NUTRIENT EVALUATION OF FOREST PLANT SEEDS FOR THEIR POTENTIAL APPLICATION AS ALTERNATIVE COST-BENEFIT FEEDS IN LIVESTOCK RATIONS

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Submitted: 4/9/2022; Accepted: 29/11/2022; Published: 15/2/2023

SUMMARY

This study investigated the nutritional qualities of Leucaena leucocephala (Lead tree) and Enterolobium cyclocarpum (Elephant ear) seeds to serve as indexes of nutritional values for its potential use as an alternative cost-benefit feedstuff in livestock feeding. Ripe pods of both plants were collected and processed for analysis using standard analytical procedures. The results showed that the protein content of L. leucocephala seeds was 17.88% and lower than the 24.66% recorded for E. cyclocarpum. There are considerable levels of crude fat, crude fibre, ash, and nitrogen-free extract in both seeds. The seeds were found to have high levels of vitamin A, D, C, E and B complex. Vitamin A is the most abundant recorded in both samples with a concentration of 65.27±5.05 mg/100g in L. leucocephala and 58.76±2.10 mg/100g in E. cyclocarpum, while vitamin B is the least found in both seeds. The results further revealed that the presence of anti-nutritional factors, which include 4.26±1.23 µg/g and 3.27±0.23 µg/g of alkaloids and 3.50±0.72 µg/g and 2.80±0.73 µg/g of tannins for L. leucocephala and E cyclocarpum respectively. Saponin, phenolic compounds, phytate, oxalate, and glycosides were also present at considerable levels. The findings of this study support the potential use of L. leucocephala and E. cyclocarpum seeds as an alternative to conventional animal feed ingredients to reduce competition between humans and animals for conventional field crops. The anti-nutritional compounds found in the sample seeds required more studies to minimize or reduce it by treating with different processing methods, which include boiling, roasting, fermentation and soaking.

Keywords: Forest seeds, cost-benefit, livestock, feed industry, nutrients

INTRODUCTION

A serious challenge to human survival, particularly in the developing world, is the ever-growing gap between the human population and available food supply due to overdependence on a few species of farm crops as food. Ekue *et al*. (2010) reported that food security is a challenge and a major concern as a result of over-dependence on a few plant species for human food in the world.

In most developing tropical countries, the food situation is worsening owing to the increase population, shortage of fertile land, and high prices of fertile land, leading to higher prices of available staples (Nwosu, 2011). Given the increasing demand for protein and energy to support the growing world population, researchers have directed their efforts at exploring new and nonconventional sources of animal feeds (Magdi, 2004).

Wild seeds offer a convenient but cheap means of providing adequate supplies of these nutrients to humans and animals living within the tropics (Eromosele *et al.*, 1991). There are over 7000 plant species that can be used for food (Golden *et al.*, 2002), but the world today relies on just a few for its energy requirements. Hundreds of locally wild plant species and domestic species that are rich in nutrients, which require minimum management have been neglected and underutilized (Padulosi *et al*., 2006). Over the last two decades in a context of much stronger awareness of the interaction between agriculture and the environment, rapid climate change, a realization of the need for a highly diversified diet rich in essential nutrients for good health benefits, has necessitated the need for those neglected and under-utilized plants or species to attract considerable interest in the areas of nutrition and food security, income generation and medicinal value (FAO, 2015). Such plants have been identified but the lack of data on their chemical composition has limited their prospects for their broad utilization (Viano *et al*., 1995).

Commercialization of these species can help in so many ways such as providing income opportunities and traditional pharmacology information. However, the quality of feed depends upon the presence of relatively high contents of various nutrients such as proteins, fat, carbohydrate, vitamins and minerals (Gopalan *et al*., 2004) and the availability of these nutrients after ingestion also depends on the anti-nutritional factors present in the seeds (Ladeji *et al.*, 2004).

According to Shanthankumari *et al.* (2008), a major limiting factor when it comes to the utilization of many tropical plants is the presence of a wide range of natural compounds capable of causing effects which may be harmful to man, and reduction in nutrients bioavailability. Panhwar (2005) reported that anti-nutritional factors, also called anti-nutrients,

were poisonous substances found in most feed and able to limit nutrient availability to the body.

