



Growth Performance and Economics of Production of Growing Rabbits Fed Diets with Graded Levels of *Faidherbia albida* and *Prosopis africana* Fruit Meals

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Abstract

The study was conducted at the rabbit unit of the Adamawa State University Teaching and Research farm, Mubi, to assess the effects of feeding *Faidherbia albida* and *Prosopis africana* fruit meals to growing rabbits on their growth and economic performance. The test materials were sourced from Yewa forest in Mubi, while the rabbits (mixed breed) were purchased from a rabbit farmer in Mubi metropolis. The test materials were pulverised and kept safe until they were used to compound the diets. The rabbits were allowed one week of acclimatisation before the trial began. The study examined varying levels of *P. africana* and *F. albida* fruit meal at 10 and 15%, designated as: 10PA (10% inclusion of *P. africana*); 15PA (15% inclusion of *P. africana*); 10FA (10% inclusion of *F. albida*); 15FA (15% inclusion of *F. albida*); and the control diet had neither *P. africana* nor *F. albida*. At the start of the experiment, four rabbits were randomly allocated to each of the dietary treatments, with each rabbit as a replicate in a completely randomised design. Data on feed intake, weight gain, feed conversion ratio (FCR), and economic efficiency were recorded. The results obtained revealed significant ($P < 0.05$) effects on most of the parameters measured. Daily weight gain (27.55 g/rabbit/day) and FCR (1.71) were higher ($P < 0.05$) in 10FA, while daily feed intake (52.08 g/rabbit/day) was higher ($P < 0.05$) in 15FA compared to the control diet. Cost/kg feed (₦718.72) was lower in 15FA; total cost of feed (₦2491.42) and feed cost/kg gain (₦1291.73) were lower in 10FA, while cost saving was higher in 10FA (₦63.06) compared to the control diet. It can therefore be concluded from the study that feeding 10 g/kg of *Faidherbia albida* fruit meal in the diets of growing rabbits promoted better feed efficiency and more cost savings.

Keywords: Feed intake, Weight gain, Feed conversion ratio, Cost-benefit, Rabbit

Introduction

Feed supply has remained a major constraint in livestock production in terms of its quality and quantity, due to the increasing cost of feedstuff brought about by the competition between man and animals for protein and energy (Awang *et al.*, 2023). The need to improve rabbit production in Nigeria for an increased supply of animal protein is no longer in doubt due to the high cost of chicken, pork, and beef (Mohammed *et al.*, 2018). Rabbit production has considerable potential in developing

countries to supply the much-needed protein due to its low capital investment and space requirements, short generation interval, rapid growth rate, high reproductive potential, and ability to utilise the abundant browse and fibrous materials (Abejeshi *et al.*, 2018). Mohammed *et al.* (2018) reported that rabbits can be successfully raised on unlimited green vegetables, roots and hay, but the addition of some cake is always advantageous.

Most developing countries, like Nigeria, are faced with rapid human population

growth with resultant increase in demand for animal protein, which is in short supply (Ishaya *et al.*, 2025). The increase in prices of feedstuffs, especially protein and energy sources, and their scarcity are important constraints affecting the livestock sector in the country, the authors added. It is therefore necessary to search for an alternative source that is cheap, abundant, and readily available. The use of non-conventional feedstuffs that are affordable and abundantly available, which can be used for feeding ruminants and mini livestock, has been suggested as one of the ways of making the rearing of animals such as rabbits, guinea pigs, among others, affordable and popular (Millam, 2023). One of such alternative feed resources may be *Prosopis africana* and/or *Faidherbia albida*.

One of the major benefits of using African mesquite (*Prosopis africana*) as a feed source for rabbits is its availability, especially in arid and semi-arid regions where other feed sources may not thrive (Akinmoladun *et al.*, 2019). The plant's ability to grow in poor soils makes it a valuable resource for smallholder farmers who rely on sustainable and locally available feed sources. Additionally, *P. africana* is relatively drought-resistant, which further enhances its reliability in regions with irregular rainfall patterns (Oke *et al.*, 2021). Several feeding trials have been conducted to evaluate the effect of *P. africana* on rabbit growth and productivity. The study by Oke *et al.* (2021) demonstrated that incorporating *P. africana* leaves into the diet of rabbits resulted in improved growth rates and feed conversion efficiency compared to rabbits fed on a conventional diet of grasses and concentrates. This is an indication that it can serve as a supplementary or alternative feed source, particularly during periods when

conventional feed ingredients are in short supply. However, the authors noted that the inclusion level of *P. africana* should be carefully managed to avoid negative effects on rabbit health and performance.

