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Chemical Composition, Calcium, Zinc and Phytate Interrelationships in *Albizia lebbeck* and *Daniellia oliveri* seeds

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ABSTRACT

The chemical, nutritive and antinutritive values of *Albizia lebbeck* and *Daniellia oliveri* seeds flour were determined. The seeds have very high protein contents of 42.8% and 33.4% and moderately high contents of carbohydrate of 32.5% and 44.6% respectively. The most abundant mineral in the seeds flour is K (540mg/100g) and (680mg/100g) followed by Mg (366mg/100g) in *Albizia lebbeck* and Ca (263mg/100g) in *Dariellia oliveri*. The least abundant minerals are Zn (2.22mg/100g) and 1.52mg/100g, Cu (5.12mg/100g) and (2.23mg/100g), also Mn (3.23mg/100g and (6.47mg/100g for the two seeds respectively. The levels of Na/K, Ca/P and Ca/Mg in the seeds flour are desirable when compared with the recommended valves. The antinutrional factors showed the presence of flavonoid, Tannie acid, saponin and alkaloid with values ranging from 0.22 to 1.37% for *Albizia lebbeck* and 0.86 to 7.48% for *Deniellia oliveri*. Other antinutrients are cyanide, polyphenols, phytate and oxalate. Their low values showed that the seeds may be recommended for human consumption. The prediction of Zn availability was determined using Phy: Zn, Ca: Phy and Ca x Phy/Zn molar rations which indicate an adequate availability of Zn.

Key words: *Albizia lebbeck, Daniellia oliveri*, Chemical nutritive, Mineral, Antinutritional.

INTRODUCTION

Albizia lebbeck belongs to the family Mimosaceae. It is a moderate to large deciduos tree that reaches 30m in height in rain forests. The tree develops a straight holed when grown in dense forest, but it spreads and low branching in the open. *Albizia lebbeck* tree, annually, produce abundant seeds from papery pods; of about 20cm long and 3cm wide. “Woman’s tongue” and “rattle pod” are derived from the noise of pods shaking in the wind. (Hedge and Relward, 1981). It is a well known in the Indian subcontinent for its range of uses. Although geographically widespread, little is known about the species outside India.

Deniellia oliveri is known as “Iya” in Yoruba and Rolfe in English. According to Balogun and Adebayo (2009), *Deniellia oliveri* is in amazon region of South America while Keay *et al*. (1964) said the tree is particularly found in abundance in the "moisten" savannah forest zones in Nigeria which extends westernly to Senegal, East to Sudan and South to Angola.

Phytic acid (myo –inositol hexa-phosphate) is a theromolabile rachitogenic agent (Metor, 1993). It is an important constituent of certain legumes, cereals and forage plants which is capable of chelating divalent cationic minerals like calcium, iron, magnesium and zinc (Liener, 1983). They are extremely insoluble even at pH 3 – 4 and are not readily absorbed from the intestinal tract. Such chelates make the elements nutritionally unavailable thereby inducing dietary deficiency. Phytic acid has been implicated in the reduced adsorption of calcium from the gastro intestinal tracts and consequently causing rickets when chicks are fed with cereals such as sorghum (Nelson *et al.,* 1968). Similarly, zinc and iron deficiency symptoms have been reported in man and chicken when fed with diets high in phytic acid.

Nwokolo and Bragg (1977) have shown that there is a significant inverse relationship between phytic acid and the availability of calcium, magnesium, phosphorus and zinc in feed stuffs like soybean, palm kernel, rape seed and cotton seed meals. High levels of phytic acid in monogastric animals can reduce the absorption of calcium by up to 35% as well as chelating with iron, magnesium and zinc. Phytic acid can react with protein to form phytate – protein complex (O'Dell and Savage, 1960). This complex, incorporates about 16% of the protein in beans, through the reaction is pH dependent. Formation of phytate – cation protein complex is believed to account for the decreased mineral bioavailability observed in animals consuming diets high in phytic acid.

Studies investigating the significance of the Phy:Zn, Ca:Phy and Ca x Phy:Zn interaction for human zinc status are limited because information on the Zinc and Phytate content of foods is not available (Adeyeye *et al.,* 2000).

There is little or no information about these seeds, so the purpose of this work is to determine the chemical composition, nutritive and antinutritive values of these seeds to enchase the food composition table.

MATERIAL AND METHODS

Albizia lebbeck and Deniellia oliveri seeds were harvested from trees abundant in and around Ahmadu Bello University, Zaria and Federal University of Agriculture, Markurdi, all in the Northern part of Nigeria. The seeds were sun dried, de-shellled powered and stored in polythene bags until used.

