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Physical and chemical properties of *Cassia sieberiana* seeds

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Abstract

In order to upgrade the local method of processing the seed it is necessary to collate basic data on physical, mechanical and chemical properties of the seed and pod as evaluated using standard methods. The length, breadth and thickness of the pods were 12.29 mm, 8.28 mm and 4.44 mm respectively while that of seed were 4.36 mm, 3.46 mm and 1.37 mm respectively. Seed weight, bulk density, true density, porosity and sphericity were found to be 0.02 g, 0.86 g/cm^3, 1.30 g/cm^3, 0.33 and 78.55%. Seed was found to be moderately high in crude protein (23.72%) and crude fibre (10.75%) and also in potassium (252.33 mg/L) and magnesium (52.68 mg/L) and contained tannin, alkaloids, phenol, oxalate, cardiac glycosides and flavonoids while saponnin was not detected. Data on chemical properties of seed are essential in determining nutritional importance of seed.

Introduction

Seeds are very important to nutrition (Anon[A], 2012). Many seeds are edible and the majority of human calories come from seeds, especially from cereals, legumes and nuts. Seeds also provide most cooking oils, many beverages and spices and some important food additives. In different seeds, the seed embryo or the endosperm dominates and provides most of the nutrients. Cassia seed refers to seed as obtained from pods of a tropical shrub (*Cassia sieberiana*). *Cassia sieberiana*, a member of the family *Caeasalpiniaceae*, is an annual plant that grows in the world's tropical zones. It is an upright-growing plant that can reach a height of more than four feet, with large, green leaves and very bright yellow flowers. These seeds range in colour from greenish-brown to dark brown with smooth surface and may have small bright coloured bands on the outer surface (Anon[B], 2012). It is used for multiple medical purposes in Africa.

The entire plant has numerous food uses and medicinal and non-medicinal uses (Anon[A], 2012). Cassia sieberiana seed generally grows around dumpsites and roadsides. As such, it is accessible once in season usually between September and February although it is considered a weed and is treated as such around settlements in Ibadan. Several researchers have listed advantageous uses of cassia seed, root, bark, stem, leaves and their extracts. Specifically, cassia seeds assist in expelling internal heat, detoxification, weight reduction as well as the clearing off of acne. However, these factors are yet to be evaluated extensively in Nigeria.

The entire plant is picked and reaped in autumn, then dried in the sun. The seeds threshed off the plant, and can be used either raw or after being fried (Anon[B], 2012). Pods of *Cassia sieberiana* are harvested by hand and the seeds are extracted manually as well. For harvesting the roots, the plant has to be dug up. After harvesting, the seeds need to be stored in a dry place. Storage in the pods is also feasible, but in that case extra care must be taken to prevent insect damage (Van der Maesen, 2007). Some research work has been carried out on the seed of this plant. Olapade *et al.* (2012) studied changes in some physico-chemical properties of the seed during roasting. This study showed that roasting had a significant effect on moisture content, caffeine content, weight loss, colour and swelling of the seed while it had non-significant effect on pH, total titratable acidity, acetic acid, and total soluble solid of the seed.

Physical properties are the visible, bodily properties of a plant measurable objectively, without personal bias or subjectively based on individuals opinion. The determination of seed physical properties gives data on the size and shape of seed for separating the seeds from other foreign materials and to know the most likely pattern of motion of seed, a useful index in it handling for industrial processing. The proximate composition of food shows the components of food necessary for the body's basal metabolism as well as mans' physical activities and include such components as lipids (fats and oil), protein, mineral elements, crude fibre, moisture and carbohydrates. Mineral nutrients are essential and vital components of all living cells and are involved in the metabolism of the body. Mineral nutrients make up about 4%

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of the weight of the human body. Mineral nutrients are differentiated according to the amounts needed by the body. Macro minerals are nutrients which are required in larger quantities (generally more than 50 mg per kg of the body weight). Trace elements or micro minerals are needed in smaller quantities (less than 50 mg per kg of the body weight) (Kalyango, 2011).

Since cassia seed may be used for beverage production and perhaps in future as a pastry condiment, the fundamental aim of this research is to supply basic data instrumental in the 'discovery' and innovative utilization of this seed. This research is restricted to cassia seeds available around specific settlements in Ibadan, Oyo State as a representation of that in the southern part of Nigeria. This present study was undertaken to evaluate the physical and chemical properties of Cassia sieberiana in some settlements around Ibadan, Oyo State.

