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Dietary inclusion of blanched African bread fruit (*Treculia africana*) pulp on the growth performance, haematological indices and nutrient digestibility in Weaner rabbits

C. M. Ugwu*, A. O. Ani, M. C. Ogwuegbu, N. W. Anizoba, C. Ezenwosu, E. A. Onu, C. C. Nwoga and L. C. Ali
Animal Science Department, Faculty of Agricultural Sciences, University of Nigeria, Nsukka, 410001, Enugu State, Nigeria
Corresponding E-mail : chekwube.ugwu@unn.edu.ng

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ABSTRACT

Current study examined the impact of blanched African bread fruit pulp (BABP) on growth performance, haematology and nutrient digestibility of Weaner rabbits. A total of 200 60-day-old New Zealand White Weaner rabbits with an average weight of 759.5 g were randomly assigned to five groups and fed 0% (control), 5, 10, 15 and 20 % blanched African bread fruit pulp in a completely randomized design. The trial lasted for 7 d of adaptation and 56 d for testing. Growth performance was recorded from 60 to 116 d of age (n=5 per treatment with 40 rabbits, 10 per replicate), haematological indices at 116 d of age and nutrient digestibility from 112 to 116 d of age were determined (n=5 per treatment with 16 rabbits, 4 per replicate). Results showed that dietary BABP supplementation at 15, and 20% decreased ($P < 0.05$) the feed intake and body weight gain. The digestibility of crude protein, crude fiber, and ether extract were also decreased ($P < 0.05$). Moreover, rabbit at 15, and 20% showed decreased ($P < 0.05$) packed cell volume, white blood cell and haemoglobin concentration. It was concluded that BABP can be incorporated into rabbit diets up to 5-10% inclusion level, without negatively affecting growth performance, haematological indices and nutrient digestibility of rabbits.
Keywords: *Blanched African breadfruit, Blood profile, Nutrient, Rabbits*

INTRODUCTION

In recent times, there has been a consistent decline in the animal protein intake of most citizens of developing countries especially those of Sub-Saharan Africa. In Nigeria, for instance, only 8.6 g of animal protein is consumed compared to the 35 g animal protein per person per day as recommended by Food and Agriculture Organization (FAO, 2014). The level of animal protein consumption was reported as being directly linked to the general wellbeing and health of the population. These individuals are at risk of several deficiency syndromes, as a lot of carbohydrates and fibres are taken daily, with little or no protein intake to balance the diet. The lack of protein in Nigeria is a severe issue with grave consequences. The Nigerian Protein Deficiency Report 2020 highlights the levels, feeding patterns, and barriers to protein intake and a number of Nigerians have financial, social, and health effects. Nigerians consume less protein than the global average. It makes the nation's nutritional crisis worse. Studies demonstrate the need for comprehensive strategies to address protein deficiency in Nigeria considering societal factors like poverty and inequality (Ubesie and Ibeziakor, 2012). Meeting the animal protein intake of the teeming population from developing countries should be a constant concern for animal scientists from the region. One of the measures to solving this problem is to improve the production of livestock species that have the potential for rapid growth and short generation interval. Rabbits are good at utilizing and converting non-conventional feed resources, especially forages, to meat. These non-conventional feed resources are abundant and could be easily accessed at no cost in these regions. Their growth rate is high and comparable only to that of broiler chickens, apart from the fact that the meat is relatively cheaper and comparatively lower in cholesterol than meats from other animals such as pork, beef, mutton and chevron, which are also more expensive (Olarotimi *et al.,* 2015). The ability of rabbits to convert forages and agro-byproducts into meat more efficiently than ruminants is of great importance in the tropics where both high human population and food/feed shortages are greatest.

