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QUALITY EVALUATION OF COFFEE-LIKE BEVERAGE FROM COFFEE SENNA (*Senna occidentalis LINN*) SEEDS

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ABSTRACT

One of the uses of *Senna occidentalis* seeds is that it can be roasted as coffee-like beverage in many countries. Roasting is one the processing methods by which anti-nutrients inherent in the seeds can be eliminated and improve its overall quality. Therefore, this present study evaluated physicochemical properties, vitamin composition and sensory attributes of roasted *S. occidentalis* seeds. Matured pods of *S. occidentalis* were collected and fresh seeds extracted were cleaned, sorted, air-dried for 7 days on a cabinet drier under room temperature. The dried seeds were roasted at temperatures of 190°C, 210°C and 230°C for 10, 15 and 20 minutes, respectively then ground to powder, stored in air-tight containers for chemical analysis. The physicochemical properties and vitamin contents of the roasted seed powder were determined using standard analytical methods. Sensory evaluation of the *S. occidentalis* extracts and reference sample (Nescafe)was conducted using 9-point hedonic scale. The results showed that the pH, colour and caffeine content of roasted seeds powder samples varied greatly. Vitamin A content ranged from185.20 to 206.75 UI/100g while vitaminsB_1, B_2, B_3, $B_5$and C measured (mg/100g) were 0.43 – 0.69;0.08 - 0.11;1.59 – 1.89;3.55 – 3.87;8.98 - 20.38 respectively. Sensory analysis results showed that beverage from *S. occidentalis* seeds roasted at 230°C, 20 minutes was most acceptable among the three samples compared with reference sample (Nescafe). It can therefore be concluded that coffee seeds subjected to high roasting conditions exhibited consumer preference almost as that of reference sample.

Keywords: Coffee Senna, Nutrients, Beverage, Coffee Substitute, Roasted Seeds, Temperature

Introduction

Coffee, a non-alcoholic beverage is one of the most popular drinks in the world (Odem, 2015). It is a brewed beverage mainly from the roasted or baked seeds of the two most highly regarded *Coffea arabica* and *Coffea robusta*. The dried seeds of Coffee are roasted to varying degrees depending on the desired flavour before being ground and brewed to coffee drink (Villanueva *et al*., 2006). Coffee is dark, bitter and slightly acidic with a pH of 5.0 – 5.1 and has a stimulating effect on human primarily due to its caffeine content (Cappalletti *et al*., 2015). Wikipedia, (2015) reported that the stimulating effect of coffee as a result of its caffeine content can be harmful to human health if consumed in high doses. Also, Cornellis and El-sohemy (2007) recommended that coffee should be consumed in moderate quantity because of the ‘terpenes’ a compound found in coffee which may increase the risk of heart disease. In the developing countries like Nigeria, the socio-economic problems such as poverty, malnutrition and hunger with deficiencies or excess of nutrients especially proteins, carbohydrates and vitamins have resulted into various complications and metabolic disorders which have become a major menace facing human in recent times (FAO, 2003).

S. occidentalis is a leguminous plant commonly known as coffee senna or septic-weed belonging to the family *Caesalpinoideae*. It is an erect, branched, smooth, semi-woody, fetid herb which can attain 1.5m height. The pods of *S. occidentalis* are 10 – 13 cm long and0.8 cm in diameter containing dark olive green seeds (Holm *et al.,* 1997; Yadav *et al.,* 2010).*S. occidentalis* is used as a coffee substitute in many countries, though there are reports that the seeds are toxic to cattle and rabbits which might be linked to presence of anti-nutrients (Carmo *et al.,* 2011). It is therefore necessary to use effective processing method like roasting to reduce the toxic components prior to usage as feedstuff (Augustine *et al.,* 2014).

Roasting as a food processing method is known to influence physical, chemical and functional properties of crops (FAO, 2003). Roasting generates characteristic flavour and colour which consumers require for acceptance of food product (Olapade and Akinoso, 2004). *S. occidentalis* is readily available and cheaper than the highly regarded two sources of coffee beans. Coffee senna `has been reported to be rich in proteins, lipids, carbohydrates, calcium, iron and trace of caffeine (Olapade and Ajayi, 2016) yet little or no attention is being paid to its potential use. In addition, a massive volume of this species has been wasting away which could have been harnessed to human use as a cheaper alternative source to coffee. This study is therefore designed to evaluate the quality parameters and organoleptic attributes of roasted *S. occidentalis* seeds in order to generate a baseline data for the development of the plant as an alternative source of non-caffeinated beverage.