Materials and Methods

The seeds used for this research were obtained from settlements around Agbowo - Express and Ajibode in Ibadan, Oyo state as a representation of the seeds in the Southern part of Nigeria. The pods containing the seeds were cleaned and opened and the seed within removed. The seeds obtained were carefully sorted to make sure only good seeds were used. Prior to milling, the seed sample was stored in a low density polyethylene bag (LDPE). The clean sorted seeds were ground using a Christy laboratory mill. The plant and seeds of *C. sieberiana* are shown in plates 1 and 2 respectively. The sample was thoroughly mixed prior to sampling for analysis. Milled sample was stored in a low density polyethylene bag and polyethylene bottles.

Determination of physical properties

The three principal dimensions; length, breadth, and thickness of 50 pods and 50 seeds selected at random, were determined. The length of pod was determined by use of a thread and a meter rule with values obtained in centimetres (cm). The length (b) of seed as well as breadth (a) and thickness (c) of the pods and seeds were determined using a vernier calliper (God Marc, hardened stainless steel) with reading up to 0.01 mm. These were obtained in millimetres (mm). Ten groups of 50 pods each were selected and weighed. The pods were seeded and the seeds obtained from each of the groups were weighed. Percent pod yield was obtained as the product of seed-to-pod ratio and 100 seeds were selected randomly and weighed using a sensitive balance (AND CF-2000) reading to an accuracy of 0.01 g and this was repeated a number of times. The values obtained were recorded and used in computation.

Figure 1. Samples of *Cassia sieberiana* plant showing pods (a) and seeds (b).

Bulk density is the quotient of mass of seed and its total volume (including void spaces) was determined as reported by Fraser *et al.* (1978). Seed density refers to the ratio of the mass of the seed to the actual volume of the seed accordingly occupied by the liquid displacement method (Shepherd and Bhardwaj, 1986). Porosity was determined according to Jain and Bal (1967). Density ratio is the quotient of bulk density (ρ_b) and seed density (ρ_s) expressed as a percentage. Sphericity index was determined according to Moshenin (1970), while Aspect ratio was determined according to Maduako and Faborode (1990). Geometric mean was found using the relation of Moshenin (1970). For surface area, the relationship of McCabe *et al.* (1986) was used.

Determination of chemical properties

The seed was analysed according to AOAC (2004) for proximate composition viz., moisture, ash, crude fat, crude fibre, crude protein, and carbohydrate and expressed in percentage. Carbohydrate content was calculated by deducting the sum of the values for moisture, crude protein, crude fat, crude fibre, and ash contents from 100. Detection of eight elements was done viz Na and K using a flame photometer, and Ca, Mn, Mg, Fe, Cu and Zn using the atomic absorption spectrophotometer. Metal specific hollow cathode lamps were used and each was calibrated using standard solutions containing known amounts of the minerals being determined. The results obtained were expressed in mg/L i.e. parts per million.

Determination of the alkaloid content was done by the alkaline precipitation method described by Harborne (1998). Cyanide content determination was by titration method where the resultant solution became turbid as an indicator of the end point of the titration reaction. Flavonoids content was determined according to the method of Harborne (1998). Titrimetric method was used for oxalates determination. Folin-Ciocalteu's method was employed for phenols content determination. The spectrophotometer method was used for saponnin

content analysis. Tannins were extracted with methanol and upon colour development with Folin-Denis reagent and Na_2CO_3 solution. When bluish-green coloration developed, the absorbance of sample was read on a spectrophotometer at a wavelength of 760 nm. Each experiment except phytochemicals; was performed at least in triplicate. Results were expressed as the mean ± standard deviation (S.D). All data was collated on Microsoft Excel sheet and analyzed using SPSS 16.0.