One of the major problems of rabbit production in Nigeria is high cost of concentrates. This high cost of feed is because most of the diets are based on cereal grains and oil seed meal which compete both directly and indirectly with the industry and human (Ezekwe *et al.,* 2011). A possible solution to the escalating cost of these ingredients is to explore the potentials of alternative feedstuffs as part of replacement for the expensive conventional feed ingredients. Therefore, it is important to develop and utilize unconventional feed resources for rabbits according to local conditions (Ali *et al*., 2022). Breadfruit is an energy-rich fruit tree that has been successfully introduced to the forest savanna and derived savanna region of Nigeria. This tree with a good biomass yield is often produced in surplus, between March and May, leading to heavy loss due to its inability to store for long (Amusa, 2002). Breadfruit contains moderate levels of essential vitamins and minerals. Breadfruit in its raw form can be processed into meal for poultry and rabbits to replace part of the maize in the diet (Olandunjoye *et al.,* 2010).

There is not much data, however on the effect of feeding breadfruit pulp to growing rabbits. Also, there is little scientific literature that deals with the effect of processed breadfruit pulp focused diet regarding the haematological indicators and growth performance of growing rabbits. This study therefore, geared toward assessing the growth performance, indicators of haematology and nutritional digestibility of Weaner rabbits supplied blanched breadfruit (*Treculia africana)* pulp based diet.

MATERIALS AND METHODS

Site and Duration of The Study

The study was conducted at the Rabbit Unit of the Department of Animal Science Teaching and Research Farm and Animal Science Nutrition and Biochemistry Laboratory, Nigerian University in Nsukka. For eight weeks, the trial was conducted.

Ethical Approval

The research was conducted in accordance with the recommendations put forth by Directive 2010/63/EU (European Union, 2010) and with due consideration and adherence to the ethical standards and guidelines governing animal experiments as approved by the Research and Ethics Committee of the University of Nigeria, Nsukka, Nigeria (UNN Research Ethics Committee, 2013).

Rabbits, Diets, Design and Management

Two hundred 60-day-old old (New Zealand white) Weaner rabbits (759.5g) were employed in the feeding investigation. The rabbits were allocated at random to 5 experimental diets, respectively supplemented with 0, 5, 10, 15, and 20% levels of blanched breadfruit pulp (designated BABP0, BABP5, BABP10, BABP15, and BABP20), each with 4 replicate hutches (40 rabbits per treatment) for 8weeks, in a completely randomized design. Every hutch served as a replicate pen and was equipped with windows and vents that allowed air to circulate. Additional partitions for the hutches were made using wire meshes, metallic sheets and with dimensions of 0.6m × 0.5m × 0.4m. Every hutch had well-fitting steel trays for an easily accessible collection of excrement, as well as stainless feeders and drinkers. *Ad-libitum* access to clean water and diets was provided. The diets (Table 1) were formulated to meet nutritional requirement of rabbits as recommended by National Research Council (1994). The proximate analysis

Table 1. Composition of Experimental Diet

Ingredients	BABP0	BABP5	BABP10	BABP15	BABP20
Maize	38.32	35.13	31.90	28.76	25.56
Wheat offal	25.52	23.42	21.30	19.17	17.04
Soya bean meal	19.32	19.47	19.70	19.85	20.04
Palm kernel cake	12.84	12.98	13.10	13.23	13.36
Dried breadfruit pulp	0.00	5.00	10.00	15.00	20.00
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Bone meal	3.00	3.00	3.00	3.00	3.00
Iodize salt	0.25	0.25	0.25	0.25	0.25
Vitamin and mineral premix[a]	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Proximate composition					
Dry Matter	90.5	89.6	89.9	90.1	89.8
Crude Protein (CP)	17.11	17.07	17.06	17.08	17.10
Crude Fibre	5.22	7.5	8.68	9.86	7.85
Ether Extract (EE)	4.06	3.79	3.65	3.57	3.64
ASH	3.78	5.05	5.32	5.24	5.11
Nitrogen free Extract (NFE)	59.72	66.64	65.28	64.29	66.31
ME (MJ/kg)[b]	11.78	11.76	11.74	11.73	11.72