Chemical composition and antinutrional analysis

Chemical composition and antinutrional analysis were carried out according to the procedure of Association of Official Analystical Chemist (AOAC, 1995).

Mineral composition

One gram of the seed flour was weighed into the crucible. The sample was ashed in a muffle furnace at 550^{0}C until completely ashed. The ash was dissolved into 10% ($^V/_V$) HCl, heated to boiling, cooled and filtered and made up to 100ml mark in a volumetric flask with deionized water and the mineral analysis was determined by Atomic Absorption Spectroscopy (AAS) (Vogel, 1962).

RESULTS AND DISCUSSION

Table 1 shows the proximate composition, bulk density, calculated metabolisable energy and calculated fatty acid values of *Albizia lebbeck & Davellia oliveri*. The moisture content 3.23 and 2.85 is low compared with most tropical crop seeds. Tiger nut (*cyperus esculentus*) 9.47% (monago And Unwakwe ,2009) and whole meal flour (Triticum dinim) 7.93% (Adeyeye and Aye, 2005). The low moisture content in the seeds flour suggest that they will have a long shelf life (Oyenuga, 1968), since the low moisture content may prevent microbial spoilage and pest attack during storage. The crude fat value of the seeds 13.40% & 8.32% are also low when compare with that of *B. glabra* seed of 34.8% (Olaofe *et al*., 2006), *Cucumeropsis edulis* 43.8% (Ige *et al*., 1994) and pumpkin seed 47.7% (Aisegbu, 1989) but the value of *Albizia* agree with that of pitanga cherries 15.63% (Amoo *et al*., 2006). The crude fat of these seeds show that they will be a good source of fat which provides a major portion of man's energy. The crude protein of these seeds 42.80% & 33.40% are higher than some tropical tree seeds, breadnut 19.25% (Oshodi *et al*., 1999), *Bombcopsis glabra* 16.56% (Olaofe *et al*., 2006) benniseed 22.5% (Oshodi *et al*., 1999) and locust bean 24.1% (Adeyeye *et al*., 2002). The high protein content of these seeds show that they would be useful as alternative source of protein in livestock feeding and also in man, especially in Nigeria where the scarcity and the cost of the conventionally used plant protein sources have nearly paralyzed most of the industries. The value of the ash 4.51% & 4.30% in these seeds show that they may have a reasonable quantity of mineral elements for building healthy body and proper functioning of body tissues. The considerable amount of crude fibre 3.56% & 6.35% in these seeds show that they will enhance easy movement of bolus in the large intestine. Relatively high energy values 1776 & 1634mg/100g of *Albzia lebbeck* and *Daiella* oliveri seeds indicate that they are concentrated sources of energy and within the recommended energy dietary allowances for children (FAO, 1990).

Table 2 presents the mineral composition of the seeds. The most abundant minerals are K (540 & 680mg/100g), Mg (366 & 168mg/100g), Ca (320 & 263mg/100g), P (420 & 384mg/100g) and Fe (14.60 & 26.4mg/100g). The observation that K is the most abundant mineral element is consistent with the observation of Olaofe and Sanni (1988) and Oshodi *et al*, (1999) who reported K to be the most abundant mineral in Nigerian agricultural products. High amount of calcium, potassium and magnesium (as macro elements) may help to lower the blood pressure (Ranhotra *et al*., 1998). Several clinical studies have shown potassium, magnesium and calcium to be effective pressure lowering agents (Osborne *et al*., 1996); Zewel, 1977) hence consumption of these seeds flour may help achieve this purpose

The iron content of the seeds flour are 14.6 & 26.4mg/100g. This shows that these seeds flour are very rich in Fe. Iron is very important for the formation of haemoglobin and normal functioning of the central nervous system (Vyas and Chandra, 1984).The iron contents of these seeds are higher than that of African pear 6.41mg/100g (Ibanga and Okon, 2009), *Triticum durum* flour 4.93mg/100g (Adeyeye and Aye, 2005) that of locust bean 1.9mg/100g (Adeyeye *et al*., 2002) and that of chickpea seed 7.72mg/100g. But the values are lower than that of *Bombcopsis glabra* 30.0mg/100g (Olaofe *et al*., 2006).