Deleterious effects of anti-nutrients are mostly caused by raw plant materials. It has however been found that the majority of these anti-nutrients become ineffective upon putting in measures such as heating, soaking and autoclaving (Kassie *et al.*, 1999).

Research and development focused on the lesser-known edible plants could assist in narrowing the gap between population growth and food deficiency currently escalating in developing countries. Hence, the nutritional composition of lesser-known plants will culminate with the publication of food composition data and its inclusion in new or reviewed food tables. The use of these wild plants in animal feed will help reduce the present dependence on other competitive crops used in formulating animal feeds. However, before advocating the utilization of these plant seeds for supplementation of animal feeds, there is a need to explore the nutritional composition. Hence, this study investigated the nutritional potential of some selected wild plant seeds to serve as indexes of nutritional values for both domesticated aquatic and terrestrial animals.

MATERIALS AND METHODS

Collection and processing of sample seeds:

Ripe pods of *Leucaena leucocephala* (Lead tree) and *Enterolobium cyclocarpum* (Elephant ear) were identified with the aid of keys described by FACT (1997) and Orwa *et al.* (2009) and collected from the Federal University of Agriculture Abeokuta (FUNAAB), Abeokuta, Ogun State, Nigeria. The seeds were separately removed mechanically from the pods and cleaned to remove dirt. The seed samples were air-dried for five days and finally ground in an electric mill (National Food Grinder, Model MK308, Japan). It was then passed through a 40 mesh sieve, packaged in airtight sterile bottles, labelled and stored in a plastic container and taken to the laboratory for analysis.

The proximate, vitamins and phytochemical analyses were carried out in the laboratory of the Institute for Agriculture Research and Training (IAR&T), Moor Plantation, Ibadan, Oyo State, Nigeria.

Plate 1: *Leucaena leucocephala*seeds

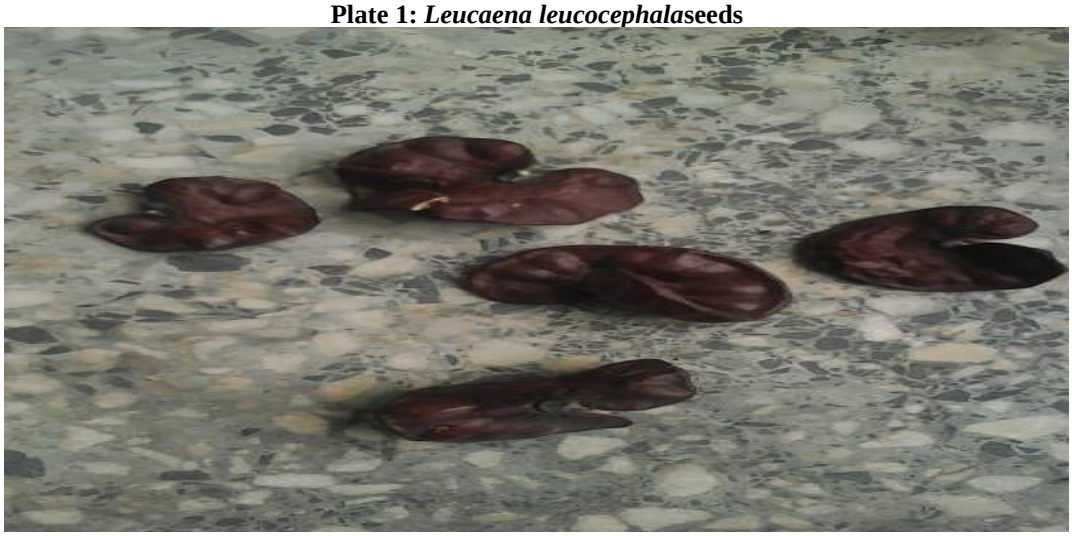

Plate 2: *Enterolobium cyclocarpum*

Proximate analysis:

The chemical analysis of crude protein, dry matter, carbohydrate, crude fibre, fat and ash was determined according to methods described by AOAC (2000). All analyses were done in triplicates.