[a]Premix provided the following per kg of diets: Vit. B1: 1800mg; Vit. B2; 5500mg; Vit. B6: 3000mg; Vit. B12: 15mg; Vit. A: 100,00000IU; Vit. D3: 2,000000IU; Vit. E: 23,000mg; Vit. K3: 2000mg; Niacin: 27500mg; Folic acid: 750mg; Pantothenic acid: 7500mg. Biotin: 60mg; Chlorine: 300,000mg; Co: 200mg; Fe: 20,000mg, Mn: 40,000mg, I: 1000mg; Se: 200mg; Zn: 30, 000mg; Antioxidant: 1250mg

[b]Calculated as ME (MJ/kg) = [37 × CP (%) + 81.8 × EE (%) + 35.5 × NFE (%)] × 0.88 = (37 × 16.08) + 81.8 × 5.70) + (35.5 × 51.42) × 0.88 = 2540kcal/kg (Pauzenga, 1985).

of the diets was carried out according to the American Organization of Analytical Chemists method (AOAC, 2012). The diet was of isonitrogenous and isocaloric values.

Preparation of Blanched African Breadfruit Pulp

African bread fruit were sourced from local African bread fruit sellers located in Nguru and Obukpa both in Nsukka Local Government Area of Enugu State, Nigeria, whilst the rest of the feed ingredients were procured from King Size Animal Care in Onuiyi, Nsukka Local Government Area of Enugu State, Nigeria. The whole fresh breadfruit was washed with distilled water, sliced into pieces while the seed was removed (Figure 1). The pulp was blanched for a minute and drained using a sieve. The drained pulp was spread to dry under the room temperature for 48hours. Finally, the pulp was passed through a pental attrition mill for particle size reduction before mixing with other feed ingredients in the feed mill.

Growth Analysis

Initial body weight, final body weight, weight gain, feed intake, feed conversion ratio and protein efficiency ratio were all determined for growth performance analysis. Feed intake was recorded daily while Weight increase was measured by weekly weighing of the rabbits. However, the formulas below were used in calculating feed conversion ratio and protein efficiency ratio.

$$Feed\ conversion\ ratio = \frac{Feed\ intake}{Weight\ gain}$$

$$Protein\ efficiency\ ratio = \frac{Gain\ in\ body\ weight}{Protein\ consumed}$$

Haematological Analysis

At the termination of this experiment (56 days), feed was withdrawn 12 hours prior to blood collection. Four blood samples (5ml) were collected at random from each treatment into test bottles treated with ethylene diamine tetra acetic acid as anticoagulant. Blood samples were drawn from ear vein using a 21-gauge sterile syringe for the haematological assay. The characteristics related to haematology determined were Hemoglobin concentration (Hb), packed cell volume (PCV), red blood cells (RBC), white blood cells

Figure 1. The processing of the Blanched African Breadfruit Pulp

(WBC), the mean cell volume (MCV), the mean cell hemoglobin concentration (MCHC), and the mean cell hemoglobin (MCH). The hemocytometer was used to measure the WBC while PCV was determined using the micro-haematocrit method (Thrall and Weiser, 2002). As described by Higgins *et al.* (2008), the cynamethamoglobin method was used to quantify the concentration of Hb, and the conventional formulas of Feldman *et al.* (2000) were used to calculate MCV, MCH, and MCHC.

Nutrient Digestibility Trial

From each hutch, two rabbits were chosen at random to participate in a five-day digestibility testing. Daily intake was calculated by keeping track of the amount of feed supplied and the amount that remained each day. Samples (droppings) were collected for five days and were dried at room temperature, ground and analyzed for dry matter (method 930.15), crude protein (method 954.01), ether extract (method 920.39), and crude fibre (Horwitz, 1975). The digestibility of each of the measured nutrients was calculated using the formula:

Nutrient digestibility (%) = {[(nutrient in feed) - (nutrient in faeces)] / nutrient in feed} X 100

Statistical Analysis

Using a Statistic Graphic Computer Package (SPSS 2007), data were gathered and statistical analysis was performed using analysis of variance (ANOVA), in accordance with the guidelines for a completely randomized design (CRD). Duncan's New multiple range tests were used to separate the means, and differences were deemed significant at $P < 0.05$ (Duncan, 1955; Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Growth Performance