Apple-ring acacia (*Faidherbia albida*), commonly known as the winter thorn, has gained recognition as a valuable fodder source in tropical and semi-arid regions due to its nutritional benefits and adaptability to harsh environments (Okoruwa *et al.*, 2022). The leaves, pods, and seeds of *F. albida* are rich in crude protein, fibre, and essential minerals, which are essential for the growth and reproduction of small livestock, including rabbits, the authors added. Rabbits, as monogastric herbivores, require diets with high digestibility and adequate protein content to support their rapid growth and reproductive efficiency. Studies have shown that incorporating *F. albida* leaves and pods into rabbit diets can significantly improve feed intake, weight gain, and overall productivity without adverse effects on health (Ogunbiyi *et al.*, 2017; Nwakalor *et al.*, 2018). The presence of anti-nutritional factors such as tannins in *F. albida* is relatively low compared to other leguminous plants, ensuring better nutrient absorption and utilisation by rabbits (Oboh and Ohiokpehai, 2016). Additionally, the tree's fodder is palatable, and rabbits exhibit a high preference for its leaves and pods, further enhancing its utility as a feed resource (Nwakalor *et al.*, 2018).

Judging from the information documented by several authors regarding the nutritional quality of these feedstuffs, their availability in rural environments, and their low cost, this study intends to find out their utility in rabbit production, especially in Mubi. Therefore, the study was designed to assess the effects of

feeding *F. albida* and *P. africana* fruit meals in diets of rabbits on growth performance and economic efficiency.

Materials and Methods

Study Area: The study was conducted at the Rabbit unit of Adamawa State University (ADSU) Teaching and Research Farm, Mubi Local Government Area (LGA). The area lies within the northern Guinea savannah zone of Nigeria. It is geo-located between latitude 10°16'6.9" north of the equator and longitude 13°16'1.2" East Greenwich meridian, with 560 meters above sea level. The dry season of the area commences in November and ends in March, while the wet season begins in April and ends in late October. The mean annual rainfall is about 1050 mm. The relative humidity is extremely low (20–30%) between January and March, but reaches a peak of about 80% in August and September. The maximum temperature can reach 40°C, particularly in April, while the minimum temperature is about 12°C between December and January (Meteorological Enclosure, 2024).

Source and Processing of *Prosopis africana* and *Faidherbia albida*: The raw *Prosopis africana* and *Faidherbia albida* fruits were obtained from Yawa ward, Mubi South LGA, Adamawa State, Nigeria. The test materials were air-dried at room temperature for three days, bagged, and taken to the study area. It was later pulverised using a local roller milling machine into powder/meal, bagged again, and kept safe before it was used in compounding the diets.

Source of Experimental Animals and Management: About 20 growing mixed-breed rabbits (New Zealand, Chinchilla, and Dutch) used for the experiment were purchased from a rabbit farmer in Mubi

LGA. They were brought to the experimental location and allowed one week of acclimatisation to the new environment. On arrival, they were given anti-stress (Vitamix®) medication, which was administered in their water. During this period, they were closely monitored for any signs of ill-health and fed with a mixture of cowpea husk and maize offal at a 60:40 ratio *ad libitum*. Anticoccidial drugs (Amprolium®) and albendazole suspension (Piperazine®) were also administered through drinking water.

Housing and Feeding: The rabbits were housed in a confined pen (pen housing method was used), equipped with individual feeders and drinkers. The pens are well ventilated and illuminated, with a concrete floor system. Feed and water were supplied using an *ad libitum* feeding regime. The feeding trial lasted for 10 weeks. Feed supplied during the trial was the experimental diets.

