

**NUTRITIONAL EVALUATION OF *Faidherbia albida* SEEDS AND PULP AS
SOURCE OF FEEDS FOR LIVESTOCK**

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ABSTRACT

The present study was conducted to find out the nutritional values of *Faidherbia albida* (*Acacia albida*) seeds and pulp to be used as components in livestock feeds. The samples were randomly collected from various trees during the period of January to February. The samples were separated, milled and analysed for proximate components and mineral elements using standard methods of the AOAC. Proximate analysis results showed that the concentrations of tested parameters in the seed and the pulp respectively on % dry matter were: dry matter (90.0 ± 0.4 ; 93.3 ± 0.2), ash (3.3 ± 0.1 ; 6.7 ± 0.1), crude protein (20.6 ± 1.2 ; 19.5 ± 0.4), crude lipid (13.3 ± 0.1 ; 3.3 ± 0.1), crude fibre (6.7 ± 0.1 ; 13.3 ± 0.2), and available carbohydrate (46.1 ± 0.1 ; 50.53 ± 0.7). The results indicated that the contents of dry matter, ash, crude fibre and available carbohydrate were significantly higher ($p < 0.05$) in the pulp compared to the seed while the crude lipid values, however, were significantly higher ($p < 0.05$) in seeds compared to pulp. Crude protein values did not differ significantly ($p > 0.05$) between treatment means of seeds and pulp. The estimated energy value was significantly higher ($p < 0.05$) in the seed (1,682 kJ/100g) compared to pulp (1,363 kJ/100g). The results for the mineral analysis indicate that the seeds and pulp contain appreciable concentrations (mg/100g) of Ca (136.6 ± 5.0 ; 55.0 ± 5.0); Mg ($135.0 \pm 2.0 \pm 5.0$; 84.7 ± 3.0); P (26.6 ± 0.9 ; 29.6 ± 0.7); K (144.5 ± 0.2 ; 88.8 ± 0.1); Na (12.5 ± 0.1 ; 6.8 ± 0.1); Fe (6.2 ± 0.2 ; 8.8 ± 0.3); Cu (5.8 ± 0.1 ; 2.5 ± 0.1) and Zn (8.0 ± 0.1 ; 3.0 ± 0.1). Mineral elements in seed are significantly higher ($p < 0.05$) compared to that of pulp in most cases. From the results it can be inferred that the seed and pulp of *F. albida* could be an important source of feed ingredient for livestock if properly harnessed.

Key words: Feed, *Faidherbia albida*, Nutrition evaluation

INTRODUCTION

Livestock play a vital role in the lives of many people on a global scale, chiefly as a source of income and in the provision of meat and milk, which are considered as first class protein sources. In most developing nations, particularly those within arid and semi-arid regions of sub-Saharan West Africa, livestock production is affected by seasonal variation in the availability and quality of pastures [1]. Even during the period of surplus (rainy season), pastures are low in protein and therefore could not meet nutritional requirements of livestock [2,3]. During the dry season, animals have to be supplemented with high quality rations to avert malnutrition. However, due to economic pressure, many of the small-scale livestock farmers cannot afford to supplement animals with the highly expensive feed ingredients [2,4].

Nigeria is blessed with diverse range of vegetation zones from dense rain forest in the southern part to plain and sandy arid zone in the extreme north. This wide variation gives an enabling environment for different types of flora to grow. Thus, the adverse effects of malnutrition for livestock can be alleviated by searching for the potentials of these vast flora for fodder.

Among the promising trees in providing high quality protein feed sources for livestock are the legume species [5, 6]. *Acacia* species, especially *Faidherbia albida*, is a multipurpose tree species (MPTS) and is used as feed for livestock in most parts of arid and semi-arid regions of sub-Saharan West Africa. The tree is known as wonder tree that displayed excellent survival growth, and produces leaves and pods during dry season (January to February) when most trees shed their leaves. This quality makes *F. albida* worthy of investigation as a feed for livestock. In view of this, the present study was designated to evaluate the proximate and mineral composition of the seeds and pulp of *F. albida* with the hope that the information could be valuable in animal feed formulation.

MATERIALS AND METHODS

Sample collection and preparation

The mature and dried pods of *Faidherbia albida* were obtained in January and February from trees growing within Sokoto metropolis and the premises of the Usmanu Danfodiyo University, Sokoto, Nigeria.

