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Research Paper

EVALUATION OF MINERALS AND ANTI-NUTRITIONAL FACTORS OF SOME UNDER EXPLOITED LEGUMINOUS CROP SEEDS

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Abstract

The cost of raw material for the production of animal feeds has been a major threat to animal production. This has necessitated the evaluation of adequacy of some underexploited leguminous crop seed for minerals composition and the possible effects of anti-nutritional factors on the availability of the required nutrients. The mineral elements and anti-nutritional factors of Hexalobus crispiflorus, Clitandra togolana and Dioclea reflexa were investigated using standard analytical methods. Analyses carried out for mineral contents of these plants showed significant variation in the seeds; sodium (66.88mg/100g-81.98mg/100g), potassium (94.49mg/100g-135.43mg/100g) magnesium (15.86mg/100g – 27.86mg/100g), calcium (71.49mg/100g-97.30mg/100g) phosphorus (10.58mg/100g – 27.86mg/100g), copper (2.08mg/100g – 5.00mg/100g), zinc (5.63mg/100g-14.06mg/100g) manganese 1.65mg/100mg – 2.94mg/100g) and iron (6.96mg/100g-16.52mg/100g). Values of minerals elements in all the under exploited leguminous crop seeds are relatively lower than the dietary requirements for animal. This might have been affected by the anti-nutritional factors. The composition of anti-nutrients varied as follows. Oxalate (7.74,mg/100g – 11.46mg/100g) Nitrate 1.71mg/100g – 7.71,mg/100g) Tannin (5.47mg/100g – 65.72mg/10g) Saponin (104.00mg/10g – 340.00mg/100g) and phytic acid (355.73mg/100g – 651.33mg/100g).

Key words: *Under exploited Leguminous crop seed, Minerals, Anti nutritional factors, Hexalobus crispiflorus, Clitandra togolana, Dioclea reflexa*.

INTRODUCTION

Formulations for animal feed have been developed but the cost of production of feeds has been a major threat to animal production [1]. Use of cheaper and under exploited leguminous seeds and conventional feed supplement may represent the low cost route to improve animal performance. [2] Evaluated the nutritive value of seeds of some under exploited leguminous crop seeds and concluded that *Hexalobus crispiflorus. Clitandra togolana and Dioclea reflexa* are potentially good sources of dietary energy and protein and may constitute an addition to the list of food legumes being advocated for consumption in Nigeria. A major constraint to the use of legumes as a livestock feed is the presence of toxic and anti-nutritional constituents.

In this study the essential mineral elements and anti-nutritional factors present in under exploited leguminous crop seeds mentioned above are determined in order to provide useful information for nutritionists and the consumers of the seeds. All the crops of interest in the present study are tropical crops and are cultivated in tropical countries including Nigeria for different purposes.

- *Hexalobus crispiflorus* is one of the legumes that is less developed and it is a dicotyledonous plant belonging to the family of leguminosae. This is one of the largest flowering plant families comprising about six hundred genera.
  It could be found in forest and it is grown in Nigeria as ornamental tree. It is also grown in the humid area of the West African rainforest under suitable condition where appropriate climatic and soil requirements are available [3].
  The fruits are eaten and the bark is used medicinally in Equitorial Africa, Nigeria and Ghana. [3] and [4]
- *Clitandra togolana* is a vine found in open forest and Savanna bush [5], also can be found in closed forest. Its distribution is from Ivory Cost to Nigeria. The seed is a specific of *Clitandra genera*. The seed do not open and it is covered with dark brown hard seed coat [6]. It is known locally as "Agba" in Yoruba language and cultivated in the month of January. The fruit is globose and over 1 ½ inches in diameter [3].
- *Dioclea reflexa* (marble wine) is an angiosperm and belongs to dicotyledon plant. It is classified under the sub family leguminous. The plant is a perennial plant. It grows wild in the forests or abandoned farmland. The seeds, which are contained in the pods, may contain as many as eight seeds [3]. The seeds are used with guinea grains as a toxic and stimulant, and are said to be used in Sierra Leone in killing head lice [3]. In Ghana, Nte called it Akan and It is used as marbles and medicine for Asthma [7]. Use of Dioclea reflexa for ritual has been reported [8]. When crushed open, the whitish cotyledons that are exposed are used as food condiments by their culture in some parts of Igbo land in Nigeria.

