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Chemical Composition and Nutritional Value of *Cassia occidentalis* Seeds

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Authors' contributions

This work was carried out in collaboration among all authors. Author ETW designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author NT managed the analyses of the study. Author UAT managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Proximate composition, amino acid, mineral content, vitamin composition and anti-nutritional factors of *Cassia occidentalis* seed were determined using a standard method of analysis. The result showed that the seed had the following proximate composition on dry weight (DW) bases: ash (39.00%), moisture content (2.00%), crude protein (18.50%), crude lipid (7.55%, Crude fibre (16.30%) and carbohydrate (16.75%). Six amino acid was detected (isoleucine, leucine, tyrosine, alanine, glutamine and valine) indicating that the seed is a good source of amino acid for adult. Vitamin composition (beta- carotene, thiamin, riboflavin, niacin, ascorbic acid and alpha-tocopherol) were also detected in the seed. The anti-nutrient analysis showed that the seed contains total phytate (1.25 mg/100 g) oxalate (1.70 mg/100 g) and nitrate (0.82 mg/100 g). While hydrogen cyanide was not detected. Elementary analysis revealed that the seed contain Na (0.015±0.02 mg/100 g), Cu (0.028±0.04 mg/100 g), Zn (0.441±0.10 mg/100 g), Mg (2.003±0.30 mg/100 g) and Mn (0.041±0.03 mg/100 g) while Cd, Cr and Pb were not detected. Comparing the nutrients and anti-nutrient constituent with WHO and FAO values, the result indicated that the *Cassia occidentalis* seed had the potential to be used as a source of nutrient in alleviating macro and micronutrient deficiencies.

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1. INTRODUCTION

A plant-based, the traditional medical system continues to play an essential role in health care, with about 80% of the world's inhabitant relying mainly on traditional medicines for their primary health care [1]. According to the world health organization medicinal plant is any plant in which one or more of its organ contain substances that can be used for the therapeutic purposes or which are precursors for the synthesis of useful drugs [2].

This definition distinguishes those plants whose therapeutic properties and constituents have been established scientifically and plants regarded as medicinal but which have not yet been subjected to thorough investigation. The term herbal drug determines the part/ parts of a plant (leaves, flowers, seeds, roots, bark, stems, etc.) used for preparing medicine [3].

Furthermore, WHO [2] defines medicinal plant as herbal preparations produced by subjecting plant materials to extraction, fractionation, purification, concentration or other physical or biological processes which may be produced for immediate consumption or as a base for the herbal product. Medicinal plants are plants containing inherent active ingredient used to cure disease or relief pain [4]. The use of traditional medicine and medicinal plants in most developing countries as therapeutic agents for the maintenance of good health have been widely observed [5].

Cassia occidentalis is a medicinal plant which belongs to leguminous family commonly known as Coffee senna. It is a small tree that grows to 5-10 m high and is found in many tropical areas including South America, India, Brazil, China and West Africa [6,7]. The plant has large green leaves and yellow flower, their seed pods are dark brown and curve slightly upward. The seeds are olive-brown and flattened on both ends.

The seeds which are in long pods can be rusted and made into a coffee-like drink [8]. *Cassia occidentalis* is sweet, bitter and salty. It used to treat asthma, fever, indigestion, gastric pain, liver complaints and as a tonic for general weakness and illness [9,10]. *Cassia occidentalis* seed has been employed in herbal medicine around the world [11,12]. The seed has been discovered to have nutritional values. The seed contains carbohydrate, terpenes, steroid, sugar, flavonoids, anthraquinones, saponins et.c [13,14]. Although the seed has a very low peroxides value and high iodine value, it cannot be recommended for consumption because of the low yield and its repulsive odours. The seed, however, can serve as a cheap source of protein, as well as micronutrients supplement in both man and animal [2,15].

Micronutrient deficiencies are a major public health problem in many developing countries) [8,16]. According to WHO [2], one-third population of the world is affected by iron deficiency, causing a varying degree of impairment in cognitive performance, lowered work capacity, lower immunity to infection and pregnancy complication. In this area, there is no coherent documented information on the nutrition composition of *Cassia occidentalis* seed although the plants are available.

This study aimed at determining the proximate chemical composition and anti-nutritional content of *Cassia occidentalis* seed (Coffee senna).

2. MATERIALS AND METHODS

2.1 Sample Collection and Identification

The *Cassia occidentalis* seeds used in this study were collected from Garden city Shuware Mubi the Adamawa State of Nigeria. The plant material was botanically identified and authenticated by the department of biological science, Adamawa State University Mubi. A voucher specimen was preserved in the department of chemistry Adamawa State University Mubi.