The effect of dietary BABP on growth performance of Weaner rabbits is presented in Table2. Dietary treatments had an insignificant impact ($P>0.05$) on initial body weight (IBW) of rabbits upon grouping. However, total feed intake (TFI), average daily feed intake (ADFI), final body weight (FBW), total weight gain (TWG), average daily weight gain (ADWG), protein efficiency ratio (PER) and feed conversion ratio (FCR) were substantially ($P<0.05$) impacted by dietary interventions. Rabbits that were supplied BABP at 5 and 10% had higher ($P<0.05$) TFI and ADFI than those that received BABP at 0, 15, and 20% rates of inclusion. Com-

Table 2. Effect of dietary bread fruit pulp on growth performance of rabbits

Parameters	BABP0	BABP5	BABP10	BABP15	BABP20	P-value
IBW (g)	559.67	558.00	558.33	559.67	559.33	0.198
TFI (g)	5176.70^{b}	5578.00^{a}	5622.30^{a}	5324.70^{b}	5274.70^{b}	0.012
ADFI (g)	92.44^{b}	99.61^{a}	100.40^{a}	95.08^{b}	94.19^{b}	0.001
FBW (g)	1250.00^{ab}	1308.30^{a}	1345.00^{a}	1141.70^{b}	1121.45^{b}	0.003
TWG(g)	690.33^{ab}	750.03^{a}	786.67^{a}	582.03^{b}	562.12^{b}	0.019
ADWG (g)	12.33^{ab}	13.39^{a}	14.05^{a}	10.39^{b}	10.04^{b}	0.007
FCR(g)	8.28^{ab}	7.44^{b}	7.15^{b}	9.15^{a}	9.38^{a}	0.016
PER (g)	104.93^{b}	107.55^{b}	107.97^{b}	136.33^{a}	87.66^{c}	0.000

^{a,b,c} Means on the same row with different superscript are significantly (P<0.05) different; IBW: Initial body weight; TFI: Total feed intake; ADFI: Average daily feed intake; FBW: Final body weight: TWG: Total weight gain; ADWG: Average daily weight gain; FCR: Feed conversion ratio; PER: Protein efficiency ratio.

parable (P>0.05) FBW, TWG, and ADWG were found in rabbits fed BABP0, BABP5, BABP10 diets which are higher than those that received BABP15 and BABP20. Rabbits that received BABP5 and BABP10 had enhanced FCR in comparison to those fed BABP15 and BABP20.

The rabbits exhibited a decline in body weight increase, low feed conversion ratio, and rising BABP levels. It is possible that the high fibre content and some anti-nutritional factors (ANFs) present in BABP could have contributed to the decreased body weight gain of the rabbits observed in the present study. Notably, previous study by Adekunle *et al.* (2006) suggested that this slight reduction could be linked to increased breadfruit pulp levels in the diet, resulting in sub-optimal feed utilization and efficiency. Similarly, the feed intake of rabbits was shown to increase at 5 and 10% inclusion levels of BABP and subsequently decreased at 15 and 20% inclusion. These findings suggest high palatability of BABP at lower inclusion levels below 15%. The poor feed conversion ratio recorded in the present study may indicate low digestibility and limited bioavailability of digestible nutrients from BABP containing diets to rabbits. A study by Nwokoro and Obasuyi (2006) reported reduced growth performance and decreased digestibility of nutrient as dietary level of bread fruit increased above 10%. This is supported by Oladunjoye and Ojebiyi (2012) which showed a decrease in BGW and FCR of rabbits due to high dietary fibre levels. The weight gain (10.04-14.05 g/day) reported in this study was marginally greater than (8.75-11.75 g/day) reported by Akuru *et al.* (2021), who fed rabbits with varying levels of cowpea hull. This suggests that dietary breadfruit meal at a lower inclusion level facilitated significant growth in rabbits, as observed in this study, while Valdivie and Alvarez (2003) reported improved performance when breadfruit was fed at 20% and above. Variations in the fibre content of different non-conventional feedstuffs may account for the differences in the study's daily feed intake as compared to previous research' findings (Akuru *et al.,* 2021). Indeed, BABP have been reported to contain some levels of ANFs such as oxalate, tannins, phytic acid (Oladunjoye *et al.,* 2010), which have been reported to poor palatability and appetite in animals due to their astringent properties (Olajide, 2012), hence the decrease in growth. The high levels of ANFs are known to inhibit the efficacy of the digestive system to digest feed to its capacity, because they obstruct nutrient absorption and processing (Abu Hafsa *et al.,* 2022). For instance tannins are generally known to bind protein molecules and form strong complexes, in doing so, they decrease the digestion and absorption of protein (Besharati *et al.,* 2022). Traditional feed ingredients often contain anti-nutritional factors that negatively impact growth when present in excessive levels. Nevertheless, processing methods like cooking (Oladunjoye *et al.,* 2010, Soaking (Olajide, 2012), fermentation (Ahemefule *et al.,* 2006) can reduce these factors to tolerable levels for animal use.

