PROXIMATE ANALYSIS AND MINERAL DETERMINATION OF *Calliandra surinamensis* SEED

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**ABSTRACT**

Proximate composition (moisture, carbohydrate, protein, ash, fat and fibre) and mineral composition (K, Na, Ca, P, Mg, Se, Fe, Cu and Zn) of *Calliandra surinamensis* seed were determined using standard methods. The % moisture content obtained was (12.80 ± 0.04), % carbohydrate (59.81 ± 0.07), % crude protein (5.95 ± 0.70), % ash (2.63 ± 0.20), % crude fat (4.74 ± 0.17), % crude fibre (14.07 ± 1.33). The mineral content that was analysed in the seed in mg/kg were; K (13.72 ± 1.09), Na (9.50 ± 1.53), Ca (36.92 ± 0.55), Mg (27.50 ± 0.61), Se (0.28 ± 0.11), Fe (0.78 ± 1.29), Cu (0.09 ± 0.08), Zn (0.49 ± 0.10) and P (1.79 ± 0.07). The result revealed that *Calliandra surinamensis* seed has a good shelf-life, high carbohydrate content, moderately and acceptable values for crude protein and lipid. The seed was found to be rich in macro mineral elements of calcium, magnesium, sodium and with a higher potassium content compared to sodium. The sodium to potassium ratio (Na⁺/ K⁺ 0.69) fell within the range (Na/K ≤1.0) recommended by World Health Organization for prevention of cardiovascular diseases. The seed is also a good source of essential micro mineral elements of iron, selenium, zinc and copper which can aid the development of cell tissues. Therefore, composition of *Calliandra surinamensis* seed from this study suggests that it would be beneficial for both domestic and industrial applications as complementary food source.

**Key Words:** Proximate analysis, Mineral composition, *Calliandra surinamensis* seed, food source

**INTRODUCTION**

Plant seeds are gradually gaining proper recognition and their impact covering an extensive range of applications as a result of their chemical composition. Within a seed there is usually a large store of nutrients needed to transform into complex plant and these include; unsaturated fat (such as omega 3 and omega 6), essential amino acid, minerals and vitamins [1]. Globally, a wide range of benefit have been claimed for both home and commercial uses [2]. Some plant seeds like walnut, maize and coconut are edible and are-rich in mineral, vitamins and amino acids [3]. Some seeds are used as raw materials for other edible products like starch and flour, most especially products derived from legumes and nuts. Oil seeds like peanut, palm nuts, olives are often used to produce rich oil for cooking while oil from linseed are used in cosmetic and paint industries [3].

*Calliandra surinamensis* is a leguminous flowering plant that is of South American origin, widely distributed in Nigeria, East and South Africa. The tree is a plant recognized for its
ornamental and horticultural purposes and valued for its year-round floral display [4]. The plant is known for its use in folk medicine for various ailments such as coughs and wound healings [5]. The flowers have shown some significant level of antioxidant activity and antimicrobial activity [6]. Pigment from the flower accordingly is used as dye pigment for the manufacture of some drugs of great pharmaceutical importance [5]. The result of the photochemical screening of the stem bark revealed the presence of secondary metabolites such as alkaloids, tannins, flavonoids and saponins and the methanolic extract of the stem bark has also demonstrated antimicrobial activity [4].

*Calliandra surinamensis* being a leguminous plant contains or may contain carbohydrates, fats, proteins and minerals although not quantified or determined. Carbohydrates, fats, proteins and minerals are among the major classes of nutrients. Carbohydrates are very essential nutrient widely distributed in both natural and processed foods. They range from simple monosaccharide (glucose, fructose and galactose) to complex polysaccharides (starch) [7]. Fats are triglycerides made of assorted fatty acids bound to glycerol backbone. Some fatty acids are essential in the diet. They cannot be synthesized in the body [8, 9]. Protein molecules contain nitrogen atoms in addition to carbon, oxygen and hydrogen. The fundamental components of protein are nitrogen containing amino acids, some of which are essential as the body cannot produce them. Some amino acids are interconvertible to glucose in through a process known as gluconeogenesis [9].