2.2 Sample Preparation

Cassia occidentalis seeds were air-dried in the laboratory and were mechanically cleaned and kept at 35ºC to dry. The seeds were grounded using motor and pestle. The finely powdered sample was stored in a clean and dry polyethene bag to be used for successive extraction.

2.3 Proximate Analysis

Moisture, ash, crude protein, fat content, carbohydrate and crude fibre were determined following the official methods of the association of official analytical chemists [17], while nitrogen was determined by the micro-kjeldahl method [18] and the percentage of nitrogen was

converted to crude protein by multiplying by 6.25. Carbohydrate was determined by difference [19]. The results were presented in the form of a percentage of dry weight bases.

2.4 Mineral Analysis

The mineral composition of *Cassia occidentalis* seed was analysed using Atomic absorption spectrophotometer (Buck scientific model 200A) from the solution obtained when 2.0 g of the samples were digested with concentrated nitric acid and concentrated perchloric acid in ratio 5:3. The mixtures were placed on a water bath for three hours at 80ºC. The resultant solution was cooled and filtered into 100 mL standard flask and made to mark with distilled water [18]. The results were presented in the form of means ±SD of triplicate determination.

2.5 Vitamin Analysis

Vitamins were determined by the colourimetric method described by Omoyeni et al. [20]. 25 mL of the digested sample was added to potassium hydroxide and saponified for 30 minutes. Thereafter it was transferred to a separating funnel, a mixture of water-hexane in 1:1.5 ratio was added. The extracts washed several times with water and filtered through a filter paper containing 5g anhydrous sodium sulphate into a flask, rinsed with hexane and made up to volume. USP vitamin reference standard water was used to prepare standard solutions. A blank solution was prepared in a similar manner (5 mL of water in place of the digested sample). The absorbance of the sample was read to standards after zeroing with the blank solution at 620 nm with UV/V in a spectrophotometer. Mineral concentrations were calculated using a five-point calibration curve.

2.6 Amino Acid Analysis

Two (2 g) of the sample was weighed into 25 mL standard volumetric flask and made up with buffer/deionised water and diluted. The flask was shaken, centrifuged and decanted. The solution was filtered using HPLC grade filter paper. Concentrations were calculated by using a four-point calibration curve.

2.7 Anti-nutritional Content Analysis

The anti-nutrient content was determined using high-performance liquid chromatography (HPLC) following the procedures adopted by AOAC [18].

3. RESULTS AND DISCUSSION

The result of the proximate chemical analysis, mineral composition, vitamin content, amino acid and anti-nutrient composition of *Cassia occidentalis* seed are presented in Tables 1, 2, 3, 4 and 5 respectively.

3.1 Proximate Chemical Composition

The result of the proximate chemical analysis of food is the nutritional composition of that food; it is the estimation of the nutritive value of human food in chemical form. The result of the proximate chemical analysis in Table 1 revealed that the moisture content has the lowest value (2.00%) among all the nutrient composition while ash content was the highest (39.00%). This is an average when compared with that of other legumes ranging from 23% to s66% in groundnut though this value is slightly high compared with that of other legumes which have been reported to range between 15.00 – 16.00% [21,22].

The crude lipid has 7.55% and can be used for storage and transport forms of metabolic fuel. This result showed that the ash, crude protein, crude lipid and crude fibre content are relatively high though they did not exceed the FAO/WHO [21] limit.

Table 1. Proximate chemical composition of *Cassia occidentalis* seed

Parameter	Concentration (% on dry wt.)	[21] FAO / WHO [21]
Moisture content	2.00	-
Ash content	39.00	-
Crude protein	18.50	56.00
Crude lipid	7.55	20 – 35
Crude fibre	16.30	38.00
Carbohydrate	16.75	130.00

3.2 Vitamin Content

Vitamins are divided into two types: fat-soluble and water-soluble. Fat-soluble vitamins (vitamins A, D, E and K) are stored in the fat tissues and liver. They can remain in the body for up to six months. When the body requires them, they are transported to the area where they are a requirement within the body with the help of special carriers. Water-soluble vitamins (B-vitamins and vitamin C) are not stored in the body like the fat-soluble ones. They travel in the

Table 2. Vitamin composition of *Cassia occidentalis* seed

Vitamin	Composition (mg/100 g)	[21] FAO/WHO [21]
Carotene (vitamin a)	1.28	6.25
Thiamine (vitamin b1)	0.082	1.00
Riboflavin (vitamin b2)	0.033	1.10
Niacin (vitamin b3)	0.028	12.00
Ascorbic acid (vitamin c)	0.370	7.50
Tocopherol (vitamin e)	0.068	12.00

Blood stream and need to be replenished every day [23]. Vitamin A has been found to enhance immune system function by supporting and promoting activities of white blood cells as well as other immune-related cells. It also helps to inhibit free radicals and their damaging effects.