The Ca/P and Ca/Mg weight ratios are 0.76, 0.68 and 1.56 respectively. The values are

Table 1: Proximate Composition of *Albizia lebbeck and Daniellia oliveri* seeds flour

Parameter	Concentration	
	Albizia lebbeck	***Danielia oliveri***
Moisture	3.23 ± 0.33	2.85 ± 0.23
Crude fat	13.40 ± 0.42	8.32 ± 0.42
Crude protein	42.80 ± 0.40	33.40 ± 0.40
Ash	4.51 ± 0.24	4.30 ± 0.35
Crude fibre	3.56 ± 0.32	6.35 ± 0.53
Carbohydrate (by difference)	32.50 ± 0.30	44.60 ± 0.30
Bulk density (g/cm^3)	0.44 ± 0.33	0.41 ± 0.52
Calculated fatty acid (g/100g)	10.7	6.66
Energy (KJ/100g)	1776	1634

Each value represents mean ± standard deviation of three replicate determinations.
Calculate fatty acid = (0.8 x crude fat)g/100g (Aremu *et al.,* 2006).

low when compared with the recommended 1.0 and 2.2 respectively (NRC, 1989). The low values of Ca/Mg and Ca/P may be due to the low calcium content or high content of phosphorus of the seeds flours. Ca, P and Mg are important in the formation of bones and teeth as well as in controlling the level of Ca in the blood of animals (NRC, 1989; Osborne and Voogt, 1978). The calcium supplementation in the diet based on these seeds flour may be necessary to prevent Ca deficiency diseases like rickets.

Table 2 also presents other antinutritional factors in the seed flour. The oxalate content of the seeds are low (0.14 & 0.19mg/100g) when compared with that of Chinese gourd 1.48mg/100g. Oxalic acid has the ability to bind some divalent metals such as Ca and Mg and has therefore been suspected of interfering with the metabolism of these minerals. According to Blood and Henderson (1974), the ingestion of an excessive amount of oxalate could cause gastrointestinal irritation, blockage of the renal tubules by calcium oxalate crystals, muscular weakness or paralysis. Plants generally tend to accumulate high oxalate levels during the early stages of growth (Aletor, 1993). We are not expecting any nutritional discomfort with the level of oxalate in these seeds.

Polyphenols and tannins in legumes are known to inhibit the activities of digestive enzymes (Jambunathan and Singh, 1981) and nutritional effects are mainly related to their interraction with protein and minerals. They also reduce the absorption of nutrients such as vitamin B_{12} (Linier, 1989). Tannin-protein complexes are insoluble and this decreases the protein digestibility (Carnovale *et al.*, 1991). The concentrations of polyphenols for *Albizia lebbeck* are 0.16 and 0.49%. These are lower than that of mucuna species which ranges from 4.34 to 7.75 (Adebowale *et al.*, 2005) and that reported for conventional legume *Vigina radiate* 1 .45%.The concentration of tannic acid 0.65 & 1.22% for the seeds flour are lower than that of chickpea seed 4.88% (Tarek, 2002).

Phytates (hexaphosphate of myo-inositol) are common antinutrients in plant seeds. They chelate di-and trivalent mineral ions, such as Ca^{2+}, Mg^{2+}, Zn^{2+} and Fe^{3+} resulting in reduced bioavailability of trace minerals to consumers (Duffus and Duffus, 1991). Phytate concentrations of these seeds flour are 3.83 & 7.13%. These values are higher than that of mucuna species 1.23% to 2.56% (Adebowale *et al.*, 2003) and that of sesbania seeds 1.89% to 2.37% (Hossain and Becker, 2001).

The saponins are diverse group of compounds containing an aglycone linked to one or more biological effects in animals including erythrocyte haemolysis, depressed growth, reduced feed intake and effect on nutrient absorption and bile acid metabolism (Cheecke, 1996). The concentrations of saponin for these seeds are 0.53 & 3.27% which are in close agreement with that of mucuna seeds which ranges from 0.52 to 3.0 (Adebowale *et al.*, 2005) but higher than that of sesbania seeds 0.50-1.46% (Hossain and Becker, 2001).

