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PROXIMATE COMPOSITION, MINERAL ELEMENTS, ANTI-NUTRITIONAL FACTORS AND PHYSICOCHEMICAL ANALYSIS OF PRIDE OF BARBADOS SEED (*Caesalpina pulcherrima*)

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between all authors. Author TOI performed the study concept, research design and manuscript preparation. Author MAA performed the project supervision, manuscript supervision and organization. Authors FO and AA managed the manuscript preparation, literature review and data collection. Authors CI and JA managed the data analysis, presentation and interpretation. All authors read and approved the final manuscript.

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ABSTRACT

Pride of Barbados (*Caesalpina pulcherrima*) is a legume which is known to contain biologically active components. The study aims at determining the proximate composition, mineral elements and anti-nutrients composition of Pride of Barbados with the view of further understanding its usefulness. The physicochemical, elemental, proximate and anti-nutrient analysis composition of pride of Barbados seeds were determined using standard method of analysis (AOAC) and instrumental method of analysis (AAS). The result of proximate analysis showed 4.970% of Ash, 8.067% of fat, 7.692% of moisture, 9.606% of crude fibre, 1.83% of crude protein. The physicochemical properties of the extracted oil from pride of Barbados seeds shows that the peroxide value is 34.00 mM, saponification value is 65.91 mg KOH/g oil, acid value is 29.17 mg/g, free fatty acid is 14.66 mg KOH/g oil, unsaponification matter is 10.98 mg/g, refraction index is 1.438, smoke fire point 98°C, melting point 26°C, flash point 108°C, fire point 112°C. The mineral elements present in the sample in mg/100 g are Na - 183.31, K - 208.56, Mg - 258.91 and Ca - 175.01. The results also showed that tannin content is 0.485 mg/100 g, oxalate 6.122 mg/100 g and phytate 0.535mg/100g. Therefore, the seed could be a good source for low cost plant protein and mineral elements.

Keywords: *Caesalpina pulcherrima*; proximate composition; mineral elements; anti-nutritional factors; physicochemical analysis.

1. INTRODUCTION

Pride of Barbados (*Caesalpina pulcherrima*) is a legume belonging to the family leguminosae [1,2] which are known to contain biologically active ingredients [3]. These anti-nutrient factors have adverse nutritional and physiological effects. According to Ihekoronye and Ngoddy [4] and Bello et

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al. [5] some of these active ingredients interfere with digestive processes thereby preventing efficient utilization of the legume deposit of Pride of Barbados with the view of further proteins that are capable of precipitation. It's deleterious effects in man and animals, with manifestable toxicity ranging from severe reduction in food intake and nutrient utilization to profound neurological effects, culminating in death [6].

It has also been reported that tropical legumes contain a more complex array of these substances than any other crop species [5]. Minerals form an integral part of functionally important organic compounds such as iron (Fe) in hemoglobin or zinc (Zn) in insulin [7]. They are essential for the normal functioning of muscles, heart, nerves and in the maintenance of body fluid composition among others [8]. Mineral deficiencies have manifested in forms of different disease conditions as goiter, rickets and one form of metabolic dysfunction or the other.

Pride of Barbados is the translucent coat over the cotyledon embedded under the green testa of the seed [9,10]. Children and adults eat this part of the plant from time to time. However, it is not a staple food in Nigeria [2,11]. Earlier studies on some functional properties, nutrient potentialities, ash and moisture contents have shown that this edible part of Pride of Barbados (extra–cotyledon) may be a potential food supplement [10,12]. Recent report has shown that of all the legumes analyzed in Nigeria, so far, Pride of Barbados presumably has the lowest cyanide content in the extra – cotyledon as well as in other parts of the plant [2].

In this work therefore, the aim is to determine the proximate composition, mineral elements, anti-nutrients composition and physiochemical composition of Pride of Barbados with the view of further understanding its usefulness as plant protein for food formulation.

2. MATERIALS AND METHODS

2.1 Sample Collection and Processing

Brown ripe pods of Pride of Barbados (*Caesalpina pulcherrima*) were collected from Iree in Osun State Southwestern part of Nigeria. The brown pods of *Caesalpina pulcherrima* were opened using knife. The seeds were then dried under the sun; both the dried whole seeds and dehulled seeds were grinded into powder using a clean pestle and mortar for each. The collected powder was sieved and stored in clean label airtight screwed up plastic containers until required for analysis.

2.2 Proximate Analysis

The proximate analysis composition for moisture content, ash, dry matter, crude lipid, crude fibre, crude protein and carbohydrates of pride of Barbados seeds were determined according to the method described by standard method of analysis [13] and Instrumental method of analysis (AAS).

