

PROXIMATE, PHYTOCHEMICAL AND MINERAL COMPOSITIONS OF ROASTED SEEDS OF COFFEE SENNA (*Senna occidentalis* Linn)

¹Olapade Abiodun Adekunle, ¹Ajayi Oreofeoluwatomi Adedamola and ²Olaniyi Musbau Bayonle

¹Department of Food Technology, University of Ibadan, Nigeria

²Forestry Research Institute of Nigeria, P.M.B. 5054, Ibadan, Nigeria

Abstract

This study evaluated the chemical compositions of roasted *S. occidentalis* seeds. Fresh seeds extracted from the matured pod of *S. occidentalis* were sorted, cleaned, air-dried for 5 days on a cabinet drier at the Food Technology Laboratory, University of Ibadan. The seeds were roasted at temperatures of 190, 210 and 230 °C for 10, 15 and 20 min, respectively, later ground to powder, stored in airtight containers for chemical analyses using standard analytical methods. The proximate compositions were moisture content (6.65-7.8 %), crude protein (21.04-24.98%), ash (3.65-3.78%), crude fibre (10.22-10.37 %), fat (2.06-3.53%) and carbohydrate (50.78-53.97%). The phytochemicals were flavonoid (487.28-754.92 mg/100g), phenol (152.81-172.11 mg/100g), alkaloid (147.60-204.33 mg/100g), saponins (15.20-18.06 mg/100g), oxalates (- 17.17-1.50 mg/100g), tannin (115.33-174.21 mg/100g), glycosides (426.61-463.51 mg/100g) and phytates (42.53-121.0 mg/100g). Mineral contents were Phosphorus (1159.00-1195.66 mg/100g), Calcium (912.33-956.96 mg/100g), Iron (201.53-232.40 mg/100g) and Zinc (48.20-54.24 mg/100g), while Retinol (185.20-206.75 UI/100g) and Ascorbic acid (8.98-20.38 mg/100g) were obtained. It was evident that *S. occidentalis* was a good source of essential nutrients as the traces of anti-nutritionals detected were not up to toxic levels that may interfere with its nutrient utilization and these were even reduced during processing (roasting).

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1. INTRODUCTION

Nutrients are viewed as food components that either cannot be synthesized in the body or whose synthesis requires a specific factor that may in certain circumstances be absent or inadequate for example, some amino acids, fatty acids and vitamins. Phytochemicals contained in plant foods have been linked to many positive effects on human health, including coronary heart diseases, diabetes, high blood pressure, cataracts, degenerative diseases and obesity (Liu *et al.*, 2000).

Senna occidentalis L. commonly known as coffee senna is distributed as a weed throughout the tropical and subtropical regions of the world. It can be found at low and medium altitudes as a weed in waste places, in open pastures and in fields cultivated with economic crops such as soybean, cotton, corn, sorghum etc. It grows also luxuriantly in all available spaces, such as neglected gardens, roadsides, near lakes or streams and unused grounds of public buildings (Egziabher *et al.*, 1989; Stevens *et al.*, 2001 and Vashishtha *et*

al., 2009). In West of Africa, *S. occidentalis* seeds are commonly roasted and infused in a coffee-like beverage (Dupriez and De Leener, 1987). However, several studies show that *S. occidentalis* seeds are toxic; they are responsible for a syndrome characterised by generalized muscles degeneration (Marrero *et al.*, 1998 and Haraguchi *et al.*, 1998). Seeds roasting and extraction of soluble solids into an aqueous infusion are the two key operations in the process of *S. occidentalis* beverage preparation (Oboh and Masodje, 2009).

The plant's tissues of *S. occidentalis* contain a host of phytoactive chemicals that may support its numerous applications in folk medicine. Extracts or powdered leaves are used as an analgesic, antibacterial, antifungal, anti-inflammatory, antiseptic, antispasmodic, antiparasitic, antiviral, diaphoretic, insecticidal, laxative, purgative etc (Raintree, 2002). It is also used against stomach disorders, rheumatism and in treatment of liver diseases (Sara *et al.*, 1994). The leaves and roots are ingredients of many popular herbal tonics, medicines for liver and stomach disorders. The

seeds of coffee senna are roasted and used as a coffee substitute and the leaves are widely used as a leafy vegetable and eaten either raw or mixed with coconut, chilli and onion (Selvam, 2007 and Vashishtha *et al.*, 2009).