Haematology

Table 3 presents haematological characteristics of diet-fed rabbits supplemented with varying degrees of BABP. Dietary supplementation of BABP affected PCV, RBC, WBC, and Hb substantially (P<0.05). Rabbits fed BABP0 and BABP5 possessed more PCV value contrasted with the BABP10, BABP15, and BABP20. On

Table 3. Effect of breadfruit based diets on haematological parameters of rabbits

Parameters	BABP0	BABP5	BABP10	BABP15	BABP20	P-value
PCV (%)	33.00^{a}	32.25^{ab}	31.00^{b}	30.89^{b}	30.45^{b}	0.026
RBC (x10^3/mm^3)	11.42^{ab}	11.20^{ab}	11.65^{a}	11.70^{a}	11.87^{a}	0.037
WBC (x10^3/mm^3)	11.26^{a}	11.13^{a}	11.06^{ab}	10.11^{b}	10.02^{b}	0.022
Hb (g/100ml)	11.43^{a}	11.80^{a}	11.43^{a}	10.20^{b}	10.60^{b}	0.020
MCV (m^3)	8.29	8.53	8.66	8.56	8.34	0.133
MCH (%)	11.33	11.55	11.38	11.43	11.85	0.107
MCHC (%)	34.16	34.82	34.17	33.42	35.77	0.073

^{a,b} Means on the same row with different superscript are significantly ($P<0.05$) different; PCV: Packed cell volume; RBC: Red blood cell; WBC: White blood cell; Hb: Haemoglobin; MCV: Mean cell volume; MCH: Mean cell haemoglobin; MCHC: Mean cell haemoglobin concentration.

Table 4. Apparent Nutrient Digestibility (%) of Breadfruit Based Diet Fed to Rabbits

Parameters	BABP0	BABP5	BABP10	BABP15	BABP20	P-value
Dry matter	68.11^{a}	67.85^{a}	57.33^{b}	53.93^{b}	53.1^{b}	0.023
Crude protein	68.74^{ab}	71.73^{a}	74.11^{a}	67.73^{b}	65.13^{b}	0.015
Crude fibre	75.85^{a}	69.42^{ab}	64.57^{ab}	55.88^{b}	57.6^{b}	0.021
Ether extract	75.5^{a}	78.3^{a}	69.75^{b}	67.71^{b}	66.35^{b}	0.017

^{a,b} Means on the same row with different superscript are significantly ($P<0.05$).

the other hand, the RBC values were comparable ($P>0.05$) among the therapy groups. WBC was greatest ($P<0.05$) in the group of BABP0, BABP5, and BABP10 rabbits, with the least amount in BABP15 and BABP20 diets. However, Hb was greatest in the BABP0, BABP5 and BABP10 in contrast to rabbits that consumed BABP15 and BABP20.