Vitamin C (ascorbic acid) is a water-soluble anti-oxidant essential for human health. It has been proven necessary for health responses, wound healing, non- Hemi iron absorption (coming from grains and vegetables), reduction in allergic responses, and development of connective tissue components such as collagen and for the prevention of disease [24].

Vitamin B (thiamin) can be found in small amount in a wide variety of food. Pork, sunflower seeds, yeast, peas and wheat are a few examples. Very little thiamine is stored within the body and must be consumed in a regular basis. A deficiency may result in weakness, loss of appetite, nerve degeneration and irritability.

Vitamin C has also been shown to have importance for cardiovascular health, reducing free radical production and free radical damage, good cognitive health and performance [25]. Due to human inability to produce vitamin C it is essential to ingest sources containing this Vitamin on a regular if not daily basis. Natural sources of vitamin C include oranges, guava pepper etc. [11,10].

Vitamin E is one of the most powerful fat-soluble anti-oxides in the body. It has been proven to help promote cardiovascular health, enhance immune system function, aid in skin repair and protect the cell membrane from damage caused by free radicals. Vitamin E contributes to proper blood flow and clotting as well as cognitive health and function [26].

Table 3. Amino acid composition of *Cassia occidentalis* seed

Amino acids	Concentration (mg/100 g protein)	[21] FAO/WHO[21]
Isoleucine*	9.10	4.20
Leucine*	18.30	4.20
Tyrosine	5.30	2.80
Alanine	7.40	-
Glutamine	33.40	-
Valine*	12.82	4.20

(*) essential amino acid

Table 4. Anti-nutritional composition of *Cassia occidentalis* seed

Anti-nutrients	Composition (mg/100 g)
Phytates	1.25
Oxalates	1.70
Cyanide	ND
Nitrate	0.82

ND = not detected

Table 5. Mineral composition of *Cassia occidentails* seed

Mineral element	Composition (mg/100 g)	[21] FAO/WHO[21]
Sodium (Na)	0.015 ±0. 02	NE
Magnesium (Mg)	2.003 ±0.30	3.30
Manganese (Mn)	0.041±0. 03	NE
Zinc (Zn)	0.441±0. 10	9.40
Copper (Cu)	0.028 ±0.04	7.00
Lead (Pb)	ND	-
Chromium (Cr)	ND	-
Cadmium (Cd)	ND	-

The data showed the mean value ± standard deviation of the series of three determinations; ND = not detected

Vitamin composition of the seed was presented in Table 2. The results showed that the seed contains appreciable values of beta–carotene (1.28mg/100g), thiamine (0.082mg/100g), Riboflavin (0.033mg/100g), niacin (0.028mg/100g), Ascorbic acid (0.370mg/100g) and alpha-tocopherol (0.068mg/100g). The high value of beta-carotene indicates a good source of vitamin A. The vitamin content of the sample compared favourably with the values reported in some Nigerian legume seed [27]. Hence all the values are below WHO/FAO acceptable limit. Therefore, consumption of adequate quantities of this plant will help to meet the daily requirement for both adult and children [27]. Vitamin A is needed for the maintenance of skin, mucous, membrane, bones, teeth, hair, vision and reproduction. Thiamine is needed for the nervous system, helps in releasing energy from carbohydrate. Riboflavin helps release energy from food and is essential for healthy eyes, skin, nails and hair. Ascorbic acid is necessary for healthy teeth and bones and is essential for proper function in adrenalin. Vitamin E also acts as an anti-dioxide and protects cell walls [8]. Thus the plant will be a valuable source of dietary vitamin in human nutrition.

3.3 Amino Acid

Table 3 shows the amino acid profile for the seed of *Cassia occidentalis* and the FAO/WHO reference value for each amino acid. The values of non-essential amino acid: Alanine (17.40mg/g), glutamine (33.40 mg/g) and tyrosine (5.30mg/g) and essential amino acid isoleucine (9.0mg/g), leucine (18.30mg/g) and valine (12.82mg/g) were found in *cassia occidentalis* seed. All the values are within the permissible limit by FAO/WHO standard. These results show that glutamine is the most abundant non-essential amino acid while leucine is the most abundant essential amino acid in *Cassia occidentalis* seed.