2.3 Mineral Element Analysis

Sodium and potassium were determined by the standard flame emission photometer using sodium chloride (NaCl) and Potassium chloride (KCl) to prepare the standard [13].

2.4 Anti-nutrients Determination

Oxalate was determined by the method of Day and Underwood [14]. Phytate was determined by the method of Ukpabi and Ejidoh [15]. Calcium and Magnesium were determined using Atomic Absorption spectrometry (AAS model SP9).

2.5 Physiochemical Analysis

All physiochemical parameters were analyzed using AOAC [13].

2.6 Statistical Analysis

The data were processed and analyzed using the statistical package SPSS Version 17.0. The data were summarized with descriptive statistics: Mean (M) ± Standard Error of Mean (SEM) and Student's t-test was used to evaluate differences between data.

3. RESULTS

3.1 Proximate Analysis

The Proximate analysis result (Table 1) shows that there are significant differences in all the parameters determined in the whole seed and dehulled seed. The percent protein in the dehulled seed (51.950±6.7) is extremely higher than that in the whole seed is (1.830±0.039). The same trend was observed for percent total ash and percent crude lipid that were lower in the whole seed (4.970±0.021 and 8.067±0.045 respectively) than in the dehulled seed (9.821±0.035 and 9.341±0.065 respectively). The percent carbohydrate is higher in the whole seed (60.935±2.872) than in the dehulled seed (20.305±0.5920). Similar trend was observed for percent moisture content; percent dry matter and percent crude fibre that were higher in the whole seed

(7.69±0.23, 7.692±0.043 and 9.606±0.45 respectively) than in the dehulled seed (4.953±0.18, 4.953±0.01 and 3.630±0.025 respectively).

3.2 Elemental Analysis

The elemental analysis results (Table 2) shows that there are significant differences in potassium and calcium level. The potassium element is higher in the whole seed (208.56±3.56) than in dehulled seed (204.84±2.81). In contrast, the calcium element is lower in the whole seed (175.01±5.21) than in dehulled seed (183.21±6.47). On the other hand, there are no significant difference in the level of sodium and magnesium in the whole seed (183.31±2.62 and 258.91±6.51 respectively) when compared to dehulled seed (188.78±3.401 and 260.73±7.31 respectively). The ratio of Na/K and Ca/Mg in both whole seed and dehulled seed are less than one.

3.3 Anti-nutrient Analysis

The anti-nutrient analysis result (Table 3) shows that there are significant differences in the parameters determined in the whole seed and dehulled seed. The Tannin is higher in the whole seed (0.485±0.012) than in the dehulled seed (0.175±0.008). On the other hand, the phytate and oxalate (0.535±0.023 and 6.122±0.123 respectively) were lower in the whole seed and higher in the dehulled seed (0.659±0.025 and 8.193±0.185 respectively).

3.4 Physicochemical Analysis

The physicochemical analysis result (Table 4) shows that there are significant differences in all the parameter determined in the whole seed and dehulled seed. The peroxide value is higher in the whole seeds (34.00±0.13) than in the dehulled seed (11.20±0.10). The same trend was determined for iodine value and specific gravity (2.94±0.05, 1.705±0.012) respectively than in the dehulled seed (2.69 ±0.04, 1.642±0.011respectively).

4. DISCUSSION

The result of proximate analysis of *Caesalpina pulcherrima* seeds shows that the moisture content in the whole seed is higher than that in dehulled seeds. Similarly, Yusuf et al. [16] and Ekop [17] reported that moisture content was higher in whole seeds than dehulled seeds in *Caesalpina pulcherrima* and

Table 1. Proximate analysis (Average chemical composition)

Parameter	Whole seed (composition)	Dehulled seed (composition)
% Moisture content	7.69±0.23	4.953±0.18
% Total Ash	4.970±0.021	9.821±0.035
% Dry Matter	7.692±0.043	4.953±0.012
% Crude Lipid	8.067±0.045	9.341±0.065
% Crude Fibre	9.606±0.045	3.630±0.025
% Crude Protein	1.830± 0.039	51.950±6.735
% Carbohydrate	60.935±2.872	20.305±0.592

Table 2. Elemental analysis (mg/100 g)

Elements	Whole seed	Dehulled seed
Sodium (Na)	183.31±2.62	188.78±3.401
Potassium (K)	208.56±3.56	204.84±2.81
Magnesium (Mg)	258.91±6.51	260.73±7.31
Calcium (Ca)	175.01±5.21	183.21±6.47
Na/K	0.8789±0.736	0.921±1.210
Ca/Mg	0.676±0.800	0.703±0.885

Table 3. Anti nutrient analysis

Anti nutrient	Whole seed (mg/100g)	Dehulled seed (mg/100 g)
Phytate	0.535±0.023	0.659±0.025
Oxalate	6.122±0.123	8.193±0.085
Tannin	0.485±0.012	0.175±0.008