Vitamins analysis:

Different vitamins such as Vitamin A, Vitamin B1, B2, B3, B12, Vitamin C, Vitamin E and Vitamin K were analyzed according to the standard methods of AOAC (2006).

Anti-nutritional analysis:

Analyses for anti-nutritional factors were carried out, and the proportion of the respective anti-nutritive factors such as tannins, saponins, oxalate, alkaloids, flavonoids, steroids and cardiac glycosides were evaluated according to the standard chemicals procedures (AOAC, 1990 and 2000).

Data Analysis:

All data generated were subjected to Statistical Package for Social Sciences (SPSS) for analysis.

Statistical analysis data were expressed as means values ±standard error of three parallel measurements obtained from the study.

RESULTS

From the study, the protein content of *L. leucocephala* was 17.88±1.13 % and was comparatively lower than the 24.66±2.88 % recorded for *E. cyclocarpum.* The results of crude fat, crude fibre, ash, moisture and nitrogen-free extract were 5.69±0.14 %, 7.52±0.17 %, 6.39 ±0.41 %, 7.21±0.19 % and 55.31±4.97 % in for *L. leucocephala* seeds respectively; while it was 9.38±1.30 %, 8.47±0.34 %, 7.26±0.13 %, 8.27±0.29 % and 41.96±1.74 %respectively in for *E. cyclocarpum* (Table 1).

The results of the vitamins composition are shown in Table (2). Vitamin A is the most abundant vitamin found in both samples with a concentration of 65.27 ±5.05 mg/100g in *L. leucocephala* and 58.76±2.10 mg/100g in *E. cyclocarpum* while vitamin B1 is the least abundant in both seeds sample with the value of 0.33±0.01 mg/100g and 0.19±0.01 mg/100g for *L. leucocephala* and *E cyclocarpum*, respectively.

The results of Vitamin D were (34.86±3.04 mg/100g and 21.69±0.73 mg/100g), vitamin C (21.38±1.04 mg/100g and 13.25±2.05), vitamin E (14.31±0.09 mg/100g and 9.65±0.61 mg/100g) and vitamin B12 (0.74±0.11 mg/100g and 0.56±0.02 mg/100g) for both *L. leucocephala* and *E cyclocarpum*, respectively.

Table 1. The proximate composition of *Leucaena leucocephala* (Lead tree) and *Enterolobium cyclocarpum* (Elephant ear) seeds (on a DM basis)

Proximate compositions	Plant samples (% composition)	
	***Leucaena leucocephala* seed**	***Enterolobium cyclocarpum* seed**
Crude Protein	17.88±1.13	24.66±2.88
Crude Fat	5.69±0.14	9.38±1.3
Crude Fibre	7.52±0.17	8.47±0.34
Ash	6.39±0.41	7.26±0.13
Moisture	7.21±0.19	8.27±0.29
NFE	55.31±4.97	41.96±1.74

Note: Mean values ±standard error

Table 2: Vitamins composition of *Leucaena leucocephala* (Lead tree) and *Enterolobium cyclocarpum* (Elephant ear) seeds (on DM basis)

Vitamins	Plant samples (mg/100g)	
	***Leucaena leucocephala* seed**	***Enterolobium cyclocarpum* seed**
A	65.27±5.05	58.76±2.10
B1	0.33±0.01	0.19±0.01
B12	0.74±0.11	0.56±0.02
C	21.38±1.04	13.25±2.05
D	34.86±3.04	21.69±0.73
E	14.31±0.09	9.65±0.61

Note: Mean values ±standard error

The utilization of wild seeds has raised concern due to the presence of anti-nutritional constituents, which interferes with the availability of nutrients, such as phytate forming insoluble complexes, or tannins bind proteins forming tannins-protein compounds while it can also chelate with minerals such as zinc, calcium, copper, and iron, hence reducing the utilization of these elements.