Materials and Method

Sample collection and preparation

The matured pods of *S. occidentalis* were collected from Forestry Research Institute of Nigeria (FRIN) Ibadan, where they are found in large quantity. The specimens were identified to species level. The seeds of *S. occidentalis* were extracted from the pod, cleaned, sorted, air-dried for seven (7) days on a cabinet dried at ambient temperature to reduce the moisture content of the fresh seeds. The seeds were roasted at temperatures of 190^{o}C, 210^{o}C and 230^{o}C for 10, 15 and 20 minutes, respectively in accordance with the established commonly adopted roasting conditions for commercial coffee production (210^{o}C, 15 minutes) Olapade *et al.,* (2018). 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. All the laboratory determinations were carried out in three replicates.

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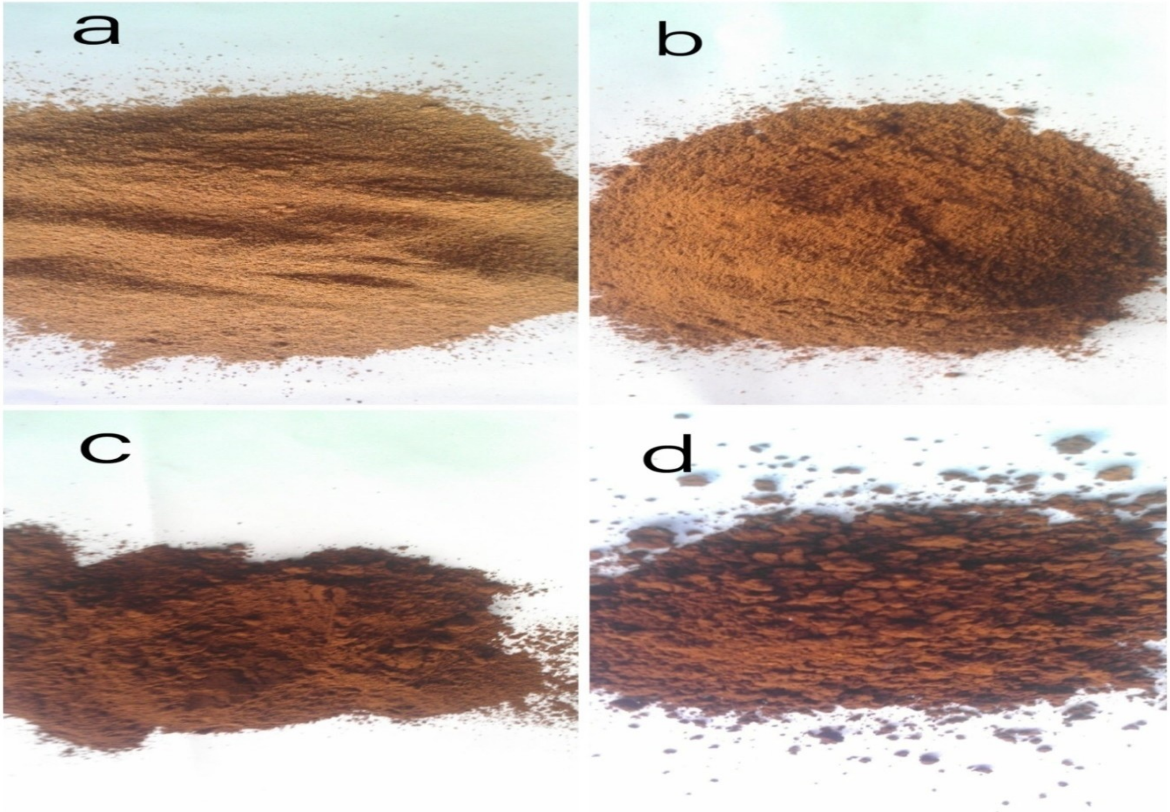

Plate 1: Samples of the powdered seed at different temperature and time.