Coffee *Senna* is a weed grown naturally in the wild which is rich in proteins, lipids, carbohydrates, calcium, iron, trace of caffeine and because of its little or no potential uses, a massive volume of this species has been wasting away which could have been harnessed for human uses. The outcome of this paper could be used among the food processing companies or even nongovernmental organizations involved in beverage production, to improve the processing (roasting) of *S. occidentalis* to obtain seeds richer in antioxidants, and therefore increase their nutritional value to create a more competitive product.

Previous work has revealed that roasting temperature and duration had significant effects on the phytochemical contents of *S. occidentalis* seeds (Olapade and Ajayi, 2016). This study is therefore designed to evaluate the chemical and nutritional composition of seeds of wild coffee senna plants in order to generate data for the development of the plant as an alternative non-caffeinated beverage source in the developing countries as an economically nutrient rich option in the fight against micronutrient deficiencies and malnutrition. This would also serve as a means of converting unwanted matter to a useful product.

2. MATERIALS AND METHODS

The matured pods of *S. occidentalis* were collected from road sides at Aleshinloye area of Ibadan Metropolis, Oyo state. The specimens were identified at the Forestry Herbarium Ibadan, Nigeria. The seeds were extracted from the pod, cleaned, sorted, air-dried for five (5) days on a cabinet drier at the Food Technology Laboratory, University of Ibadan to reduce the moisture content of the fresh seeds. The seeds were roasted at temperatures of 190, 210 and 230 °C for 10, 15 and 20 min, respectively. The

roasted seeds were cooled to ambient temperature and subsequently ground to powder using household blender and the powdered samples were stored in air-tight containers. The samples were coded for chemical analysis and all the laboratory determinations were carried out in triplicates.

Chemical analysis

The proximate composition such as moisture content, crude protein, crude fibre, crude fat and total ash of the seeds of *S. occidentalis* was determined using method of AOAC (2005), while the carbohydrate content was determined by difference of other nutrients. Aluminum chloride method was used according to Quettier-deleu *et al.* (2000) for the determination of total flavonoids content of all crude extracts of the *S. occidentalis*, while alkaloids determination was done according to the quantification method as described by Harborne (2005). Total saponin was determined according to the method of Obadoni and Ochuko (2001) with minor modifications. Estimation of tannins was carried out using the modified vanillin-HCl method (Price *et al.*, 1978).

Total phenolic content of the three samples of *S. occidentalis* was estimated according to the method described by Lister and Wilson (2001) with slight modification. Oxalate content was determined according to the method described by AOAC (2005). Phytate content was carried by an indirect colorimetric method of Wheeler and Ferrel (1971). Glycosides were determined according to the method described by Sofowora (2006). Mineral analysis was carried out by the method of AOAC (2005). Caffeine content of the three samples was determined according to a method described by Smith (2002). The samples (1g each) were incinerated at 550 °C. The ash was boiled with 10 ml of 20% hydrochloric acid in a beaker for 20 minutes and then filtered into a 100 ml standard flask. The filtrate was made up to the mark with deionized water. The minerals were determined from the resulting solution.

Sodium (Na) and Potassium (K) were determined using the standard flame emission

photometer. Phosphorus was determined colorimetrically using the spectronic 20 (Gallenkamp, UK) with KH_2PO_4 as the standard. Calcium (Ca), Magnesium (Mg), Iron (Fe), Copper (Cu) and Zinc (Zn) all were determined using Atomic Absorption Spectrophotometer (AAS Model SP9). The results of all parameters measured in the above study were analyzed using analysis of variance (ANOVA). Means comparisons was done with Duncan multiple range test (DMRT) at 5% level of probability.