Table 4. Physicochemical analysis

Physiological parameters	Whole seed	Dehulled seed
Peroxide value (millimoles)	34.00±0.13	11.20±0.10
Saponification value (mg KOH/g oil)	65.91±2.86	63.11±1.95
Acid value (mg/g)	29.17±0.25	30.01±0.28
Free fatty acid (mgKOH/g oil)	14.66±0.18	14.66±0.16
Unsaponification value (mg/g)	10.98±0.02	10.57±0.10
Iodine value (g/100 g)	2.94±0.05	2.69±0.04
SP gravity	1.705±0.012	1.642±0.011
Refractive index	1.438±0.013	1.442±0.012
Smoke point (ºC)	98±5.69	142±7.89
Melting point (ºC)	26±2.68	28±2.89
Flash point (ºC)	108±6.87	154±8.52
Fire point (ºC)	112±9.58	162±11.21

Cinetum africanum (Afang) respectively. The ash value is also higher than that obtained in four Nigerian underutilized legume flours but within the range reported by Parkash et al. [18] in 104 legume seeds by Aremu et al. [19].

The crude fibre contents of the whole seed is higher than that in dehulled seed. The value obtained was higher than the range legumes reported by Parkash et al. [18] but lower than that reported by Hassan and Umar [20] for Balsam apple (*Momordica balsami* L). *Caesalpinia pulcherrima* leaves could not be a rich source of crude fibre because it fell short of the recommended dietary allowance (RDA) of crude fibre in children, adult, pregnant women and lactating mothers [21]. Crude fibre is an important part of diet, which helps decrease serum cholesterols level risk of coronary heart diseases hypertension, diabetes, colon and breast cancer [21].

Crude protein was lower in whole seeds than in dehulled seed. These values were higher than those reported by Parkash et al. [18] for Mellifera, Bauhiniatriandra, Llathyrus odorants and soya bean. This qualifies *Caesalpina pulcherrima* as a good potential source for low cost protein. Carbohydrates were higher in whole seed than in dehulled seed. The value obtained in the whole seed was greater than that obtained by Musah et al. [11] and Yusuf et al. [16] in the whole seed of same plant. But the Carbohydrate percent in dehulled seed was similar to that obtained in the seed nut by Musah et al. [11] and Yusuf et al. [16]. This shows that *Caesalpina pulcherrima* are poor source of carbohydrate when compared to the other food source [17,18].

Calcium contents in *Caesalpina pulcherrima* whole seed is higher than that in dehulled seeds. Fleck [22] reported that calcium in conjunction with other elements magnesium, phosphorus, manganese, and vitamins (Vitamins A, C and D) and protein are involved in bone formation. From the result obtained, *Caesalpina pulcherrima* could serve as a good source for the mineral involved in bone formation.

The ratio of sodium to potassium and that of calcium to magnesium are shown in Table 2. The ratio of (Na/K) in the body is of great importance in the control of high blood pressure, hence *Caesalpina pulcherrima* seeds might not be good sources for lowering blood pressure since they fall slightly above (1.23-1.30) as against the four Nigeria underutilized legumes blood [19].

The values of phytate and oxalate contents were lower in whole seed than in dehulled seed (Table 3). On the other hand, tannin content of *Caesalpina pulcherrima* in whole seed was higher than in dehulled. This result was similar to that obtained by Musah et al. [11].

Physicochemical properties (Table 4) of the extracted oil from *Caesalpina pulcherrima* seeds showed no difference in the saponification value, acid value, free fatty acid, unsaponification value and melting point in dehulled seed. These values were higher than the range obtained from *Annona muricata* [23]. In addition the value obtained for peroxide value, iodine value, specific gravity, were higher in the whole seed than in dehulled seed. These values were higher than that obtained in palm oil and Avocado oil [24]. The flash point, refractive index, smoke point and fire point in whole seed were higher than in dehulled seed. These findings from whole seed were similar to that obtained by Oyeleke et al. [24] in *Ficus capensis*.

5. CONCLUSION

The physicochemical, elemental, proximate and anti-nutrient analysis composition of pride of Barbados

seeds (*C. pulcherrima*) seeds revealed that the seed has potentials to serve as a good source of essential nutrients necessary for good health. These seeds, either whole or dehulled, also have higher nutritional values than some legumes especially in crude protein. Also, the high mineral compositions and low Na/K and Ca/Mg ratios of the seeds make them a good source of minerals and suitable for lowering high blood pressure. The values of the antinutritional principles are also indicative of the facts that consumption might not pose much nutritional problems to either man or his farm animals.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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