The seeds and pulp were separated manually. Infected and stunted pods/seeds were discarded. The seeds and pulp were separately milled with mortar and pestle into fine powder, sieved to pass through 20 mesh sieve and stored in labelled polythene bags until required for analysis. The dried powdered samples were used for proximate and mineral analysis.

Proximate Analysis

The methods for various analyses were the standard procedures of the AOAC [7]. Dry matter (DM) content was determined by drying two grams of each representative sample in an oven (Gallenkamp, UK) at 105 °C for 24 hours. Ash content was determined by the incineration of two grams of each sample in a muffle furnace (Lenton Furnaces, England) at 600 °C for 2 hours. Micro-Kjeldahl method was used to determine the nitrogen content of the samples; and the samples. Crude protein contents were estimated by multiplying their respective percentage nitrogen values by a factor 6.5.

Crude lipid was extracted with n-hexane using a soxhlet apparatus, in each case, two grams sample was extracted for 8 hours. Crude fibre was estimated by acid-base digestion with 1.25 % H₂SO₄ (w/v) and 1.25 % NaOH (w/v) solutions. Available carbohydrates were calculated by difference by subtracting total sum of crude protein, crude lipid, crude fibre and ash from 100 % DM. The samples' energy values were estimated in kJ/100 g DM, by multiplying the percentages of crude protein, crude lipid and carbohydrate by the factors 17.7, 37.7 and 17.7 respectively, and summing up the values [8]. All determinations were carried out in triplicate and reported as mean (% DM) ± standard deviation.

Mineral Analysis

Mineral analysis was done after triple acid digestion by placing one gram-portion of each sample into Kjeldahl flask and digested with 24 ml mixture of HNO₃, H₂SO₄ and HClO₄ (9: 2: 1 v/v) until a clear solution was obtained. After cooling, the digest was filtered with Whatman No. 42 filter paper into a 50 cm³ volumetric flask to which 4 ml of 5 % lanthanum chloride (LaCl₃.7H₂O) solution was added to overcome phosphate interference. The flask was made up to the 50 cm³ mark with distilled water [9].

Copper, iron, calcium, magnesium and zinc were analysed with atomic absorption spectrophotometer (Alpha 4 model), Phosphorus content was determined colorimetrically using phospho-vanadomolybdate method with spectrophotometer 6100 model (Jenway, UK), while flame photometer (Corning 400, UK) was used for sodium and potassium analysis. All determinations were carried out in triplicate and reported as mean mineral content (mg/100 g DM) ± standard deviation.

Statistical Analysis

The data generated were subjected to t-test Microsoft Excel statistical package, to compare the means composition of seed and pulp. Significance was accepted at $P \leq 0.05$.

RESULTS

Table 1 shows the results of the proximate composition of the seed and pulp of *Faidherbia albida*. The samples' dry matter contents were found to be high (90.0 ± 0.4 % for the seed and 93.3 ± 0.2 % for the pulp). The pulp DM was significantly ($p < 0.05$) higher than that of seed. Similarly, ash content is significantly ($p < 0.05$) higher in pulp (6.7 ± 0.1 %) compared to that of seed (3.3 ± 0.1 %).

On the other hand, it was observed that the crude protein content in seed was higher (20.63 ± 1.2 %) than that of pulp (19.5 ± 0.4 %) even though not significant ($p > 0.05$). The seed sample also has a significantly ($p < 0.05$) higher concentration of crude lipid (13.3 ± 0.1 %) than the pulp sample (3.3 ± 0.1 %). Furthermore, available carbohydrate is significantly ($p < 0.05$) higher in pulp (50.5 ± 0.7 %) when compared to seed (40.1 ± 0.1 %). Crude fibre content was also significantly ($p < 0.05$) higher in pulp (13.3 ± 0.2 %) than in seed (6.7 ± 0.1 %). The samples' energy values were observed to be significantly ($p < 0.05$) higher in seed (1,682 kJ/100 g) compared to pulp (1,363 kJ/100 g). Table 2 shows the results of mineral composition in the seeds and pulp of *F. albida*. The results show that Ca, Mg, K, Na, Cu and Zn were significantly higher ($p < 0.05$) in seeds compared to the pulp, while P and Fe, were significantly higher ($p < 0.05$) in the pulp.