- Sample A – *S. occidentalis* seeds roasted at 190^{o}C for 10 minutes
- Sample B – *S. occidentalis* seeds roasted at 210^{o}C for 15 minutes
- Sample C –*S. occidentalis* seeds roasted at 230^{o}C for 20 minutes
- Sample D – Whole coffee beverage (Nescafe).

Physicochemical analysis

The pHvalues of the three samples of *S. occidentalis* seed powderwere carried out using electronic pH meter according to method of Afoakwa*et al*. (2006).Colour of the three samples of roasted *S. occidentalis*seeds was determined according to standard method described by AOAC (2005). Caffeine content of the three samples was determined according to a method described by Smith (2002).

Vitamins determination

Vitamin A content of the three samples of *S. occidentalis* seed powder was determined by colorimetric method of AOAC (2000). Vitamins B_1, B_2, B_3 and B_5 content of the three samples of *S. occidentalis* seeds were all determined using standard method of AOAC (2000).Vitamin C was quantitatively determined according to the modified 2,6-dichlorophenolidophenol (DIPH) method.

Sensory evaluation of coffee-like beverage

Sensory attributes like aroma, colour, taste and overall acceptability were carried outat Biomedicinal Research Centre laboratory, FRIN, Ibadan on three samples of *S. occidentalis* and control (Nescafe) by fifty panelists using a multiple comparison difference analysis on 9-point hedonic scale where nine and one represented “liked extremely” and “dislike extremely”, respectively(Ihekoronye and Ngoddy, 1985).

Statistical Analysis

Treatments were replicated three times and data obtained were subjected to Analysis of

Variance (ANOVA).The differences between means were evaluated by Duncan Multiple Range Test (DMRT) at 5% level of probability.

Results and Discussion

Physicochemical properties

An increase in any solution temperature will cause decrease in its viscosity and an increase in the mobility of its ions in solution (Zumdhal, 1993). The mean pH of the roasted seeds shown in Table 1 ranged from 5.53 to 5.23 where sample A had the highest value of5.53 and sample B had the lowest (5.23). All the three samples of *S. occidentalis* seeds roasted at 190^{o}C, 210 ^{o}C and 230^{o}C for 10, 15 and 20 minutes respectively were significantly different from one another at P<0.05. The results obtained for the pH values are lower than those values (6.06, 6.03 and 6.41) obtained for *Cassia seberiana* seeds (Olapade *et al.*, 2012). The variation observed might be as a result of variation in geographical location of the seeds and stage of maturity as at when the seeds were collected. Meanwhile, the values obtained for colour of the samples ranged from 10.30 - 7.73absorbance where sample C roasted at 230^{o}C had the highest value and sample A had the least (Table 1). The three samples were significantly different (p>0.05) from one another. Effect of roasting was evidently significant on colour of the *S. occidentalis* seeds. This further confirms that there is a relationship between roasted *S. occidentalis* colour, roasting temperature and time. Caffeine is odourless with a bitter taste and highly soluble in hot water (CRI, 2006). It occurs naturally in coffee, tea, cocoa, kolanut and a variety of other plants. Caffeine content of the samples varied from 0.05 to 0.04 mg/100g with sample A, having the highest and sample B had the least (Table 1). The effect of heat treatment (roasting) was found to be significant (P<0.05) as caffeine content reduced with increase in roasting temperature and duration. The values obtained are lower than 65 – 175 mg/100g reported for variants of *Coffea robusta* and *Coffea Arabica* (Cornellis, 2012).