Minerals are chemical elements needed by the body to regulate chemical reactions and maintain structures. They are essential nutrients that play important roles in biological processes in tissue cells [10]. Nutrient minerals being elements cannot be produced by humans, rather they are obtained by eating plant and animal based food or from drinking water. Minerals are classified into macro minerals, which the body required in relatively large quantities and micro minerals which the body required in relatively small quantities [10].

The macro minerals include: potassium, sodium, calcium, phosphorus, magnesium among others. Potassium and sodium are electrolytes that help regulate the body fluid, while calcium, phosphorus and magnesium build strong bones and protects the bones against fracture [11]. Potassium activates the nerve muscles which help to regulate the contractions of the muscles and that of the heart and also provide a balance between the fluids in and outside the cells [11, 12]. Sodium helps to regulate volume of blood, blood pressure, pH and the movement of water across cell tissues and also help calcium and other minerals remain soluble in the blood [11]. Phosphorus helps to regulate with adenosine triphosphate (ATP) the transfer of cellular energy necessary for every cellular process that uses energy and neutralizes excess acidity.
Phosphorus as calcium phosphate forms the main structural component of bones and teeth [13]. Magnesium also helps in the proper functioning of nerves, prevent heart attack and help to regulate brain function and mood [12, 13]

The micro minerals such as selenium (Se), copper (Cu), iron (Fe) and zinc (Zn) though needed in minute quantities, also play important roles to the good healthy living. Selenium is an essential trace mineral that helps the body to produce special protein called selenoprotein is involved in the synthesis of the thyroid hormone and reduces the toxic effect of lead and arsenic [14]. Iron is the most essential and abundant element within the hemoglobin molecule which transports oxygen round the body and plays important role in a great number of cellular reactions within living organism; however, its catalytic ability has been found to generate free radicals and this contributes to its toxicity [15]. Copper acts as an essential cofactor for the formation of various number of proteins such as cuproprotein [16]. Zinc is antioxidant enzyme, a cofactor for superoxide dismutase (SOD) distributed in cell all over the body where they functions as the body’s defensive (immune) system. Zinc is also needed for growth and development of cells [16].

This study is focused on the evaluation of the proximate analysis of the seed of calliandra surinamenses with a view to establishing the content and to ascertaining the possibility of its domestic and industrial application as possible complementary food source.

MATERIALS AND METHODS

Collection, Identification and Preparation of samples.
The Calliandra surinamensis pods containing the dry seeds were collected from the Department of Plant Biology and Biotechnology, Faculty of Life Sciences, University Benin, Benin-City and identified by a Plant Taxonomist in Plant Biology and Biotechnology. The pods were cracked open to release the dry seeds which were pulverized into powder using mechanical blender.

Proximate Composition Analysis;
The seeds (powder) of Calliandra surinamensis were subjected to proximate nutrient composition analysis and components analyzed were moisture, ash, protein, fat, crude fibre and carbohydrate.

This was done using standard methods as described by the Association of Official Analytical Chemists [17].

Moisture Content Determination;
The seed (2.0 g) was weighed into a previously weighed crucible and oven dried to a constant weight at a temperature of 105°C. The amount of moisture in triplicate samples was carried out and expressed as loss in weight after cool weighing.

Crude Ash Content Determination
Crude ash is described as the mass of a product sample determined after heating at 550-600°C for 2 hours to burn in a container. Approach as stated
by AOAC, [17]. 5g of the sample each was measured in replicate into a container, where the sample product was enflamed in a soundproof furnace at virtually 550°C till ash was observed, and an invariable weight realized. The sample product was then chilled in a desiccator in order to prevent moisture absorption and reweighed to produce the ash content.