Results and Discussion

A summary of the results for the physical parameters measured and determined is shown in Table 1. Length breadth and thickness dimension of the pod where found to have mean values of 12.29 cm, 8.28 mm and 4.44 mm respectively. For the dimensioning of the seed, mean values for length, breadth and thickness were 4.36 mm, 3.46 mm and 1.37 mm respectively. According to Olapade *et al.* (2012), average length, diameter and thickness of the seeds are 4.65, 3.85, and 1.5 mm respectively. From available data for oil bean seed, gram seed and African star apple seed, it can be seen that *Cassia sieberiana* seed is much smaller (Oyelade *et al*., 2005). The average pod yield was found to be 69.96 ± 2.17%.

From Table 1 it is seen that the sphericity and aspect ratio were found to be 78.55 ± 8.16% and 126.56 ± 8.67% respectively. As reported by Omobuwajo *et al.* (2000), high sphericity value suggests that seeds tend towards a spherical shape. The values of aspect ratio and sphericity generally indicate that the seeds are most likely to have difficulty in rolling. They can on the other hand, slide along their flat surfaces. Seeds surface area was 23.25 ± 4.46 cm^2, the value of which is a relevant tool in determining the shape of seed. Average weight of seed is found to be 0.02 g. This value is much lower than that of oil bean seed and star apple seed and is important in mechanical cleaning of seed using aerodynamic forces. The density of seed had a mean value of 1.30 ± 0.03 gcm^{-3}. This characteristic can be used for separating the seeds from other foreign materials.

The result of proximate analysis shows the variant proportions of nutrients in seed (Table 2). According to the result of the analysis, carbohydrate and protein contents were found to be highest with mean values of 56.72 (± 0.07)% and 23.72 (± 0.13)%. Seed has a moisture content of 13.50 (± 0.25)%, crude fibre content of 10.75 (± 0.18)%, ash content of 4.46 (± 0.02)% and least of all crude fat content of 2.08 (± 0.11)%. Compared to the work of Olapade *et al.* (2012) on raw seeds of *Cassia sieberiana*, the results for ash, crude fibre and crude fat contents presently obtained were lower while those of moisture, crude protein and carbohydrate were higher with values of 9.3 ± 0.03%, 16.21 ± 0.09%, 5.31 ± 0.05%, 9.04 ± 0.04%, 19.88 ± 0.03% and 40.26 ± 0.33% respectively.

The moisture content and protein content of the seed was found to be higher than that of selected medicinal plant species while its ash content was found to be lower. The selected plants are *Aerva javanica*, *Calotropis procera*, *Datura alba* and *Nepeta suavis* (Hussain *et al.*, 2011). Fat content of seed was discovers to be less than that in coffee having fat

Table 1. Physical properties of *Cassia sieberiana* plant

Parameter	No. of replicates	Value
Pod dimensioning (L: cm, B&T: mm)	50	L: 12.29 ± 1.30 B: 8.28 ± 0.60 T: 4.44 ± 0.45
Seed dimensioning (mm)	50	L: 4.36 ± 0.30 B: 3.46 ± 0.31 T: 1.37 ± 0.20
Pod yield (%)	10	69.96 ± 2.17
Seed weight (g)	7	Average: 0.02 ± 0.00 1000 seed: 21.06±0.42
Seed density ($g\,cm^{-3}$)	25	1.30 ± 0.03
Bulk density ($g\,cm^{-3}$)	25	0.86 ± 0.02
Density ratio (%)	20	33.38 ± 2.39
Porosity	20	0.33 ± 0.02
Aspect ratio (%)	50	126.56 ± 8.67
Sphericity (%)	50	78.55 ± 8.16
Geometric mean dimension (mm)	50	2.70 ± 0.30
Surface area (mm^2)	50	23.25 ± 4.46

Mean ± SD of replicate analysis

Table 2. Proximate content of *C. sieberiana* seed

Parameter	Value (%)
Moisture content	13.50 ± 0.25
Ash content	4.46 ± 0.02
Crude fat content	2.08 ± 0.11
Crude fibre content	10.75 ± 0.18
Protein content	23.72 ± 0.13
Carbohydrate content	56.72 ± 0.07

Mean ± SD of replicate analysis

Table 3. Mineral content of *Cassia sieberiana* seed

Mineral element	Value (mg/l)
Ca	29.73 ± 0.90
Mg	52.68 ± 6.68
K	252.33 ± 14.95
Na	12.13 ± 3.61
Mn	0.29 ± 0.02
Fe	1.20 ± 0.16
Cu	0.19 ± 0.05
Zn	0.99 ± 0.26