It has been known for a long time that a wide variety of plants are potentially toxic because

Table 2: Mineral Contents (mg/100g) of *Albizia lebbeck* and *Daniellia oliveri*

Mineral & Antinutrients (mg/100g)	*Albizia lebbeck*	*Danielia oliveri*
Ca	320	263
Mg	366	168
K	540	680
Na	7.22	7.42
Na/K	0.05	0.011
Fe	14.6	26.4
Mn	3.23	6.47
Zn	2.22	1.52
Cu	5.12	2.23
P	420	384
Ca/P	0.76	0.68
Tannic acid	0.65	1.22
Polyphenol	0.16	0.49
Cyanide	0.093	0.42
Phytate	3.83	7.13
Oxalate	0.14	0.19
Alkaloid %	1.37	7.48
Saponin %	0.53	3.27
Flavonoid %	0.22	0.86

they contain glycosides from which hydrogen cyanide may be released by hydrolysis (Conn, 1979) Hydrolysis occurs quite rapidly when the ground plant is cooked in water, and most of the liberated hydrogen cyanide is lost by volatilization. The concentrations of cyanide in these seeds are 0.093 & 0.42% which are lower than the values for kidney bean 2.0% and garden pea 2.3% (Montgomery, 1969). These results show that *Albizia lebbeck* and *Daniellia oliveri* seeds contain minimum levels of antinutritional factors which the body can accommodate and these can also be reduced by boiling. According to Fagbemi *et al*, (2005), processing especially boiling can effectively reduce the antinutritional factors.

Table 3 presents the results of Ca, Zn, Phytate (Phy), Phy: Zn, Ca: phy, phytinphosphorus and Ca x Phy/Zn. Oberleas and Harland (1981) showed that foods with a molar ratio of Phy:Zn less than 10 showed adequate availability of Zn and problems were encountered when the value was greater than 15. In Table 4.3, the Phy:Zn ratios are shown for all the seeds flour, the values were less than 10 which indicate adequate availability of Zn.

Table 3: Concentration of Ca, Zn, Phytate and Calculated Phy:Zn, Ca:Phy and [Ca][Phy]/[Zn] Mole ratios of *Albizia lebbeck* and *Daniellia oliveri*

Mineral & Antinutrient	*Albizia lebbeck*	*Danielia oliveri*
Phytin phosphorus pP%	1.2	0.22
Ca (mg/100g)	320	263
Zn (mg/100g)	2.22	1.52
P (mg/100g)	420	384
Phytate (g/100g)	3.83	7.13
[a] Phy: Zn	0.17	0.48
[b] Ca: Phy	1379	636
[c] [Ca][Phy]/[Zn]	0.014	0.03
pP/P %	0.29	0.06
Ca/P	0.76	0.68
Ca/Mg	0.87	1.56

[a](mg of Phy/MW (molecular weight) of Phy: Mg of Zn/MW of Zn)

[b](mg of Ca/MW of Ca:Mg of Phy/MW of Phy)

[c](Mol/kg of Ca) (Mol/kg Phy/Mol/kg Zn)

Also phytic acid has been observed to have markedly decreased Ca bioavailability and the Ca: Phy molar ratio has been proposed as an indicator of Ca bioavailability. The critical molar ratio of Ca:Phy is reported to be 6.1 (Oladimeji, 2000). The molar ratio of Ca;Phy obtained for *Albizia lebbeck* and *Daniellia oliveri* are 1379 and 636. These values are much, much greater than reported critical molar ratio of Ca:Phy, indicating that absorption of calcium would not be affected by phytate in the seeds flour.

Ellis *et al.*, (1987) and Davies and Warrignton (1986) indicated that the ratio of Ca x Phy/Zn is a better predictor of Zn availability and that if the values were greater than 0.5mol/kg, there would be interferences with the availability of Zn. For *Albizia lebbeck* and *Daniellia oliveri* are seeds flour the Ca x Phy/Zn value is less than 0.5, which means that there would not be interferences in the availability of Zn. Ekpedeme *et al*, (2000) reported that high levels of anti-nutrients, such as oxalate, phytic acid and HCN, are known to be very poisonous to humans. Since the results indicated that the seeds flour have low amount of phytates, (1.2 & 0.22 phytin phoshorus), the bioavailability of essential dietary minerals, especially calcium and zinc were assured.

The total phosphorus of *Albizia lebbeck* and *Daniellia oliveri* 420 & 384mg/100g are higher than that of Chinese bottle gourd (*Lagenaria siceraria*) 51mg/100g (Olaofe and Adeyeye, 2009). Also the value of phytinphosphorus 1.2 & 0.22 for the seeds flour are lower than that of Chinese bottle gourd. This means that only 1.2 & 0.22total phosphorus were linked to phytin for *Albizia lebbeck* and *Daniellia oliveri* respectively. The nutritional implication of high phytin phosphorus rests on the fact that monogastric animals lack phytase, which can break down the phytin to release phosphorus for utilization (Olaofe and Adeyeye, 2009). It means that with the low values of phytinphosphorus in these seeds flour, monogastric animal taking them will have the phosphorus released for utilization.

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