3. RESULTS AND DISCUSSION

Proximate composition of roasted *S. occidentalis* seeds are presented in Table 1. The moisture content ranged from 6.65 to 7.80%, which were lower than the 13.50% earlier reported for the raw seed (Olapade *et al.*, 2014). The moisture content is one of the very important factors that influence the storage life of a plant material. The earlier study reported that moisture content of 12% as sufficient to prevent rapid deterioration that may occur during storage of seeds? Reduction in the moisture content of roasted samples as the temperature increased was observed in this study.

Protein is the source of free amino acids which combines with sugar to produce flavor and colour during roasting. When heat is applied, there is breaking down of amino acid to lower molecular substances for instance, amine and ketone which combine with sugar to give colour and flavor. This type of reaction occurs in cocoa, coffee and during bread baking. The values of crude protein of *S. occidentalis* obtained in this study are within the ranges of the values of other wild legumes reported by Vadivel (2005) and Pugalenthi *et al.* (2004).

This is known as an insoluble residue which consists of cellulose, lignin and mineral matter. The crude fibre is often used as a nutrient value because of its low digestibility and high mineral content hence low crude fibre is suggested to be low when compared with coffee, thus the nutritive value of *S.*

occidentalis is low. The highest crude fiber value (10.37%) of roasted *S. occidentalis* seed is higher than the value (10.18%) reported by Ingweye *et al.* (2010). The fiber content obtained in this study is within the ranges of the crude fiber content of other wild legumes reported by Vadivel (2005) and Pugalenthi *et al.* (2007).

The highest mean crude fat found in sample B (3.53%) shows an indication that roasted *S. occidentalis* seeds are healthier because the lower the fat content of food the better the food. The crude fat of *S. occidentalis* recorded in this study is lower than values (10.18%) reported by Ingweye *et al.* (2010).

The highest mean value 3.78% found in roasted *S. occidentalis* seeds (sample C) is slightly lower than that of coffee. Vincent *et al.*, (2001) reported that the ash content of coffee was found to be 3.93%. This low ash content suggests that low content of organic compound in the *S. occidentalis* seeds compared to that of coffee. This might be due to losses due to volatilization of some parts of organic compound during roasting process. The ash content *S. occidentalis* seeds indicated that the seeds may be potential sources of some vital dietary mineral elements. However, the ash values were slightly higher than values (3.70%) reported by Ingweye *et al.* (2010) but lower than values (4.16%) reported by Augustine *et al.* (2014).

It consists of reducing and non-reducing sugars and as a result of the breaking down of sugars such as to lower molecular compounds such as ketones, aldehyde and furanes are responsible for the flavor and colour formed consequently, result in lowering of pH of a food material. The carbohydrate component of the samples (*S. occidentalis* seeds) is low when compared to coffee which is 60%. This low carbohydrate content might be due to losses due to volatilization of some parts of sugars and other molecular compounds during roasting process therefore, contributing to the low proportion of colour and flavor liberated in the samples.

Phytochemical components of roasted *S. occidentalis* seeds (powder)

Phytochemicals are biologically active compounds found in plants in small amounts which are not established nutrient but contribute significantly to protecting the body against degenerative diseases. Flavonoid contents of the samples increases as the roasting temperature and time of *S. occidentalis* seeds increases as shown in Table 2. This shows that roasting temperature and time improves the flavonoid contents of the seeds during roasting with sample C has the highest value (754.92 mg/100g) and sample A has the lowest value (487.28 mg/100g). These values are significantly different from each other at $p < 0.05$.

Flavonoids are potent water-soluble super antioxidants and free radical scavengers which prevent oxidative cell damage, have strong anti-cancer activity and protects against all stages of carcinogenesis. Sofowora (1993) reported the roles of these phytochemicals as analgesic, anti-inflammatory, anti-hypertensive and anti-microbial. Saponins and tannins also exhibit cytotoxic effects and growth inhibition making them suitable as tumor inhibiting compounds. This phytochemical analysis revealed that flavonoids, phenols, phytate and tannin were higher in sample C and increased as roasting temperature increased with time. While sample C has the lowest values of glycosides, saponin, oxalates and alkaloids decreased as roasting temperature was decreased with time.