Mean ± SD of replicate analysis

Table 4. Phytochemical content of *Cassia sieberiana* seed

Phytochemical	Quantity (%)
Tannin	1.1
Saponnin	ND
Flavonoids	0.8
Cardiac glycosides	0.016
Alkaloids	1.04
Phenol	0.25
Oxalate	0.006

ND – Not detected

Table 5. Proximate content of *Cassia sieberiana* seed and other plant seeds

Constituent	*C. sieberiana*[a]	Groundnut seed[b]	*M. oleifera*[c]	Saduragiri accessions of *Mucuna pruriens*[d]	Melon[e]	*Garcinia mangostana*[f]	Paprika seed[g]
Moisture content	13.50 ± 0.25	NR	2.14 ± 0.01	10.21 ± 0.01	5.92 ± 0.07	13.08 ± 1.99	NR
Ash content	4.46 ± 0.02	3.00 ± 0.04	4.98 ± 0.04	4.10 ± 0.01	3.85 ± 0.07	1.99± 0.30	43.2
Crude fat content	2.08 ± 0.11	50.42 ± 1.02	43.56 ± 0.03	8.50 ± 0.41	53.23 ± 0.92	21.18 ± 6.18	25.61
Crude fibre content	10.75 ± 0.18	NR	4.70 ± 0.2	NR	NR	13.7 ± 0.89	34.9
Protein content	23.72 ± 0.13	32.00 ± 1.19	35.37 ± 0.07	32.48 ± 0.47	26.3 ± 2.47	6.57	24.4
Carbohydrate content / N-free extract	56.72 ± 0.07	NR	9.17 ± 0.25	47.51	10.7 ± 3.53	43.5 ± 2.09	10.7

[a] Present work.
[b] Shad *et al*. (2009)
[c] Compaore *et al.* (2011)
[d] Fathima *et al*. (2010)
[e] Onyeike *et al.* (1995)
[f] Ajayi *et al*. (2007)
[g] El-Adawy and Taha (2001).
NR: Not Reported.

Table 6. Mineral content of *Cassia sieberiana* seed and other plant seeds

Mineral content	*C. sieberiana*[a]	*M. oleifera*[b]	Saduragiri accessions of *Mucuna pruriens*[c]	Paprika seed[d]	*Garcinia mangostana*[e]
Ca	29.73 ± 0.90	78 ±1	562.51 ± 0.23	163	454
Mg	52.68 ± 6.68	261 ± 1	410.10± 0.47	396	865
K	252.33 ± 14.95	48.2 ± 0.2	1527.94 ± 0.04	121	707
Na	12.13 ± 3.61	25.01 ± 0.01	54.12 ± 0.42	37	26
Mn	0.29 ± 0.02	95.40 ± 0.4	7.10 ± 0.27	7.2	18
Fe	1.20 ± 0.16	12.77 ± 0.4	8.16 ± 0.47	14.6	90
Cu	0.19 ± 0.05	54.2 ± 0.2	0.66 ± 0.02	3.72	ND
Zn	0.99 ± 0.26	300.47 ± 0.07	1.98 ± 0.01	6.7	19

[a] Present work.
[b] Compaore *et al.* (2011)
[c] Fathima *et al*. (2010)
[d] El-Adawy and Taha (2001)
[e] Ajayi *et al.* (2007)
ND: Not Detected

content value ranging between 7 and 17% (Speer and Kolling-Speer, 2006). The protein and fat content of the seed was found to be lower than those of four varieties of melon seed whose protein contents ranged from 33.80-39.96% and 40.26-45.21% respectively. Nonetheless, *Cassia sieberiana* seed was found to have higher values for moisture, ash and crude fibre content. The relatively high crude protein content of the seed indicates that it could be used to enrich food product while the crude fibre can reduce constipation through increased bowel movement; this may serve partially as the scientific basis for recorded laxative activity of seed (Abiodun and Adeleke, 2010). Table 5 compares the proximate content of leguminous *Cassia sieberiana* to some plants.