MATERIAL AND METHODS

Mature seeds of *Hexalobus crispiflorus, Clitandra togolana* and *Dioclea reflexa* were harvested from location around Federal Polytechnic, Ilaro. The seeds were shelled and winnowed manually. The seeds were sun dried, milled into flour in a Wiley mill to pass through an 80 mesh sieve and stored in an airtight container and kept in refrigerator at 4^{o}C prior to use. Triplicate samples were taken from each of the milled seeds sample for minerals and anti-nutritional factors determination. Oxalate was estimated quantitatively by redox titration with standard potassium permanganate, according to the procedure of [9]. Saponin was determined using the method similar to that of [10], Phytic acid was determined in accordance with the procedure of [11]. Tannic acid was determined in accordance with the procedure of [12], Nitrate was analysed by the methods of [13].

Prior to the mineral analysis, samples were digested with a tri acid mixture (concentrated nitric acid, perchloric acid and sulphuric acid) (4,0; 5,0;0.5 V/V).

Phosphorus was analysed by spectrophotometer based on the reaction of phosphorus with molybodovanandate complex, sodium and potassium were determined by flame photometry Standard methods, [12]. Iron, Copper, manganese, zinc, calcium and magnesium were analysed by Perkin Elmer, Model 403 Atomix absorption spectrophotometer. The data obtained from the analysis was subjected to a statistical analysis using univariate analysis of variance and significant treatments of means were

separated by the multiple range test of Duncan according to the procedure stated in SPSS Package [14].

RESULTS AND DISCUSSION

Table 1: Mineral Composition (mg/100g) of *Clitandra togolana, Hexalobus crispiflorus and Dioclea reflexa*

	SAMPLE		
Components	*Hexalabus Crispiflorus*	*Clitandra togolana*	*Dioclea reflexa*
Sodium	$60.88^{a}\pm0.66$	$81.98^{c}\pm2.20$	$70.55^{b}\pm0.58$
Potassium	$111.29^{b}\pm0.15$	$135.43^{c}\pm3.79$	$94.49^{a}\pm2.10$
Magnesium	$27.71^{c}\pm0.15$	$22.21^{b}\pm0.23$	$15.86^{a}\pm0.28$
Calcium	$97.30^{c}\pm0.75$	$71.49^{a}\pm2.27$	$88.51^{b}\pm0.57$
Phosphorus	$10.58^{a}\pm0.19$	$15.94^{b}\pm0.20$	$27.86^{c}\pm0.20$
Copper	$3.33^{b}\pm1.50$	$2.08^{a}\pm0.41$	$5.00^{c}\pm1.10$
Zinc	$5.63^{a}\pm2.81$	$8.45^{b}\pm2.82$	$14.06^{c}\pm5.85$
Manganese	$2.94^{b}\pm0.49$	$2.39^{b}\pm0.18$	$1.65^{a}\pm0.24$
Iron	$6.96^{a}\pm0.87$	$11.30^{b}\pm2.30$	$16.52^{c}\pm1.74$

Mean ± standard deviation of triplicate determinations on dry weight basis.
Values with different superscript in the same row are significantly different ($p < 0.05$).

Table 2: Anti nutritional factors (mg/100g) of *Hexalobus crispiflorus, Clitandra togolana* and *Dioclea reflexa.*

	SAMPLE		
Components	*Hexalobus Crispiflorus*	*Clitandra Togolana*	*Dioclea reflexa*
Oxalate	$11.46^{c}\pm0.06$	$7.74^{a}\pm0.03$	$9.04^{a}\pm0.03$
Nitrate	$4.07^{b}\pm0.77$	$7.71^{c}\pm0.78$	$1.71^{a}\pm0.21$
Tannin	$65.72^{c}\pm0.81$	$40.16^{b}\pm0.54$	$5.41^{a}\pm0.40$
Saponin	$138.00^{b}\pm20.00$	$340.00^{c}\pm40.00^{a}$	$104.03^{a}\pm20.00$
Phytic acid	$590.67^{b}\pm25.30$	$355.75^{a}\pm33.50$	$651.33^{c}\pm29.62$

Mean ± standard deviation of triplicate determinations on dry weight basis.
Values with different superscript in the same row are significantly different ($p < 0.05$).

