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Nutritional Composition and Fatty Acids Profile of *Senna siamea* Flower and Flower Oil

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Abstract: The proximate composition, mineral elements contents and fatty acid profile of *Senna siamea* flower were examined with a view to evaluating its nutraceutical potentials. The proximate analysis showed that the flower contains valuable nutrients; (g/100g) crude protein (25.49± 0.014), crude fibre (15.63±0.04), ash (7.10±0.03), crude fat (9.68±0.04), moisture content (5.54±0.03) and carbohydrate (36.56±0.01). The results of mineral analysis (mg/100g) indicated that calcium, magnesium, manganese, copper, zinc, iron, cadmium and lead are 726.00, 938.00, 64.00, 30.00, 30.00, 8.00 and 16.00 respectively. The fatty acid profile of the flower oil showed that the oil contains higher proportion of unsaturated fatty acid (51.06 %) than saturated fatty acid (39.75 %). Among the saturated fatty acids present, palmitic acid (31.92 %) was the most abundant while linoleic acid (20.86 %) and linolenic acid (16.93 %) were the most abundant unsaturated fatty acids. The results showed that the flowers of *Senna siamea* are good sources of essential nutrients but the detection of cadmium and lead present calls for caution and as a consequence, the flowers should be properly processed before consuming them.

Key words: *Senna siamea*, proximate, minerals, nutraceuticals

Introduction

Senna siamea (syn. *Cassia siamea*) is a shrub belonging to the *Fabacea* family[1], native of Southeast Asia and better known in folklore, feeding and agriculture, and it is widely distributed in Africa (including Nigeria, Cote d'Ivoire, Eritrea, Ethiopia, Ghana, Kenya, Togo, among others) and in Latin America.[2, 3] The plant is about 10-12m tall, occasionally reaching 20m. The bole is short, crown dense and rounded at first, and later becoming irregular and spreading. The young bark is grey and smooth and possesses longitudinal fissures at later stages. The leaves are alternate, 15-30 cm long; compound with 6-14 leaflets each ending in a tiny bristle. [4] It has bright-yellow flower which is up to 60 cm long, upright with pyramid-shaped panicles. The fruits are flat with indehiscent pod, 5-30 cm long, and constricted between the seeds. There are about 20 seeds per pod. The seeds are bean-shaped greenish brown and 8-15 mm long.[5] *Sienna siamea* is effective in managing several ailments including constipation, diabetes, insomnia [6], hypertension, asthma, typhoid fever, and diuresis. [7] The leaves and bark of the plant are used locally as antimalarial drug especially when decocted. [8] In traditional medicine, the fruit is used to charm away intestinal worms and to prevent convulsion in children. The young fruits and leaves are also eaten as vegetables in Thailand. The flowers and young fruits are used as curries. [9]

However, under nutrition is the basic concern of developing countries. *Senna siamea* flowers are only known for their medicinal properties as reported in the literature. This study therefore sought to examine the proximate compositions, mineral content and fatty acid profile of *Senna siamea* flowers for public and dietary awareness of its nutritional status.

Materials and methods

Sample Collection and Preparation

Fresh young flowers of *Senna siamea* were collected from Ladoke Akintola University of Technology (LAUTECH) Ogbomoso, Nigeria, and authenticated in the Department of Pure and Applied Biology of the institution. The fresh young flowers were oven dried to a constant weight and then crushed into small pieces using laboratory mortar and pestle. It was further reduced to powders using an electric bender. The powdered was then stored in an air-tight container prior to analyses.

Proximate analysis

The proximate composition of the sample was determined using the method of Association of Official Analytical Chemists. [30] Drying loss content was obtained by heating the samples to a constant weight in a thermostatically controlled oven at 105 ^{0}C. The ash content was done by igniting a 0.5 g test sample in a muffle furnace at 550 ^{0}C until light grey ash results, protein was determined using the Kjedhal method (N× 6.25). The dried pulverized sample was extracted with petroleum ether (boiling point 40-60 ^{0}C) for 6 hours using a Soxhlet apparatus to obtain the crude lipid content while crude fibre content was determined by consecutive acid and alkali digestion of sample followed by washing, drying, ashing at 600 ^{0}C and calculating the weight of the ash free fibre and carbohydrate was calculated by difference.