Table (3) shows the anti-nutrient compositions of *L. leucocephala* and *E. cyclocarpum* seeds samples. The concentrations of phytate (1.73±0.22 µg/g and 1.57±0.53 µg/g), oxalate (1.26±0.10 µg/g and 1.18±0.21 µg/g), tannin (3.50±0.72 µg/g and 2.80±0.73 µg/g), saponin (2.54±1.01 µg/g and 1.37±0.52 µg/g), an alkaloid (4.26±1.23 µg/g and 3.27±0.23 µg/g), phenolic (2.25±0.40 µg/g and 1.96±0.26 µg/g) and glycosides (1.24±0.07 µg/g and 0.96±0.17 µg/g) in both seeds revealed that there are high levels of anti-nutritional factors in *L. leucocephala* seed than E. *cyclocarpum* seeds. It is also noteworthy that alkaloids have the highest composition while glycosides have the least value in both seeds.

Table 3: Anti-nutrient contents of *Leucaena leucocephala* (Lead tree) and *Enterolobium cyclocarpum* (Elephant ear) seeds (on DM basis)

Phytochemicals properties	Plant samples seed concentration (µg/g)	
	Leucaena leucocephala	*Enterolobium cyclocarpum*
Phytate	1.73±0.22	1.57±0.53
Oxalate	1.26±0.10	1.18±0.21
Tannins	2.25±0.40	1.96±0.26
Saponin	2.54±1.01	1.37±0.52
Alkaloid	4.26±1.23	3.27±0.23
Phenolic	3.50±0.72	2.80±0.73
Glycosides	1.24±0.07	0.96±0.17

Note: Mean values ±standard error

DISCUSSION

This study revealed that in addition to their high protein content, *L. leucocephala* and *E. cyclocarpum* seeds contain a high concentration of vitamins, especially vitamins A, C and D.

The chemical composition of the seeds under study revealed that they have the potential to fill the gap in the animal feed industry and these results agree with Babayemi and Bamikole (2006) observations that forage seeds are rich in crude protein and hold prospects as a feed for animal feed production. Moreover, Arigbede *et al*. (2008) in a research trial discovered that some of the adaptable tree species including *E. cyclocarpum* produce seeds that have high protein content.

The crude protein from *E. cyclocarpum* seeds in this study was a similar result to what was obtained from the boiled seeds of the same plant for animal feed production (Ojo *et al*., 2018). Protein content found in the seeds of *L. leucocephala* and *E. cyclocarpum* in this study were comparatively higher than 15.35 % and 14.84 % as reported for both soaked and raw seeds respectively of *Napoleona imperialis* fed to finisher broilers (Uchegbu *et al*., 2010). Both plants in the current study also contain a high level of crude fat; which is a source of energy and required for optimum system regulation in fish (Eyo, 2003a).

The crude fibre and ash of both seeds are comparatively lower when compared with the composition found in *Canavalia cathartica* (Coastal dune) seeds (D'Cunha *et al.*, 2009). Hasan (2001) stated that feed ingredient with crude fibre exceeding 8-12% is not desirable for fish feed production because it will lead to a decrease in nutrient digestibility and eventually the poor performance of the fish. However, the crude fibre composition of both *L. leucocephala* and *E. cyclocarpum* seeds is within the range suggested for livestock feed ingredients (Amata, 2014).

The Vitamins contents in both plant seeds are generally higher than those reported for other legumes (Akinhanmi *et al*., 2008; Aremu *et al*., 2006), hence, it has the potential to supply a sufficient amount of vitamins for livestock. Adelakun*et al*. (2014) recommended the inclusion of *Sterculia setigera* (a plant with a comparatively low level of vitamins) in fish feed. However, high levels of vitamins in *L. leucocephala* and *E. cyclocarpum* seeds make both plants good alternatives to conventional livestock feed ingredients in the tropics.