DISCUSSION

Mineral composition. Table 1 shows the mineral compositions of the samples. Potassium was the most abundant mineral in all the samples. (94.49mg/100g – 135.43mg/100). This is in agreement with the observations of [15] and [16] that potassium is the predominant mineral in Nigerian agricultural products. All the values of potassium obtained for the samples studied are relatively low compared to potassium content of *Telfiara occidentallis* Hook (1078.55±1.2mg/100g) [17] but similar to that reported for Jack Bean 141mg/100g. Calcium ranked next to potassium – in abundance, the values ranged from 71.49mg/100g in *Clitandra togolana* to 97.30mg/100g in *Hexalobus crispiflorus*. These values are low compared to calcium content of *Mucuna utilis flour*. (104.00mg/100g) [19] but higher than lentil seed (38.6mg/100g) and Lima bean (28mg/100g) as reported by [18]. Calcium which play an important role in strengthen the tissues and bones of the body may not be available as a metabolize nutrient in the seeds investigated due to high oxalate and phytic acid

content. As reported by [20] wherever calcium is found in food combined with oxalic acid, the calcium is not free and thus cannot be used by the body. The values of phosphorus ranged from 10.58mg/100g *Hexalobus crispiflorous* to 27.86mg/100g in Dioclea reflexa. These values are comparatively lower than phosphorus content of *Cajanus cajan* (290mg/100g) as reported by [21]. As stated by [22] Phosphorous is an essential component of nucleic acid and nucleoproteins which are responsible for cell division reproduction and heredity. The different in phosphorus in the three crops may be a reflection of the different location where the seed were collected in accordance with the views of [23]. The Recommended Daily Allowance (RDA) of phosphorus for mature animal is 80-120mg/100g [24] Hence the three crop seed cannot provide the dietary phosphorus.

The sodium content of the samples ranged from 60.88±0.60mg/100g in *Hexalobus crispiflorus* to 81.98±2.20mg/100g in *Clitandra togolana*. The values of sodium obtained are low and may be desirable where diets are already over laden with sodium [25]. However, the values are higher than value obtained for lentil seed (36.0mg/100g)]18].

Magnesium is an important mineral elements in connection with circulatory diseases such as Ischemic heart disease and calcium metabolism in bone [26]; [27]. The value of magnesium content of the three crop seed range from 15.86±0.28mg/100g to 27.71±0.15mg/100g. The values are higher than the quantity reported for pumpkin seed flour (5.34±0.05mg/100g) [17] and lower than that of winged beans, (381.8±0.04mg/100g) as stated by [28].

The value of zinc content of the samples are relatively low ranging from 5.63±2.81mg/100g in *Hexalobus crispiflorus* to 14.06±2.85mg/100g in *Dioclea reflexa*. The values are higher than 3.86mg/100g as reported for *Cicer arietinum* and (*Arachis hypogea*) seed flour (14.143mg/100g) by [29] but lower than 17.17±0.90mg/100g as stated by [17] for *Telfairia occidentallis* Hook seed flour. Manganese (Mn) was highest in *Hexalobus crispiflorus* (2.94±0.49mg/100g) and lowest in *Dioclea reflexa*. (1.35±0.24). The highest value is similar to that of *Cicer arietinum* L (< 2.10mg/100g) as stated by [29].

Results obtained for copper for the three crop seeds ranged from 2.08±0.41mg/100g – 5.00±1.10mg/100g. These values are relatively low compared to winged beans 907.7±0.72mg/100g and Orchia fruit 69.31±0.70 as stated by [28] but higher than *Cicer arietinum* L (1.04mg/100g) as reported by [29]. Copper is a mineral that facilitate the absorption or iron & its low availability may account for low content of iron in the samples [30].

Iron content of the three samples followed a trend similar to that obtained for zinc and copper they ranged from 6.96±0.87mg/100g to 16.52mg/100g. The least value was higher that *Arachis hypogea* (3.8mg/100g) and *Cicer arietinum* L (6.42mg/100g as reported by [31] and [29] respectively. However, the values of iron from the three crops seeds were lower than the iron content (200 – 810mg/100g) of some under exploited leguminous seeds in Nigeria reported by [32].

Anti-nutritional factors

The presence of anti-nutritional factors is one of the major drawbacks limiting the nutritional and food qualities of the legume [33]. Table 2 shows the value of the anti-nutritional factors of the crop seeds under investigation. Plant with high oxalate content may produce acute metabolic calcium deficiency (hypocalcemia) when we use plant product as main food source [34].