Quantification of mineral elements

(i) Ground Samples were digested by weighing 0.5 g of samples into kjedahl flask and 10 ml of concentrated HNO_3 was added and allowed to stand overnight. The content was heated until the production of brown nitrogen (iv) oxide fume ceased. The flask was cooled and 2-4 ml of 70 % H_2O_2 was added. Heating was continued until the solution turned colourless. The solution was transferred into 100 ml standard flask and made up to mark with deionized water. Total mineral content was analysed by Atomic Absorption Spectrophotometer.

(ii) 10 ml of the Infusion was digested by adding 5 ml of concentrated HNO_3 and 5 ml of 30 % H_2O_2 solution to it. The mixture was evaporated to near dryness.

The mineral constituents of the whole plant and its infusion, namely calcium (Ca), iron (Fe), magnesium (Mg), manganese (Mn), copper (Cu), zinc (Zn), lead (Pb) and cadmium (Cd) were determined using the methods of analysis described by AOAC [30] with little modifications. The sample mineral elements were analyzed using X-ray fluorescence (XRF) transmission emission technique at the Centre for Energy Research and Development (CERD), Obafemi Awolowo University, Ile Ife, Nigeria with model: IPX2CR Power Supply and Amplifier for the XR-100CR Si Detector. The samples were pulverized and then irradiated with X-Ray for 1000s, to obtain the characteristics spectral, each spectral was made up of peaks which was characteristic of certain elements contained in the sample. The spectrum was checked on the computer system and then interpreted for quantitative determination of elements by direct comparison of count rates.

Fatty acids analysis and quantification

A 50 mg of the extracted fat content of the sample was esterified with 3.4 ml of 0.5 M methanolic KOH for five minutes at 95 ^{0}C. The mixture was neutralized using 0.7 M HCl and 3 ml of 14 % boron trifluoride in methanol. The mixture was heated for 5 minutes at temperature of 90 ^{0}C to achieve complete methylation process. The fatty acid methyl esters were extracted thrice from the mixture with redistilled n-hexane. The content was concentrated to 1 mL for gas chromatography analysis and 1 μL was injected into the injection port of the gas chromatography (HP6890 Powered with HP Chem Station Rev. A 09.01 (1206) software) equipped with a flame-ionization detector and a 30×0.25 m column coated with a 0.25 μm film of HP INNOWAZ. Split injection (split ratio 20:1) was performed, with nitrogen as a carrier gas at flow rate of 22 psi. The column temperature was maintained at 60 ^{0}C for 1 min after injection then programmed at 12 ^{0}C min^{-1} to 250 ^{0}C, held for 2 min and then at 15 ^{0}C min^{-1} for 3 min, held for 8 min. The injection port temperature was 250 ^{0}C and detector temperature was 320 ^{0}C. The fatty acids were identified by comparing their retention times those of standards and the contention retention times with those of standards and the content of fatty acids was expressed as percentage of total fatty acids.

Statistical analysis

Three replicates were analyzed per sample and the data generated are subjected to statistical analysis reported as mean ± standard deviation (SD) of the three different determinations.

Results and discussion

Proximate Composition

The proximate composition of *Senna siamea* flower (on dry weight basis) was depicted in Table 1. The percentage moisture content was (5.54±0.03). This was lower compared to 46.01 % in *Senna siamea* leaf [10] and 6.16 % in *Senna alata* flower. [11] However, the moisture content is low to ensure prolonged shelf life and prevent deterioration due to microbial attack and this implies that the flowers of *Senna siamea* can be stored for some days without any physiological changes and biochemical reactions. The protein content of the flower is much higher than 4.01 % reported in the leaves of *Senna siamea* [10] and 18.23 % and 13.14 % in *Senna alata* leaf and flower respectively. [11] The observed variations may be due to the difference in the geographical locations and plant parts. Apart from the nutritional significance of amino acids, it also plays a part in the organoleptic properties of foods [12].