DISCUSSION

The results for the proximate analysis showed that both the seeds and pulp of *F. albida* had high DM content. This is an indication that *F. albida* samples analysed constitute important, useful and dependable sources of DM for feeding livestock. The high DM content of the seed and pulp of *F. albida* which is an indication of low moisture content, show a better storage potential of the pods, since high moisture content is associated with increase of microbial activities during storage which reduces the nutritional value of feed material [10, 11]. The values of the DM obtained in the present study are comparable with those reported for two species of *Acacia tumida*, and *A. colei* [12].

The ash content of the seeds and pulp of *F. albida* are 3.3 % and 6.7 %, respectively. Akintayo [13] reported that ash content in feed ingredient to be used in compounding feed should be < 2.5 %. Nevertheless, the ash content could be brought within the range when mixed with other low ash containing feed ingredients. The ash content of the pulp obtained from the present study is high when compared with the value of 3.7 % reported in pods of *Acacia albida* grown in Tanzania [14], but compares favourably with the value of 6.3 % found in pods of the same tree in the Republic of Niger [14]. Furthermore, the ash content reported herein compares favourably with the levels of ash in some feeding stuffs such as groundnut meal (6.0 %), cotton seed meal (5.82 %) and soya bean (4.86%) [15,16].

The protein content of both the seed and pulp (Table 1) are relatively high. This could be attributed to the association of the plant with nitrogen-fixing bacteria [17]. The protein content reported here is comparable to the value reported in seeds of *A. colei*

(23.4 %), but lower than that of *A. tumida* seed (34.1 %) [12]. The crude protein for the pulp (19.5 %) is higher than that of *A. albida* reported in Niger republic (14.3 %) and Tanzania (8.8 %) [14]. The differences could be due to genetic and eco-climatic variations. The result indicates that the protein content of the samples is adequate for meeting the maintenance requirement of small ruminants (8.90 %) as well as average requirements (9.70 %) for nursing cows in Nigeria [3]. The values are also above 10 % set by US National Research Council as maintenance requirement for sheep and goats [4]. Generally, the protein content of *F. albida* seeds and pulp is sufficiently high to affirm consideration of their use as plant protein sources in animal rations as high protein content in food if fully utilized by the body, will favour live weight gain and good animal performance.

The crude lipid content of the seeds was high, which indicates that the seeds might possibly be used as a source of oil in food, pharmaceuticals, cosmetics and alkyd resin preparations or used as biofuel [18, 19, 20]. However, further analysis is required to illustrate their tendencies in such applications. Also considering the protein content of the seed sample, if the oil is extracted, the cake produced as by-product could form a better feed ingredient with much higher protein content. The seed crude lipid content obtained in this study (13.3 %) is comparable to the 10.9 to 12.1 % reported in the seed of *A. colei* [12]. The pulp crude lipid content is high, when compared to the values of 1.4 % and 1.5 % found in *A. albida* pods obtained in Tanzania and Republic of Niger, respectively [14]. This low lipid content makes the pulp suitable in feed formulation.

Carbohydrate content in both seeds (46.1 %) and pulp (50.5 %) was relatively high. The high fat and carbohydrate contents of the samples make the seeds and pulp flours of *F. albida* a good source of energy to livestock. The carbohydrate content of the pulp is comparable with the values of 53.2 % and 61.7 % reported in the pulp of the same tree grown in Republic Niger and Tanzania, respectively [14].

The crude fibre content of *F. albida* seeds (6.7 %) was low compared to that of *Acacia colei* (39.9%) and *Acacia tumida* (20.3%) [12] and some legume grains such as blue lupin (16.1 %) and yellow lupin (20.2 %), which are used as components of livestock feeds [21]. The pulp also has a low crude fibre value (13.3 %) that compared with 24.7 % and 24.4 % reported in the pulp of the same tree species grown in the Republic of Niger and Tanzania, respectively [14]. According to Shiawoya and Adeyemi [3], low fibre content of feeds could stimulate increased feed intake as well as enhance the quality and digestibility of the feed. In this study, the fibre contents of the two samples prove that they are unsuitable for animal feed compounding [13].

F. albida seeds have higher energy values than the pulp as shown in Table 1. The relatively high energy value of the seed could be due to higher concentration of crude lipid in the seed compared to the pulp. This further confirms that fruits of *F. albida* pods are important sources of energy to livestock.

The results for mineral analysis reveal that calcium and magnesium content in the samples were significantly within the levels that are optimal for ruminants (Table 3).