**Crude fat content**

Crude fat of the sample was measured using the Automated (Soxhlet System HT) approach as stated in AOAC, [17]. In the process, 10 g of the sample was weighed and extracted using 25 ml of petroleum ether, the solvent was expunged by oven drying and then chilled in a desiccator and reweighed. The crude fat content percentage was then estimated by using equation

\[
\text{Percent fat} = \frac{\text{weight of fat extracted}}{\text{Weight of sample}} \times 100
\]

**Protein Content Determination**

An approach as described by AOAC, [17]. This approach involves wet digestion of the sample material, distillation and titration. 3 g of the sample was measured into a boiling tube which also contained concentrated sulphuric acid of 25 ml, and 0.15 g of TiO2 as catalyst, 5 g of K2SO4, and 0.15 g of CuSO4. Tube was heated at very low temperature to allow digestion to take place. The digested sample was then diluted with distilled water of 100 ml, Na2S2O3 of 5 ml, and 40% NaOH of 10 ml. Anti-growth agent was added, and then, the product sample was again diluted with boric acid of 10 ml. The content NH4 in the distillate was estimated by titrating with HCl of 0.1 N standards using a burette of 25 ml. A bare was condition without the product sample. The valued protein captured was then multiplied by a conversion factor, and the result indicated as the amount of crude protein. Thus:

\[
\% \text{ crude protein} = \frac{\text{ATV} - \text{TOTB} \times 0.1N \text{ HCl} \times 0.014 \times \text{CF}}{\text{Weight of sample}} \times 100
\]

Where; ATV = actual titre value; TOTB = titre of the blank; CF = conversion factor; HCl = hydrogen chloride (ml).

**Crude Fibre Determination**

The crude fiber of the samples was determined by an approach as described by AOAC, [17]. 5 g of each sample was measured in an Erlenmeyer 500 ml flask, and TCA digestion agent of 100 ml added. The mixture was then boiled and allowed to reflux for about 40 minutes. It was then allowed to chill a little, then filtered through Whiteman paper of 15.0 cm number 4. The remnant was rinsed with hot water and transferred into a porcelain dish, and then oven dried overnight at 105°C. The sample was then poured in a desiccator and weighed as W1. After that, it was burnt at 500°C in a soundproofed furnace for 6 hours, allowed to chill, then reweighed as W2. Thus:

\[
\% \text{ crude fibre} = \frac{W1 - W2 \times 100}{\text{Weight of sample}} \times 100
\]
Carbohydrates Content Determination
The carbohydrate content was determined by the difference in percentage;

\[
\% \text{ carbohydrate} = 100 - (\% \text{ fibre} + \% \text{ protein} + \% \text{ ash} + \% \text{ moisture} + \% \text{ fat})\%
\]

Determination of Mineral Elements
The mineral elements were determined by the dry ash extraction and wet digestion methods [17]

RESULTS AND DISCUSSION

Table 1: Proximate analysis of C. surinamensis seed

<table>
<thead>
<tr>
<th>Components</th>
<th>% Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>12.80 ± 0.04</td>
</tr>
<tr>
<td>Ash</td>
<td>2.63 ± 0.20</td>
</tr>
<tr>
<td>Fat</td>
<td>4.74 ± 0.17</td>
</tr>
<tr>
<td>Fibre</td>
<td>14.07 ± 1.33</td>
</tr>
<tr>
<td>Protein</td>
<td>5.95 ± 0.70</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>59.81 ± 0.07</td>
</tr>
</tbody>
</table>

Table 2: Macrominerals of C. surinamensis seed

<table>
<thead>
<tr>
<th>Components</th>
<th>Mean (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na</td>
<td>9.50 ± 1.53</td>
</tr>
<tr>
<td>K</td>
<td>13.72 ± 1.09</td>
</tr>
<tr>
<td>Ca</td>
<td>36.92 ± 0.55</td>
</tr>
<tr>
<td>Mg</td>
<td>27.50 ± 0.61</td>
</tr>
<tr>
<td>P</td>
<td>1.79 ± 0.07</td>
</tr>
</tbody>
</table>