The crude fibre contents of *Senna siamea* flower were higher than the reported values of 13.63 %, 4.63 % and 3.09-4.66 % for *Senna siamea* seeds and some legumes.[13, 14, 15] The presence of fibre in food helps to reduce overweight of the body. The intake of fibre can lower serum cholesterol level, risk of coronary heart disease, hypertension, diabetes, colon and breast cancer. [16] A low fibre diet has been associated with heart diseases, colon cancer, obesity, diabetes, constipation and appendicitis. [17, 18] Thus, *Senna siamea* flowers could be valuable sources of dietary fibre in human nutrition as a result of its relatively high fibre.

Crude fat contents of the sample were low but this value is higher than 3.50 % reported for *Senna hirsuta* and 4.40 % for *Senna obtusifolia* flower.[19] The ash content which represents the total nutrient content in the food is higher than 6.00 % reported for *Senna alata* leaves. [19] Thus, *S. siamea* flowers could be sources of mineral elements. Moreover, high content of carbohydrate in *Senna siamea* flowers may play a significant role in protein sparing action.

Table 1: Proximate Composition of *Senna siamea* flower (g/100g)

Parameters	Concentration (%)
Moisture content	5.54 ± 0.03
Crude fat	9.68 ± 0.04
Crude protein	25.49 ± 0.04
Crude fibre	15.63 ± 0.04
Ash content	7.10 ± 0.03
Carbohydrate	36.56 ± 0.01

Mineral contents

The levels of micro and macro elemental nutrients were presented in Table 2. Minerals are found to be important in human nutrition. [20] It is evident from Table 2 that there are significant difference ($p<0.05$) in the mineral constituents (calcium, magnesium, iron, manganese, lead, cadmium and zinc) of the whole and infusion samples with the whole flower having higher values than the infusion. However, the level of calcium (Ca) was found higher in the current results than that of *Senna alata* leaf and flower (mg/100g) which are 158.38 and 63.30 respectively. Thus the calcium in the flowers of the plant will help in preventing calcium deficiency related diseases such as osteoporosis. [21]

Copper (Cu), which is required in the body to prevent anemia, heart diseases and nervous disorders is found in this sample. It is also responsible for the production of vitamins, enzymes and hormones. Cu deficiency decreases the tinsel strength of arterial walls and hence leads to aneurysm formation and skeletal maldevelopment. [22]

The zinc (Zn) contents of *Senna siamea* flower were low but this is moderate because very small amount of zinc is required for human health. Zinc is used in the treatment and prevention of zinc deficiency and its consequences, including stunted growth and acute diarrhea in children. Adequate levels of supports body's immunity and strength [23].

The iron (Fe) content of the sample is high. Iron is an important element required by the body to prevent diseases such as anemia. For the formation of hemoglobin, normal functioning of the central nervous system and in the oxidation of carbohydrate, proteins and fats. [24] Deficiency of iron often leads to fatigue, decrease immunity and antioxidant stress. The RDA for iron is 8 mg. The high level observed in *Senna siamea* is beneficial to the body because high concentration of iron has been to enhance pro-oxidant activity via the Fenton reaction. Iron is also required for growth of tissue and organs and for expanding the red blood cells mass. [25]

Manganese (Mn) is one of the important essential elements required in carbohydrate metabolism. It is required by the body for treatment and prevention of weak bones (osteoporosis) and anemia. It is also required in a small quantity and its deficiency rarely occurs [26]. The level of Mn in the sample is 4.03±0.01; and this is moderate in any food supplement, only about 2-5 mg per day is required by the body as excess of it can cause serious side effect such as Parkinson's disease. [27]