Dietary inclusion of BABP at 10, 15 and 20% were shown to decrease the blood's PCV. Additionally, WBC and Hb exhibited a significant decrease at inclusion levels of 15 and 20%. The observed reduction in PCV and Hb with high inclusion of BABP could be as a result of reduced nutrient absorption due to some ANFs in the diets which could have impaired production of red blood cell. A similar result in the decrease of Hb and PCV was reported by Oladunjoye and Ojebiyi (2012) in rabbits fed high levels of breadfruit meal attributing it to the destructive effect of ANFs on red blood cell. The decrease in the WBC of rabbits fed high BABP (15 and 20%) may be linked to the inability of the animals to fight pathogens that attack the immune system. It is possible that the BABP used in our study retained some biotoxins, which could hinder the ability of the rabbits to fight any health related stress of some sort (Muhammad *et al.*, 2015). This is further supported due to the noted decline in PCV, Hb, and WBC of rabbits fed cowpea hull as reported by Akuru *et al.* (2021). Regardless of these observations, the values found in our investigation were within the range that Njidda and Isidahomen (2010) reported as normal haematological parameters of rabbits.

Nutrient Digestibility

The effect of dietary BABP inclusion on crude protein (CP), crude fiber (CF), ether extracts (EE), and dry matter (DM) as indicators of apparent nutritional digestibility of rabbits is shown in Table 4. At increasing level of inclusion, BABP was found to have depressing ($P<0.05$) effects on the digestibility of DM, CP, CF, and EE. The DM and EE digestibility of rabbits that consumed BABP10, BABP15, and BABP20 were lower ($P<0.05$) than those fed BABP0, and BABP5. Rabbits supplied BABP0, BABP5, and BABP10 had increased ($P<0.05$) CP and CF digestibility than BABP15, and BABP20.

The decrease observed in the apparent digestibility DM, CP, CF and EE in rabbits fed BABP-supplemented diets in our study may be attributed to the processing method used. It is possible that this method did not adequately reduce the ANFs in the breadfruit to a tolerable level. In spite of the fact that the experimental diet had a fibre content of 5.5-9.86%, the breadfruit pulp used had a significantly higher fibre content of 19.5%. Given that rabbits' dietary fiber requirements range from 10% to 12% and can just digest 14% of ingested fibre (Trocino *et al.,* 2012). It becomes apparent that further processing would have been beneficial to reduce the fibre content of the breadfruit used in this study, as Ahemefule *et al.* (2006) and Emiola *et al.* (2007) observed that cooking, and fermentation were able to reduce the fibre content of breadfruit. The result of our study revealed that the control (BABP0) and BABP5 diets exhibited better digestion compared to 20 % incorporation rate of breadfruit pulp. The increased digestion of nutrients noted at BABP0 and BABP5 inclusion levels suggests its superiority over BABP15 and BABP20. The results of this study on apparent nutrient digestibility supports the finding of Oladunjoye and Ojebiyi (2012), they found that rabbits' digestibility was lowered when dietary fiber levels were raised. Our findings concur with the discovery of Zarkadas and Wiseman (2005) who reported that higher inclusion levels of breadfruit notably decreased the apparent nutrient digestibility. Consequently, this in all likelihood may have been accountable for the reduced feed usage noted among the experimental rabbits in their study. Notably, feeding system, feed type, and dietary fibre such as lignin, cellulose, and pectin have a remarkable impact towards the morphology and structure of the animals intestinal mucosa (Jha and Berrocoso, 2015). Diets greater in fibre moves rapidly through the digestive tract, restrict the activities of proteolytic enzymes and resulting in an general decline in nutrient digestibility (Grundy *et al*., 2016).

CONCLUSION

Dietary incremental levels of BABP decreased the characteristics of growth performance and health condition of the rabbits. Considering the responses found, Consequently, it may be said that the amount of BABP that can be added to rabbit diets ranges from 5 to 10% without negatively affecting the animal. Nevertheless, the primary restrictions on this research are center around approaches to address the anti-nutritional elements found in BABP to enhance its nutritional worth. Still, additional study on substitute processing techniques is needed to reduce the anti-nutritional factors in BABP like soaking, extrusion; acid or alkaline treatment, enzymatic treatment and genetic modifications might be applied.

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