Mineral concentrations of *Cassia sieberiana* seed are shown in Table 3. Potassium content was significantly the highest. Potassium content is the most important intracellular element and is required for various physiological functions (Olaniyi *et al*., 1993 in Adejumo *et al*., 2009). Its replacement is often crucial in any acute fluid loss for example in diarrhea. The order of decreasing mineral content is K>Mg>Ca>Na>Fe>Zn>Mn>Cu, with a low amount of copper (0.19 ± 0.05 mg/L). This result for Cu concentration is found similar to result obtained on paprika seed flour as reported by El-Adawy and Taha (2001) where probable use of seed flour in fortification of baking flour was suggested. The Ca content was found to be 29.73 ± 0.90 mg/L. This would upon consumption enable individuals achieve the RDA of Ca. The biological roles for Ca and K are essential for disease prevention and control and may, therefore, contribute to some of the traditional medicinal influences of the plant (Aliyu *et al*., 2008).

The Na concentration level ranged from 12.13 ± 3.61 mg/L and is found to be higher than that report in Onyeike and Acheru (2002) for some seeds used in the preparation of Nigerian diets but is lower than that found in three accessions of *Mucuna pruriens* var. *Pruriens* (Fathima *et al*., 2010). Vavidel *et al.* (2000) reported in Fathima *et al*. (2010); that the low sodium range makes the seed a good food source for people on low sodium diets. The Mg, Mn, Fe and Zn concentrations were found to be 52.68 ± 6.68, 0.29 ± 0.02, 1.20 ± 0.16 and 0.99 ± 0.26 mg/L respectively. Trace elements such as manganese, iron and zinc are essential in enzymes metabolism. The concentrations of these elements in the seed are quite important (Aliyu *et al*., 2008). All eight of these minerals are also present in the coffee bean seed (Anon, 2007). The rich mineral profile of seed is such that aids digestion, formation of strong bones and teeth and haemoglobin formation. Table 6 compares the mineral content of *Cassia sieberiana* to some other plant seeds.

Amongst the phytochemical constituents of seed are tannin, flavonoids, cardiac glycosides, alkaloids, phenols, and oxalate as shown in Table 4. Saponnin was not detected.

Flavonoids, tannins, saponnins and reucing agents have been listed among anti-diarrhoeal agents (Adejumo *et al*., 2009). Flavonoids are reported to inhibit intestinal motility (Speroni and Ferri, 1993; Di-Carlo *et al.*, 1994). Flavonoids have been implicated in the anti-diarrhea properties of *Psidium guajava* and *P. amarus*. The ability of quercetin, a flavonoid, to inhibit the release of acetylcholine in the gastrointestinal tract has been demonstrated, as this mechanism relaxes the intestinal muscle and reduces gastric motility (Lutterodt, 1989).

Phytochemical analysis of ethanolic extracts of leaf, stem, seed and root sample of *Cassia obtusifolia* and *Cassia auriculata* showed the presence of

alkaloids, tannins, flavonoids and anthroquinones while, saponins was not detected. Phytochemical analysis was previously reported by Kalaichelvi *et al.* (2009) from root and leaf sample of *Cassia auriculata* which exhibited the presence of anthroquinones, alkaloids, flavonoids, steroids, tannins and phenolic compounds. *Cassia* species are rich sources of polyphenols, anthroquinone derivatives, flavonoids and polysaccharides and tannins (Deshpande and Bhalsing, 2011). The phytoconstituents which are phenols, anthraquinones, alkaloids, glycosides, flavonoids and saponins are antibiotic principles of plants (Hafiza *et al*., 2002). From these phytoconstituents, saponins have been reported to exhibit hemolytic and foaming activity, antifungal, anti-inflammatory, fungistatic, molluscidal (Ajayi *et al.*, 2011). The occurrence of tannin as one of the phytochemicals/ antinutrients might result in lowering the food value of the seed (Rao and Prahavathi, 1982). It is reported that tannins lower the digestibility of grain legumes (Odo *et al.*, 2005).

Conclusions

The relatively high carbohydrate and protein values obtained reveal that seed can be used as food and is rich in potassium, contains magnesium, calcium and iron; although it is low in copper, sodium, zinc and manganese. Phytochemical determination showed the presence and quantities of valuable constituents like tannin, flavonoids, cardiac glycosides, alkaloids and phenols. Seed also contains oxalates. These results therefore offer a scientific basis for the use of *Cassia sieberiana* seed as food in Nigeria.

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