Treatment and Experimental Design: The experimental diets were formulated to include varying levels of *P. africana* and *F. albida* fruit meal at 10 and 15%, designated as: 10PA (10% inclusion of *P. africana*); 15PA (15% inclusion of *P. africana*); 10FA (10% inclusion of *F. albida*); 15FA (15% inclusion of *F. albida*); and the control diet had neither *P. africana* nor *F. albida*. The diets were formulated to meet the crude protein and fibre requirements of the growing rabbits (MSD Manual, 2025). The ingredient composition of the experimental diets is presented in Table 1. At the start of the experiment, four rabbits were randomly allocated to each of the dietary treatments, with each rabbit serving as a replicate in a completely randomised design.

Growth trial: Feed intake was determined by obtaining the differences

between the quantity of feed offered and the leftover daily. The average daily feed intake of all the rabbits was obtained by dividing the total feed intake of each rabbit during the periods under study by 70 days. Regarding the weight gain, the animals were weighed at the beginning of the experiment using a digital weighing scale (kitchen electronic scale, SF-400). Subsequent weights of the rabbits were taken weekly. The average daily weight gain was obtained by dividing the total weight gained by the number of days spent during the study (70 days). The feed conversion ratio was calculated at the end of the feeding trial. It was computed as the feed intake of the rabbits divided by the weight gain over the same period.

Cost-benefit analysis: The profitability of feeding the growing rabbits with the experimental diets was assessed using a cost-benefit analysis. Inputs and product costs were calculated based on the cost of goods at current market prices in 2024 (April–June). The value of gain was determined to examine the returns of growing rabbits fed with *P. africana* and *F. albida* fruit meal-based rations. The total cost of feed was obtained as the cost/kg feed multiplied by total feed intake. Feed cost/kg gain was acquired as the total cost of feed divided by total weight gain, while cost saving was calculated as the feed cost/kg gain of treated groups subtracted from that of the control.

Laboratory analysis: Samples of the experimental diets were collected, and the proximate compositions were determined as described by AOAC (2007). Dry matter was determined by oven drying the samples at 105°C overnight. The Ash

content was obtained by igniting the sample in a muffle furnace at 660°C for an hour. Crude fat (ether extracts) was determined using the ether extract method using a Soxhlet apparatus. For crude fibre analysis, the fat-free sample was digested using a 2.5% HCl solution and later subjected to alkali digestion using a 2.5% NaOH solution. The residue was ignited in a furnace at 600°C till ashing. For crude protein determination, the sample was digested using a digestion mixture of K₂SO₄ and CuSO₄ (8:1) and conc. H₂SO₄. The digested sample was subjected to a distillation process using 40% NaOH and 4% Boric acid solutions, then it was titrated against 0.1N HCl solution. Nitrogen Free Extract represents the digestible carbohydrates. This value was obtained by subtracting the sum of the percentages of moisture, crude protein, crude fibre, ether extract, and ash from 100. The cell wall constituent of the feed was determined using the methods of Van Soest *et al.* (1991). These analyses were conducted in the Animal Nutrition Laboratory, Department of Animal Production, ADSU, Mubi. The metabolizable energy for the feed samples was estimated according to the formula of Pausenga (1985) as cited in Kwari *et al.* (2014).

Data analysis: All data collected were subjected to Analysis of Variance according to procedures of Statistix 9 Analytical package, Version 9.1 (Analytical Software, 2012). The effects of treatment means were tested at a probability level of 95% ($P < 0.05$), and significant effects were compared using Dunnett's Test. The statistical model for this study was

$$Y_{jk} = \mu + T_j + e_{jk}$$

Where μ = population mean
 T_j = effect of the j^{th} treatment
 e_{jk} = all error terms are assumed to be random, normally distributed and independent with expectations equal to zero

Results and Discussion

Effects on growth performance: The growth performance of growing rabbits fed diets containing *Prosopis africana* and *Faidherbia albida* fruit meals is presented in Table 2. Significant ($P<0.05$) effects were observed for most parameters measured, except for initial weight gain, which recorded a non-significant ($P>0.05$) effect.