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

Parameters	Sample A	Sample B	Sample C
pH	5.53 ± 0.11^a	5.23 ± 0.11^b	5.33 ± 0.11^{ab}
Colour (Abs)	7.73 ± 0.15^b	9.56 ± 0.15^c	10.30 ± 0.20^a
Caffeine (mg/100g)	0.05 ± 0.001^a	0.04 ± 0.001^c	0.05 ± 0.001^b

Mean value ± S.D with same superscript are not significantly different at 5% level (p<0.05)

Vitamin contents of roasted *S. occidentalis* seeds

Vitamins are a diverse group of organic molecules required in very small quantities in the diet for health, growth and survival (Stenesh, 1975). The absence or inadequate intake of a vitamin from the diet results in characteristic deficiency signs and ultimately death (Smith *et al.*, 1997). Vitamin A is important in the formation of epithelial tissues for proper bones maintenance and growth, reproduction, good vision, healthy skin, hair and nails (Stryer, 1995).The reduced level of vitamin A in diets results in poor vision, growth and reproductive disability. Results of vitamin contents of roasted *S. occidentalis* seeds shown in Table 2 revealed that the three samples (A, B and C) contain 206.75 IU/100g, 202.10IU/100g and 185.20IU/100g, respectively, sample A had the highest value while sample C had the lowest. These values obtained were lower than 710 UI/100g reported for soybeans but higher than 158 IU/100 for mung beans (Vansuderan and Sreekumari, 2007). However, sample A and B are not significantly different from one another but both are significantly different from sample C ($p< 0.05$). Vitamin A content appeared to reduce with increasing oven temperature.

Vitamin B_1 (Thiamine) is involved in the metabolism of keto-acids and carbohydrates. Its deficiency can results in loss of appetite, nausea, constipation, irritability, tiredness and development of cardiac difficulties. In addition, vitamin B_2 forms the prosthetic part of many enzymes and its deficiency in diets causes marked swelling and softening of sciatic and brachial nerves in human (Banergee, 2004). Riboflavin deficiency leads to blurred vision and intolerance of light. The concentration of vitamin B_1 (thiamine) obtained in the three samples ranged from 0.41 - 0.69 mg/100g (Table 2), where sample B roasted at 210^{o}C for 15 min had the lowest and sample A roasted at 190^{o}C for 10 minutes had the highest. There is no significant difference between the samples B and C but both were different from sample A, ($p< 0.05$). Vitamin B_2 (riboflavin) content ranged from 0.08 - 0.11 mg/100g where sample A roasted at 190^{o}C for 10 min had the highest and is significantly different from the other samples (Table 2). The vitamin B_1 and B_2contents of roasted *S. occidentalis* seeds (powder) were low compared to 2.75 mg/100g and 4.24 mg/100g obtained for *Amaranthus hybridus* (Akubugwo *et al*., 2007). This is in line with the report of McDonald *et al*. (1995) that grains are poor sources of vitamins especially the water-soluble vitamins.

The concentration of vitamin B_3(niacin) of the three samples ranged from 1.59 - 1.89 mg/100g with a significant progressive increase as roasting temperature increased. Niacin is involved in glycolysis, fat synthesis and tissue respiration. The values of vitamin B_3 (niacin) obtained for the three samples were higher than 1.54 mg/100g reported for *Amaranthus hybridus* leaves (Akubugwo *et al*., 2007). This agrees with reports of Vansuderan and Sreekumari, (2007) that legumes (pulses) and oil seeds are rich sources of niacin. Meanwhile, vitamin B_5 (pantothenic acid) levels obtained were between 3.49 mg/100g and 3.87mg/100g where Sample C had highest amount and sample B had the lowest. Sample A and B are the same but both are significantly different from sample C (Table 2).

Vitamin C (ascorbic acid) promotes the absorption of iron, boosts immune system, neutralizes blood toxins and helps in maintaining the epithelial tissues of the skin and connective tissues. It is required for the maintenance of healthy gums for healing of wounds and mopping up excess oxygen from the tissue. The deficiency of ascorbic acid in human diets causes scurvy. Vitamin C contents ranged from 8.98 - 20.38mg/100g where sample A had the highest value and sample B had the least. Statistically, the three samples are different from one another (Table 2). Vitamin C (ascorbic acid) content of the three roasted samples was low. This was lower than 25.40 mg/100g for *Amaranthus hybridus* (Akubugwo *et al*., 2007). This agrees with Vansuderan and Sreekumari, (2007) and Banergee, (2004) who reported that vitamin C (ascorbic acid) is generally poor in seeds but abundant in citrus, guava and leafy vegetables.