Magnesium (Mg) content of the sample is moderate; the need for magnesium in food diet is very important since type 2 diabetes have been reported to be associated with low magnesium content in the body. [28]

Table 2: Mineral element contents of *Senna siamea* flower

Mineral elements	Concentration(mg/100g) **infusion**	Concentration(mg/100g) **whole**
Ca	19.75 ± 0.01[b]	726.00 ± 0.26[a]
Cd	0.38 ± 0.01[b]	8.00 ± 0.18[a]
Cu	2.13 ± 0.02[b]	236.00 ± 0.41[a]
Fe	14.50 ± 0.17[b]	30.00 ± 0.22[a]
Mg	53.00 ± 0.23[b]	938.00 ± 0.27[a]
Mn	3.88 ± 0.13[b]	64.00 ± 0.17[a]
Pb	1.75 ± 0.13[b]	16.00 ± 0.09[a]
Zn	8.88 ± 0.15[b]	30.00 ± 0.13[a]

Fatty acids profile

Twenty-nine fatty acids were identified in the *Senna siamea* flower (Table 3). The result reveals that saturated fatty acids constitute 39.75 % while monounsaturated fatty acids constitute 9.06 % and polyunsaturated fatty acids amount to 51.06 %. Among the saturated fatty acids present, palmitic acid was found to be the most abundant (31.92 %). The unsaturated fatty acids present were majorly linoleic acid (20.86 %) and linolenic acid (16.97 %). Linoleic and linolenic acids are essential polyunsaturated fatty acids that cannot be synthesized by the body and they have been reported to be crucial in the maintenance of some key physiological functions in the body. Deficiency of bioactive linoleic acid leads to poor growth, fatty liver, skin lesions and reproductive failure [29], hence *Senna siamea* could be a dietary source of this acid in ameliorating health related diseases.

Table 3: Fatty acids profile of *Senna siamea* flower oil

Fatty acid	Percent (%)
SATURATED	
Lauric (C12:0)	0.16
Myristic (C14:0)	0.35
Palmitic (C16:0)	31.92
Stearic (C18:0)	7.05
Arachidic (C20:0)	0.13
Behenic (C22:0)	0.13
Lignoceric (C24:0)	0.02
TOTAL	**39.75**

Fatty acid	Percent (%)
MONOUNSATURATED	
Myristoleic C14:1(cis-9)	0.02
Palmitoleate C16:1(cis-9)	1.53
Petroselaidate C18:1(trans-6)	0.05
Petroselinic C18:1(cis-6)	3.13
Eladic C18:1(trans-9)	0.00
Oleate C18:1(cis-9)	3.82
Cis-vaccinic C18:1(trans-11)	0.11
Gondoic C20:1(cis-11)	0.22
Erucic C22:1(cis-13)	0.17
Nervonic C24:1(cis-15)	0.02
TOTAL	**9.06**
POLYUNSATURATED	
Linoleic C18:2(cis-9,13)	20.86
Linoleate C18:2(trans-9,12)	0.05
linolenic C18:3(cis-6,9,12)	16.93
Linolenate C18:3(cis-9,12,15)	12.73

Eicosadienoic C20:2(cis-11,14)	0.02
Dihomo-linolenic C20:3(cis-8,11,14)	0.15
Eicosatrienoate C20:3(cis-11,14,17)	0.08
Arachidate C20:4(cis-5,8,11,14)	0.14
Clupanodonic C20:5(cis-5,8,11,14,17)	0.09
Brassic C22:2(cis-13,16)	0.08
Cervonic C22:6(cis-4,7,10,13,16,19)	0.06
TOTAL	**51.06**

Conclusion

The results obtained from this present research indicated that Senna siamea flowers contain essential nutrients for good human and animal health. In line with increase in global demand for food, *Senna siamea* flower can serve as a potential source of functional foods if properly consumed.

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