The overall weight gain and daily weight gain (DWG) were observed to be higher ($P<0.05$) in the group of rabbits receiving 10FA (1928.80 and 27.55 g, respectively) compared to the control diet (1843.80 and 26.34 g, respectively). Higher DWG observed in this experiment was higher than the value of 17.76 g recorded when weaner rabbits were fed with raw *F. albida* pod meal in guinea Savannah zone of Adamawa State (Shehu *et al.*, 2018). The differences in the result obtained with the one cited might be attributed to the differences in age and breeds of rabbits, the duration of the feeding trial, or the quality of the diets (Osei *et al.*, 2024). Similarly, the observed weight gain might be due to adequate nutrition provided by the diet (Table 1). This coincided with some studies that reported optimum weight gain when *F. albida* was included at levels lower than 15% (Zarah, 1999) and 20% (Bah *et al.*, 2017). The overall feed intake and daily feed intake (DFI) were higher ($P<0.05$) in the group of rabbits receiving 15FA (3645.50 and 52.08 g, respectively) compared to the control diet (3442.50 and 49.18 g, respectively). The higher DFI observed in this study was within the range of values (49.93–58.29 g) recorded by Shehu *et al.* (2018), who fed 15% *F. albida* to weaner rabbits. However, the same value was less than the range of values (55.62–62.26 g) when growing rabbits were fed locally up to 40% *F. albida* pods in their diets

(Igwebuike *et al.*, 2007). Higher feed intake in this study suggests that the inclusion of *F. albida* did not affect the acceptability and nutritive value of the diet. In other words, inclusion up to 15% in the diets of rabbits may not affect their intake or the nutritive quality of the diets. Similarly, the high feed intake might also be attributed to the palatability of the diet brought about by the level of soluble carbohydrate in the diet (Table 1). This coincided with the work of Abbator (1996) and Zarah (1999), who reported that optimum intake was observed when *F. albida* was included at 15%, but differed from the findings of Bah *et al.* (2017), who recorded optimum intake at 20%. Feed conversion ratio (FCR) is the most extensively used parameter to express the efficiency of converting feed to live weight gain (McDonald *et al.*, 2010). The FCR value was the least ($P<0.05$) in the group of rabbits receiving 10FA (1.79) compared to the control diet (1.87). The least FCR in this study was lower than the findings of 2.89 (Shehu *et al.*, 2018) when 15% of *F. albida* were fed to weaner rabbits in the guinea Savannah zone of Adamawa State. This implies that the diets were sufficiently utilised by the rabbits.

Effects on economic efficiency: The economics of feeding growing rabbits with varying levels of *P. africana* and *F. albida* fruit meal are presented in Table 3. The cost per kilogram of feed was observed to be lower in the group of rabbits receiving 15FA (₦718.72) compared to the control diet (₦725.22). This reduction in feed cost may be attributed to the decreased levels of conventional feed included in the diet. The test material was very inexpensive, and acquiring it was less burdensome, especially in areas where it is abundantly available. Consequently, when the levels of the test ingredient are increased, the

costly conventional feed material is included at a lower level, thus reducing the overall feed cost. Therefore, the cost reduction can be attributed to the price differential between maize offal and the *F. albida* at the time of the study (Adamu *et al.*, 2013).

Total cost of feed and feed cost/kg gain were observed to be lower in the group of rabbits receiving 10FA (₦2491.42 and ₦1291.73, respectively) compared to the control diet (₦2496.58 and ₦1354.08, respectively), while maintaining a higher cost saving of ₦63.06 in the same group. Lower results for the total cost of feed could be attributed to the relatively lesser feed consumed by the rabbits in the treatment group and relatively lower feed cost/kg. This result was unlike the reports of Adamu *et al.* (2013), who indicated a low cost of total feed consumed in the treatment where less test material was added. However, it was consistent with the total feed intake recorded by the authors, which resulted in lowered total feed cost as the intake reduced. The lowest feed cost/kg gain could be attributed to the relatively lower cost of feed consumed (total cost of feed). A similar observation was made by Ishaya *et al.* (2025), showing lower feed cost per kg gain as well as lower cost of feed consumed. Higher cost savings observed

in this study could be attributed to lower feed cost/kg gain. Yakubu *et al.* (2022) also reported higher cost savings due to lower feed cost/kg gain. On economic grounds, therefore, diet 10FA is much better than the others. Even though a relatively lower intake and weight gain in the control diet resulted in its poor performance, the study revealed that the best biological and economic returns were obtained in 10FA (10 g/kg inclusion of *F. albida*).