The anti-nutrient properties were relatively low in the seeds investigated when compared to reported values in some crop seeds (Akinyede *et al.,* 2005 and Johnson *et al.,* 2012). These anti-nutritional factors could be detrimental to available nutrients in livestocks feed, therefore high intake may reduce digestibility and rumen microbial activity, which will consequently affect the growth performance of animals (Soetan and Oyewole, 2009). However, anti-nutritional compounds found in the *L. leucocephala* and *E. cyclocarpum* seeds can be minimized or reduced if treated by different processing methods, which include boiling, roasting, fermentation and soaking (Soetan, 2008).

CONCLUSION

The present study showed that both *L. leucocephala* and *E. cyclocarpum* have an appreciable amount of crude protein, crude fats, crude fibre, ash content, and carbohydrate. Though there was variability in levels of proteins and carbohydrates as well as vitamins, and this may be important for the selection of nutrient-rich compliances for a particular species. The seeds under

study were also found to have high levels of vitamins A, D, C, E, B, and B12 and can also be a good source of other essential nutrients, indicating that *L. leucocephala* and *E. cyclocarpum* can be used as a nutritionally valuable ingredient in animal feeding.

The finding of this study supports the potential use of *L. leucocephala* and *E. cyclocarpum* seeds in the food processing industry as well as an alternative to conventional animal feed ingredients to reduce competition between humans and animals for conventional feed crops.

Perspectives for further research are also recommended to determine the bioavailability of minerals elements and the best processing techniques to reduce anti-nutritional factors that may be p*L. leucocephala* and *E. cyclocarpum* seeds to make case for its inclusion in the animal feed industry.

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التقييم الغذائي لبذور نباتات الأشجار لإمكانية إستخدامها كأعلاف بديلة منخفضة التكلفة في علائق الحيوانات المزرعية

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أجريت هذه الدراسة لإجراء التقييم الغذائي لبذور الليوسينا *Leucaena leucocephala* وبذور أذن الفيل *Enterolobium cyclocarpum* لتكون بمثابة مؤشر لإمكانية إستخدامها كأعلاف بديلة منخفضة التكلفة في تغذية الحيوانات المزرعية.

تم جمع القرون الناضجة من كلا النباتين وتجهيزها للتحليل باستخدام إجراءات التحليل الكيماوي القياسية. أظهرت النتائج أن محتوى البروتين في بذور الليوسينا كان ١٧,٨٨٪ بينما كانت ٢٤,٦٦٪ في بذور أذن الفيل. وأيضاً مستويات كبيرة من الدهن الخام والألياف الخام والرماد والمستخلص الخالي من النيتروجين في كلا البذور. وجد أن البذور تحتوي على مستويات عالية من فيتامين A وD وC وE وB المركب. أظهرت نتائج التحليل أن فيتامين A هو الأكثر وفرة في كلا النوعين من البذور بتركيز ٦٥,٢٧ ± ٥,٠٥ مجم / ١٠٠ جم في بذور الليوسينا و٥٨,٧٦ ± ٢,١٠ مجم / ١٠٠ جرام في بذور أذن الفيل بينما فيتامين B هو الأقل وجوداً في كلا البذور. أظهرت النتائج كذلك وجود عوامل مضادة للتغذية والتي تشمل ٤,٢٦ ± ١,٢٣ ميكروجرام / جرام و٣,٢٧ ± ٠,٢٣ ميكروجرام / جرام من القلويدات و٣,٥٠ ± ٠,٧٢ ميكروجرام / جرام و٢,٨٠ ± ٠,٧٣ ميكروجرام / جرام من التانينات في بذور الليوسينا وبذور أذن الفيل على الترتيب.

كما أن الصابونين والمركبات الفينولية والفيتات والأكسالات والجليكوسيدات كانت موجودة أيضًا بمستويات كبيرة. توضح نتائج هذه الدراسة الاستخدام المحتمل لبذور الليسوسينا وبذور أذن الفيلكبديل لمكونات العلف الحيواني التقليدية لتقليل المنافسة بين الإنسان والحيوانات على المحاصيل الحقلية التقليدية. تتطلب المركبات المضادة للتغذية الموجودة في البذور مزيدًا من الدراسات لتقليلها أو الحد منها عن طريق المعالجة بطرق مختلفة، والتي تشمل الغليان والتحميص والتخمير والنقع.