and AST were not significantly different across the treatments.

Discussion

The crude protein content of the BPSM used in this study (11.7%) was slightly higher but comparable to the average value (11.2%) reported by Heuze *et al*., (2013), the crude fibre content obtained (20.52%) was however lower than the value reported by the same author.

This study revealed that the rabbits that received diets that contained BPSM performed as well as those that received no BPSM in their diets. This is an indication that growing rabbits can tolerate up to 15% BPSM in their diets. The present study however contradicts the findings of Anene *et al.*, (2012) who reported that weight gained by juvenile *Clarias gariepinus* decreased with increased level of baobab seed meal in replacement for soybean meal in their diet and also that of Mwale *et al.,* (2008) who observed a decrease in the weight gain of guinea fowl keets at 10% and 15% inclusion level of baobab seed meal. Also, Chimvuramahwe *et al*., (2011) also reported that feeds that contained 5%, 10% and 15% seed meal depressed the growth of broiler chickens. The difference could be due to the fact that the present study used the pulp and seed meal with higher carbohydrate and vitamin C (Sidibe *et al.,* 1996) which could have diluted the effect of anti-nutrients in BPSM. It could also be due to difference in the species of animal used.The results reported here however agrees with that of Ezeagu (2005) who also observed that raw baobab seed protein supported the same growth rate as casein in the diet of albino rabbits.

In this study, the feed intake of the rabbits that received diets that contained BPSM and control diet were similar. This agree with the findings of Ezeagu (2005) who also observed no difference in the feed consumed by albino rats fed raw baobab seed protein and those fed casein.

It was revealed that feed conversion and nutrient digestibility by the rabbits that received diets that contained BPSM and the control diets were similar and also that visceral organs were not altered by inclusion of BPSM in the diets. This suggests that the anti-nutritional factors contained in BPSM did not interfere with digestion nor alter the organs. Nkafamiya *et al.,* (2007) earlier reported that baobab seed meal contained anti-nutritional factors such as oxalate, phytate, saponins and tannins but their levels are generally assumed to be below the established toxic levels for most poultry species.

The higher PCV and RBC that were observed at 10% and 15% inclusion level of BPSM could be due to the fact that the pulp is rich in vitamin C (Sidibe *et al.,* 1996) and also have anti-oxidant property which may favour red blood cell formation. The values however fall within the normal range (Ozkan *et al.*, 2012).

It was also revealed that the Hb, WBC, MCHC, serum total protein, albumin, glucose, creatinin, ALT and AST values were not affected by inclusion of BPSM in the diets. The values obtained for these parameters were within the normal range reported by Ozkan *et al.*, (2012).

Conclusion

This study revealed that growing rabbits can tolerate up to 15% BPSM in their diets without adverse effect on growth, digestibility, carcass and blood composition. Feed cost and production cost reduced with increase level of BPSM inclusion in the diets.

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