Table 3: Micromineral Composition of C. surinamensis seed

<table>
<thead>
<tr>
<th>Components</th>
<th>Mean (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selenium</td>
<td>0.28 ± 0.11</td>
</tr>
<tr>
<td>Iron</td>
<td>0.78 ± 1.29</td>
</tr>
<tr>
<td>Copper</td>
<td>0.09 ± 0.08</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.49 ± 0.10</td>
</tr>
</tbody>
</table>
DISCUSSION OF RESULTS

The proximate analysis of *C. surinamensis* seed in percentages (%) shown in Table 1, revealed the % moisture content to be 12.80 which falls within the range of some legumes in agreement with that reported by Alina, *et al* [18]. Since the life of a seed largely revolves round its moisture content and seeds are most suitably harvested and dried immediately to reach a moisture content of 12 to 13% [18] therefore, *C. surinamensis* seed has a good shelf-life. The % ash content of 2.63 agreed with the value reported for a legume (groundnut seed) and comparable to the values for chickpea and mung bean [19]. % Fat content of 4.74 compared favourably with that of Faba bean, chickpea, but greater than that of mung bean and adzuki bean [18]. The % crude protein value 5.95 falls within the value for some legumes [20]. % Crude fibre content value 14.07 compared moderately with the Recommended Dietary Intake (RDI) of total fibre 19-38. This % fibre content has been confirmed by literature that legumes contain just the right amount of fibre to prevent constipation when eaten and help improve digestion [20]. % Carbohydrate content of 59.81 was found to be within the range of values 14-70 for most legumes [20] and also met the Acceptable Macronutrient Distribution Range.

The macro mineral composition of *C. surinamensis* seed in mg/kg are shown in Table 2, revealed calcium 36.92 to be the most abundant mineral, an important macro mineral essential for strong bones and teeth. Magnesium 27.50 was the next abundant essential mineral important for variety of cellular metabolic activities and sometimes has the ability to replace a portion of the body calcium [21]. Potassium 13.72 was the third abundant mineral element which according to literature was widely distributed in plants and was rarely deficient in diet [22]. Sodium 9.50 was found to be the fourth abundant mineral. Sodium and potassium work in tandem throughout the body. Potassium naturally balances the metabolic action of sodium such that diets low in potassium and high in sodium increase the risk of high blood pressure and cardiovascular diseases [23]. The ratio of sodium to potassium (Na⁺/K⁺) in the diet is an important predictor of hypertension than the amount of either one alone [23]. From the results obtained the ratio of sodium to potassium (Na⁺/K⁺) was 0.69 which is quite within the range ((Na⁺/K⁺ ≤ 1.0) recommended by World Health Organization for the prevention of cardiovascular diseases [23, 24]. The results of the assay of the micronutrient elements also in mg/kg contained in Table 3, showed the presence of iron which is important for its role in oxygen and electron transport as well as Zinc vital for the production of hormone. Selenium and copper were also found in trace amounts that the micro elements would act either independently or jointly in enhancing their established biological functions [22].
CONCLUSION

This research work has revealed that *Colliandra surinamensis* seed is a good source of carbohydrate and crude fibre with complementary protein content. It has variable macro mineral content of calcium, magnesium, potassium and sodium. The low ratio of sodium to potassium particularly shows that the seeds hold a promise to reducing cardiovascular problems. It also contains essential micro nutrients such as iron, selenium and zinc all which recommends it for both domestic and industrial application as possible complementary food source. This obviously proved that the seeds of calliandra surinamenses would have beneficial effect in the maintenance of heart function and prevention of cardiovascular diseases such as hypertension.

REFERENCES