3.4 Anti-nutrient Composition

The anti-nutrient content of *Cassia occidentalis* seed is shown in Table 4. The results indicate that oxalate (1.7mg/100g) have the highest value while nitrate (0.82mg/100g) has the lowest value and cyanide was not detected. Oxalate can be complex with the most essential trace metal, therefore, making them unavailable enzymatic activities and other metabolic activities. Phytic acid has a complicated effect in the human system including indigestion of food and flatulence [28]. These anti-nutritional factors can easily be reduced to the tolerable limit by proper simple technics such as soaking, cooking and frying [19].

3.5 Mineral Composition

Table 5 shows the mineral composition of Cassia occidentalis seed. The result revealed that the seed contain Mn (0.041±0.30mg/100g), Cu (0.028±0.04mg/100g), Na (0.015±0.02mg/100g), Zn (0.441±0.10 mg/100g) and Mg (2.003 ±0.30 mg/100g). Mg was the most abundant element. Mg is an important mineral element in connection with a circulatory disease such as heart disease [29]. High Mg concentration is expected since Mg is a component of leaves chlorophyll in plant. Mg is an active component of several enzyme systems in which thymile pyrophosphate is cofactor oxidative phosphorylation is greatly reduced in the absence of magnesium. A common form of Mg deficiency in human include depressed deep tendon reflexives and respiration. Sources include leaves and green vegetables [14].

Cu is an essential trace element in the human body, which is a concern with the release of Iron from the cell into the plasma and is involved in energy metabolism [30]. Cu is a micronutrient necessary for the neurologic systems. It is also necessary for the growth and formation of bones, formation myelin sheaths in the nerves systems. The sources of Cu include liver, whole grains, molasses, legumes, nuts, shellfish and other seafood. Cu deficiency is associated with cardiac hypertrophy and sudden cardiac failure [15].

Mn is another microelement essential for human nutrient; it acts as an activator of many enzymes [31]. It is also a cofactor of hydrolase, decarboxylase and transferases enzymes [32]. Mn activates several important enzyme systems and in this capacity it is required for the synthesis of acid mucopolysaccharides, such as chondroitin sulphate, to form the matrices of bone and eggshell. Consequently, skeletal deformity defects in shell quality occur when the Mn intake is inadequate [6].

Zn is involved in the normal function of the immune system. The *Cassia occidentalis* seed has Zn content 0.441±0.10mg/100g comparable with the most value reported for plant seed in literature [33].

Na is the principal cation in extracellular fluid. It regulate plasma volume and acid –base balance,

involve in the maintenance of osmotic pressure of the body fluid, preserves normal irritability of muscles and cell permeability ,activate nerve and muscle function, main tenancy of membrane potential, transmission of nerve impulse and absorptive processes of monosaccharide, amino acid, and bile salt [23]. Insufficient Na causes the low blood pressure of the body. Sources of Na are table salt, salt added to prepare food and most natural food contains Na. Na content 0.15±0.02mg/100g was observed which suggested the possibility of incorporating it into the diet of the obese patient [5]. Na concentration in the sample was low compared to Mn content which agreed with the result reported for plant seed [1].

In trivalent state, Cr is an essential trace element that potentiates insulin action, lipid and protein [25,34]. Sources of Cr include meat, liver, brewer's yeast, whole grain, nut and cheese. The concentration of Cr in *Cassia occidentalis* seed was not detected.

Cadmium compounds are classified as carcinogens by several regulatory bodies [13]. Cadmium is a very toxic metal that should be monitored to prevent Cd related diseases.

Cd and Pb were not detected in the sample. Cd causes kidney problem, liver, including heart, brain and eye problem on longer time of accumulation [2]. While Pb causes reproductive dysfunction which decreases sperm quality and altered sperm morphology and low androgen level [27].

4. CONCLUSION

From the study, it can be concluded that the *Cassia occidentalis* seed analysed to have great potential as nutrient sources particularly considering their proximate chemical composition, amino acid profile, mineral composition and vitamin content. Thus the *Cassia occidentalis* seeds can be used as food in narrowing the amino acid and other nutrients supply deficit that are prevalent in many developing countries. Furthermore, the ash content indicates the potential of the plant seed as sources of the important mineral needed by the body. The mineral analysis of the *Cassia occidentalis* seeds indicated that these are rich in most mineral element, with high predicted availability of Mg and Zn. However, Cd, Cr and Pb were not detected. Therefore, the seed is less toxic as compared to the recommended WHO and FAO values.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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