Antinutritional factors

The results of the anti-nutritional factors of samples A, B and C as shown in Table 3 revealed that except for saponins has more concentration of glycosides (452.78 mg/100g, 463.51 mg/100g and 426.61 mg/100g). This clearly showed that *Senna occidentalis* may have more toxic potentials, lower digestibility and utilization of dietary nutrients. The tannin, alkaloid, oxalate, phenol and saponin content of *S. occidentalis* recorded in this study were far lower than the values (269.23 mg/100g); (251.00 mg/100g); (176.50 mg/100g); (220.33

mg/100g) and (76.05 mg/100g) respectively reported by Augustine *et al.* (2014). The phytochemicals of the three samples A, B and C are significantly different from each other at $p < 0.05$. Majority of wild legumes have anti-nutritional factors associated with them which have adverse effects on food utilization and may also be toxic when consumed beyond certain threshold. Tannins are generally known to reduce food palatability, voluntary intake and protein and carbohydrate digestibility and further reduce the growth rate of animals (Dawson, 1999). Also, phenolic compounds are known to inhibit the activity of digestive enzymes like trypsin, chymotrypsin and lipase (Salunkhe *et al.*, 1982) and decrease the digestibility of proteins, carbohydrates and availability of vitamins and minerals (Udayasekhava and Deosthale, 1982).

Mineral content of roasted *Senna occidentalis* seeds (powder)

Table 3 summarizes the elemental composition of the three samples *S. occidentalis* powder. Phosphorus was the most abundant mineral in *S. occidentalis* seeds followed by potassium. The mineral occurring in the least quantity was zinc (48.20, 52.25 and 54.24 mg/100 g). However, highest values were found in sample C for all the mineral elements except sodium and phosphorus highest values were found in sample A. The calcium contents of sample A and B are the same but both are significantly different from sample C at $p < 0.05$. Also, there is no significance between copper and zinc contents of sample B and C but both samples are significantly different from sample A ($p < 0.05$). However, there are significant differences among the three samples (A, B and C) in their iron, magnesium, phosphorus, potassium and sodium ($p < 0.05$).

Mineral elements such as calcium, magnesium, potassium, zinc, iron, manganese and sodium found in reasonable amount in the seeds are nutritionally and biochemically important for proper body function. For instance, calcium is known to play a significant role in muscle contraction, bone and teeth formation and blood clotting (Peters and Martini, 2010).

Some of these minerals such as magnesium and zinc are needed as cofactor in enzyme catalysis in the body (Ahmed and Chaudhary, 2009). Iron is an essential trace element for haemoglobin formation and normal functioning of the central nervous system (Adeyeye and Otokiti, 1999). Iron is known to be a component of some myoglobin and haemoglobin which is needed in the transport of oxygen and carbon dioxide during respiration or cellular metabolism (Ahmed and Chaudhary, 2009). Zinc present in the plant is beneficial to prevention and treatment of diarrhoeal episode.

It is also involved in normal functioning of immune system and for the proper functioning of the reproductive system (Hambidge, 2006). Low sodium diet has been reported to be beneficial in the prevention of high blood pressure (Lichtenstein, 2006) and high potassium has been reported to have a protective effect against excessive sodium intake. Sodium and potassium which are present in the intracellular and extracellular fluid helps to maintain electrolyte balance and membrane fluidity (Ahmed and Chaudhary, 2009).