Studies have shown that oxalic acid effect in food is indigestion of large amount of oxalic which can be toxic. The formation of insoluble complex by oxalate has stimulated the

awareness that consumption of plants containing oxalate may interfere with calcium metabolism. The values of oxalate content of the crop seeds are significantly different ($p<0.05$) and ranges from 7.74mg/100g in *Clitandra tagolana* to 11.46mg/100g in *Hexalobus crispiflorus*. These values are in concordance with values obtained for some under-utilized crop seek in Nigeria [35] but relatively on the low side when compared to reported values in some Lesser known crop seeds [36].

Presence of nitrate in food are non-toxic but may be considered as a potential hazard as they are the prosecutor of nitrites the actual toxic constituents. Nitrate contents of the samples are significantly different ($p<0.05$) with peak values of nitrate obtained in *Clitandra togolana* (7.71±0.78mg/100gm) while the least is in *Dioclea reflexa* (1.71±0.21mg/100g). The nitrate level in the crop seeds is within the safe limit and cannot pose any danger to the animal.

The values of Tannin obtained for the samples are significant different ($p<0.05$) and it ranged from (5.47±0.40mg/100g) in *Dioclea reflexa* to (65.72±0.81mg/100g) in *Hexalobus crispiflorus*. The values obtained for the samples studies are less than 228.31±0.09mg/100g reported for *Telfairia occidentalis* Hook Seed flour (84.3mg/100g) [17].

However they are higher than (2.23mg/100g) reported for pigeon pea (*Cajanus cajan L*) by [37]. [38] described Tannin as phenolic compound whose degree of hydroxylation and molecular size are sufficient to form complexes with protein and also yield precipitate with relative, protein, alkaline salt of many heavy metals e.g. lead, copper, acetate and antimony. The low content of metabolized zinc and copper in the seeds investigated could be linked to high tannic content. *Hexalobus crispiflorus* may probably have low metabolizable protein content as it recorded the highest tannin, content [2]. The Tannin amount in this study may not be as much harmful as expected for consumption. However, relatively some amount of Tannin, like this finding, may have a potential role as protective factors against free radical mediated pathologies, such as cancer and atherosclerosis in human [39].

Saponin is a group of substances that occur in plant and can produce soapy lather with water [40]. The values of Saponin content obtained for the samples ranged from (104.00±20.00mg/100g) in *Dioclea reflexa* seed flour to (340.00±40.00mg/100g) in *Clitandra tagolana*. The results obtained are lower than that of some lesser known crops seeds [36].

The phytic acid content of the samples are significantly different ($p<0.05$) *Dioclea reflexa* had the highest (651.33±29.62mg/100g) while the least is in *Clitandra togolana* (355.73±33.50mg/100g). The phytate content of the crops seeds were lower than (810.50mg/100g) reported for pigeon pea (*Cajanus cajan L*) by [37]. Phytic acid seduces the availability of many minerals like iron zinc, calcium and magnesium. The ability of the phytate to form complexes with these mineral can make the mineral content of a food inadequate especially for children.

Several workers have attributed the incidence of several mineral deficiency symptoms in animals to the occurrence of phytic in seeds [35] it is important to known that most of the seeds contain low level of tannin acid and moderate to high level of phytic acid, this is in accordance with the view of [35].

The anti-nutritional content of the samples under investigation are not out of the range value of different legumes seeds and other crops reported by other literatures.

The compositions of nutrients and anti-nutrients in food plants may vary depending on the variety and growing conditions. This may partly explain the variation in results obtained.

CONCLUSION

The results obtained in this study indicated that all the seeds are deficient in all the minerals elements and unable to meet the animal dietary requirement. Considering the mineral component of the crop seeds alone one will be tempted to arrange them preferentially as *Clitandra togolana Hexalobus crispiflorus* and *Dioclea reflexa* but however, the high anti-nutritional factor of the *Hexalobus crispiflorus* followed by *Dioclea reflexa* ranked *Clitandra togolana* the best out of three crops.

Poor utilization of these minerals element present in crop seeds are caused by the anti nutritional factors prominent, among these are oxalic acid and phytic acid [41] and [42].

The presence of anti-nutritional factors identified in the current study should not pose a problem in human consumption if the seeds are properly processed.

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