The phosphorus content in these samples is low (26.6 ± 0.9 and 29.6 ± 0.7 mg/100gDW) compared to the recommended value, which is 120 – 480 mg (Table 3). This low phosphorus value is of significant importance as calcium is closely related to phosphorus metabolism in the formation of bones with the tolerable limits of Ca:P ratio being in the range of 1:1 to 7:1 [22]. The Ca:P ratio in the present study ranged from 5:1 in the seeds to 2:1 in the pulp, which are within the tolerable limits. Thus, a phosphorus deficiency and infertility in cattle due to intake of excess Ca is unlikely [22, 23]. The Ca:P ratio in this study shows that if *F. albida* seeds are mixed with cereal by-products which are low in calcium and high in phosphorus [22] it could form a nutritious diet for livestock.

The concentrations of microelements (iron, copper, and zinc) in these samples are high considering the recommended values for ruminants (Table 3), thus indicating that *F. albida* seeds and pulp are good sources of these essential microelements. Generally, in most cases, ruminant animals consuming up to one kilogram per day of these seeds can fulfill up their macro elements requirement while between 12 to 81g and 28 to 133g of seeds and pulp, respectively, could provide the recommended dietary allowances for Fe, Cu and Zn (Table 3), in all cases assuming total utilization of elements and ignoring the effect of toxicants and antinutritional factors.

CONCLUSION

The results of the present study indicated that the seeds and pulp of *F. albida* are good sources of plant protein and minerals, which might be an indication that they could be used as feed supplements for livestock. The seeds of *F. albida* could be a very useful source of oil for domestic and industrial uses. Furthermore, the cake obtained after oil extraction could be a good protein source for livestock. However, chemical analysis alone should not be the sole criterion for judging the nutritional importance of a particular feed ingredient. Thus, it becomes imperative to consider other aspects such as animal responses to nutritional potentials of the pods as well as its antinutritional and toxicological effects.

Table 1: Proximate composition of the seed and pulp of *Faidherbia albida*

Parameters	Seed (% DM)	Pulp (% DM)
Dry matter (DM)	90.0 ± 0.4 ^b	93.3 ± 0.2 ^a
Ash	3.3 ± 0.1 ^b	6.7 ± 0.1 ^a
Crude protein	20.6 ± 1.2 ^a	19.5 ± 0.4 ^a
Crude lipid	13.3 ± 0.1 ^a	3.3 ± 0.1 ^b
Crude fibre	6.7 ± 0.1 ^b	13.3 ± 0.2 ^a
Carbohydrate	46.1 ± 0.1 ^b	50.5 ± 0.7 ^a
Energy value (kJ/100g)	1682 ^a	1363 ^b

The data are mean value ± standard deviation (SD) of three replicates. Values within a row marked with different superscript are significantly different ($p < 0.05$).

Table 2: Mineral Composition of Seed and Pulp of *Faidherbia albida*

Element	Seed (mg/100g DM)	Pulp (mg/100g DM)
Calcium	136.6 ± 5.0 ^a	55.0 ± 5.0 ^b
Magnesium	135.0 ± 2.0 ^a	84.7 ± 3.0 ^b
Phosphorus	26.6 ± 0.9 ^b	29.6 ± 0.7 ^a
Potassium	144.5 ± 0.2 ^a	88.8 ± 0.1 ^b
Sodium	12.5 ± 0.1 ^a	6.8 ± 0.1 ^b
Iron	6.2 ± 0.2 ^b	8.8 ± 0.3 ^a
Copper	5.8 ± 0.1 ^a	2.5 ± 0.1 ^b
Zinc	8.0 ± 0.1 ^a	3.0 ± 0.1 ^b

The data are mean value ± standard deviation (SD) of three replicates. Values within a row marked with different superscript are significantly different ($p < 0.05$).

Table 3: Amount of seeds and pulp of *Faidherbia albida* to be consumed to give the minerals recommended dietary levels for Ruminants

Mineral	*Recommended dietary levels for Ruminants (mg)	Seeds (mg)	Pulp (mg)
K	500 – 1,000	346 – 692	563 – 1,126
Na	60 – 180	480 – 1,440	878 – 2,635
Ca	190 – 820	139 – 600	345 – 1,491
Mg	100 – 250	74 – 185	118 – 295
P	120 – 480	451 – 1,805	402 – 1,608
Fe	3.0 – 5.0	48 – 81	34 – 57
Cu	0.7 – 1.1	12 – 19	28 – 44
Zn	2.0 – 4.0	25 – 50	67 – 133

*Source: Khanal and Subba, 2001.

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