Table 1: Proximate composition of *Senna occidentalis* Seed powder on dry basis

Components (%)	Samples		
	190 °C, 10 min	210 °C, 15 min	230 °C, 20 min
Moisture	7.80 ± 0.25 ^a	7.35 ± 0.44 ^a	6.65 ± 0.08 ^b
Crude protein	22.46 ± 0.59 ^b	21.04 ± 0.86 ^c	24.98 ± 0.29 ^a
Crude fibre	10.22 ± 0.23 ^a	10.29 ± 0.11 ^a	10.37 ± 0.09 ^a
Crude fat	2.06 ± 0.05 ^c	3.53 ± 0.14 ^a	2.49 ± 0.12 ^b
Total ash	3.65 ± 0.05 ^b	3.74 ± 0.05 ^{ab}	3.78 ± 0.03 ^a
Carbohydrates	53.78 ± 0.50 ^a	53.97 ± 1.16 ^a	50.78 ± 1.92 ^b

Mean value ± S.D with same superscript along row are not significantly different (p<0.05).

Table 2: Phytochemical composition of roasted *Senna occidentalis* Seeds on dry basis (mg/100g)

Components	Samples		
	190 °C, 10 min	210 °C, 15 min	230 °C, 20 min
Alkaloid	204.33 ± 4.93 ^a	166.76 ± 2.92 ^b	147.60 ± 3.06 ^c
Flavonoid	487.28 ± 6.37 ^b	568.43 ± 2.47 ^b	754.92 ± 6.20 ^a
Glycosides	452.78 ± 4.15 ^b	463.51 ± 4.06 ^a	426.61 ± 3.60 ^c
Oxalate	31.50 ± 1.37 ^a	17.17 ± 1.26 ^c	25.68 ^c ± 1.17 ^b
Phenol	172.11 ± 1.64 ^a	161.06 ± 6.43 ^b	152.81 ± 1.31 ^c
Phytate	42.53 ± 2.99 ^c	58.33 ± 2.40 ^b	121.00 ± 1.56 ^a
Saponin	18.06 ± 0.41 ^a	16.03 ± 0.40 ^b	15.20 ± 0.20 ^c
Tannin	127.02 ± 2.19 ^b	115.33 ± 1.62 ^c	174.21 ± 2.04 ^a
Terpenoid	12.10 ± 0.31 ^c	14.18 ± 0.07 ^b	14.76 ± 0.15 ^a
Caffeine	0.05 ± 0.01 ^a	0.04 ± 0.00 ^b	0.05 ± 0.01 ^a

Mean value ± S.D with same superscript along row are not significantly different (p<0.05).

Table 3: Mineral composition of roasted *Senna occidentalis* Seeds on dry basis (mg/100g)

Components	Samples		
	190 °C, 10 min	210 °C, 15 min	230 °C, 20 min
Calcium	912.33 ± 7.76 ^b	922.16 ± 5.57 ^b	956.96 ± 7.42 ^a
Copper	9.30 ± 0.22 ^b	10.42 ± 0.13 ^a	10.61 ± 0.40 ^a
Iron	201.53 ± 2.65 ^c	218.83 ± 5.79 ^b	232.40 ± 2.40 ^a
Magnesium	610.00 ± 4.58 ^c	627.66 ± 5.50 ^b	638.33 ± 5.50 ^a
Phosphorus	1195.66 ± 7.37 ^a	1173.33 ± 5.77 ^b	1159.00 ± 3.60 ^c
Potassium	924.83 ± 21.79 ^c	967.66 ± 6.52 ^b	1002.16 ± 11.72 ^a
Sodium	543.33 ± 5.77 ^b	525.33 ± 5.50 ^c	586.00 ± 7.21 ^a
Zinc	48.20 ± 2.40 ^b	52.25 ± 0.88 ^a	54.24 ± 1.01 ^a

Mean value ± S.D with same superscript along row are not significantly different (p<0.05).

4. CONCLUSION

This research has shown that *S. occidentalis* seeds can be used as coffee substitute apart from its medicinal purposes. The results of caffeine content determination indicate the presence of caffeine only in trace amount (0.005 mg/100g) in the roasted seeds at temperature of 230 °C. The phytochemical screening indicates the presence of anti-nutritional factors such as alkaloids, tannins, saponins, oxalates, glycosides and phytates but as a result of roasting temperatures and time tannin and phytate that usually cause adverse food digestibility and toxicity have been volatilized to a safe level.

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