Conclusion and Recommendation

The results of the study showed that:

- feed intake improved in 15FA by 3.10 g, while weight gain and feed conversion ratio were improved by 1.22 g and 0.16, respectively, in 10FA compared to the control;
- Cost saving was higher in 10FA by ₦63.06.

Therefore, it could be concluded from the study that feeding *Faidherbia albida* fruit meal in the diets of growing rabbits at 10 g/kg could improve feed efficiency, resulting in higher cost savings, and it is therefore recommended.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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Table 1: Percentage (%) ingredient composition of the experimental diets

Ingredients	PA10	PA15	FA10	FA15	Control
Maize offal	64.00	59.00	64.00	59.00	74.00
<i>Prosopis africana</i>	10.00	15.00	-	-	-
<i>Faidherbia albida</i>	-	-	10.00	15.00	-
Cowpea husk	20.00	20.00	20.00	20.00	20.00
Fish meal	3.25	3.25	3.25	3.25	3.25
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt	0.50	0.50	0.50	0.50	0.50
Premix	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Laboratory analysis (%)					
Energy (ME, kcal/kg)	3169.44	3138.76	3191.57	3096.24	3,674.24
Dry matter	94.00	94.00	94.00	94.00	94.35
Crude protein	12.53	14.22	16.95	18.00	22.70
Crude fibre	5.95	6.25	5.20	7.00	8.90
Ether extract	5.45	5.50	6.00	5.65	6.95
Ash	6.30	7.00	7.32	7.80	8.00
Nitrogen-free extract	63.77	61.03	58.53	55.55	47.80
Neutral detergent fibre	47.25	51.37	54.48	57.40	60.25
Acid detergent fibre	41.76	44.26	39.35	38.26	39.56

10 and 15: levels of inclusion, PA: *Prosopis africana*, FA: *Faidherbia albida*

Table 2: Growth performance in rabbits fed diets containing *Prosopis africana* and *Faidherbia albida* fruit meal

Parameters	10PA	15PA	10FA	15FA	Control	SEM
Initial weight (g/rabbit)	711.75	687.25	708.25	817.25	744.75	87.14 ^{NS}
Final weight (g/rabbit)	2555.50 ^{ab}	2531.80 ^b	2637.00 ^{ab}	2653.00 ^a	2587.50 ^{ab}	59.21
OWG (g/rabbit)	1843.80 ^b	1844.50 ^b	1928.80 ^a	1835.80 ^b	1842.80 ^b	24.83
DWG (g/rabbit/day)	26.34 ^b	26.35 ^b	27.55 ^a	26.23 ^b	26.33 ^b	0.37
OFI (g/rabbit)	3442.50 ^b	3479.50 ^b	3451.30 ^b	3643.50 ^a	3428.30 ^b	33.55
DFI (g/rabbit/day)	49.18 ^b	49.71 ^b	49.30 ^b	52.08 ^a	48.98 ^b	0.48
Feed conversion ratio	1.87 ^b	1.89 ^b	1.71 ^a	1.99 ^c	1.87 ^b	0.02

^{abc}: Means with different superscript on same row are significantly (P<0.05) different, 10 and 15: levels of inclusion, PA: *Prosopis africana*, FA: *Faidherbia albida*, NS: not significant, OWG: overall weight gain, DWG: daily weight gain, OFI: overall feed intake, DFI: daily feed intake, SEM: standard error of means

Table 3: Economic performance of rabbits fed varying levels of *Prosopis africana* and *Faidherbia albida* fruit

Parameters	10PA	15PA	10FA	15FA	Control
Cost/kg feed (₦)	725.22	723.72	721.89	718.72	728.22
Total feed intake (kg)	3.44	3.48	3.45	3.65	3.43
Total cost of feed (₦)	2496.58	2518.19	2491.42	2620.10	2496.53
Total weight gain (kg)	1.84	1.84	1.93	1.84	1.84
Feed cost/kg gain (₦)	1354.08	1365.24	1291.73	1427.26	1354.78
Cost saving (₦)	0.71	-10.46	63.06	-72.48	-

10 and 15: levels of inclusion, PA: *Prosopis africana*, FA: *Faidherbia albida*