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Table 2: Vitamin content of roasted *S. occidentalis* seed on dry basis

Components	Sample A	Sample B	Sample C
Vitamin A (UI/100g)	206.75 ± 2.86^a	202.10 ± 3.04^a	185.20 ± 8.92^b
VitaminB_1(mg/100g)	0.69 ± 0.03^a	0.41 ± 0.08^b	0.43 ± 0.02^b
VitaminB_2(mg/100g)	0.11 ± 0.01^a	0.08 ± 0.01^b	0.08 ± 0.01^b
VitaminB_3(mg/100g)	1.59 ± 0.037^b	1.78 ± 0.034^c	1.89 ± 0.036^a
VitaminB_5(mg/100g)	3.55 ± 0.08^b	3.49 ± 0.10^b	3.87 ± 0.09^a
Vitamin C(mg/100g)	20.38 ± 0.60^a	8.98 ± 0.67^b	12.97 ± 0.63^c

Mean value ± S.D with same superscript are not significantly different at 5% level ($p<0.05$).

Sensory Evaluation

The results of organoleptic test conducted in this study provide useful information on an existing product characteristics or the future commercial potential of a newly developed coffee-like beverage, by quantifying its consumer preference or degree of liking/disliking (Trigueros *et al*., 2012). The response of sensory panel for beverages made from the three roasted seeds of *S. occidentalis* (sample A, B and C) in comparison to reference sample D (Nescafe) is presented in Table 3. This results revealed that beverage from sample D (Nescafe) had the highest degree in color score (8.0) followed by sample C (6.90) and sample B (5.64) while beverage from sample A had the lowest (4.65). At the same time, Sample D recorded the highest score in taste (7.55), aroma (8.0) and overall acceptability (7.55) respectively, while sample A had the lowest score in taste and aroma. Apart from the reference sample (Nescafe), sample C was the most comparable among the three compared samples in terms of aroma, taste and overall acceptability. Furthermore, all the samples are significantly different from one another in all the sensory attributes ($p<0.05$). The values obtained in this study were similar to values reported for coffee-like beverage from date seeds; aroma (5.6 – 6.6), colour (4.0 – 5.5), taste (5.6 – 6.6) and overall acceptability (7.8 – 8.7), (Ghnimi *et al.*, 2015). This also corroborates the findings of Ingweye *et al.*, (2010) on *Senna obtusifolia.* The highest roasting temperature – time combination (230 ^oC, 15 minutes) may be considered as most important factors which had contributed to the development typical coffee beverage characteristics therefore, sensory quality of beverage can be improved by adopting this roasting condition for the development of desirable characteristic colour, flavour and taste typical of coffee.

Table 3: Sensory attributes of beverages from roasted *Senna occidentalis* seeds

Attributes	Sample A	Sample B	Sample C	Control
Aroma	3.65 ± 1.44^{d}	5.41 ± 1.71^{c}	6.40 ± 1.21^{b}	8.00 ± 0.84^{a}
Colour	4.65 ± 1.62^{c}	5.64 ± 1.34^{c}	6.90 ± 0.95^{b}	8.00 ± 0.71^{a}
Taste	3.62 ± 1.40^{d}	4.84 ± 1.82^{c}	5.67 ± 0.94^{b}	7.55 ± 0.98^{a}
Overall acceptability	4.05 ± 0.97^{d}	5.27 ± 0.90^{c}	6.31 ± 0.59^{b}	7.55 ± 0.56^{a}

Mean value and standard deviation for each attribute followed by same letter are not significantly different at 5% level ($p<0.05$). Higher values indicate greater preference.

Conclusion

The quality characteristics and sensory attributes of roasted *S. occidentalis* seeds (coffee-like product) were evaluated in this study. The determined attributes allowed comparison between the coffee-like beverages and traditional *Coffea species* (*Arabica* and *robusta*).The sensory evaluation revealed that *S. occidentalis* seeds are acceptable and only slightly lower in quality compared to the reference. Therefore, future process of making coffee-like beverages from *S. occidentalis* seeds may be improved and other additives may be investigated to improve the overall quality of the product. Also, the presence of estrogenic compounds is a serious issue that needs to be investigated before *S. occidentalis* seeds can be recommended for human consumption.

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