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Research Article

Quality Evaluation of Coffee-like Beverage from Baobab (*Adansonia diditata*) Seed

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Abstract: Coffee, one of the most consumed beverages in the world is slightly acidic (pH 5.0-5.1) and contains caffeine which has stimulating effect on human and also found to have negative effect on the brain, kidney, cardiovascular and respiratory systems hence the need to produce coffee-like beverages without such negative effects on the body. Baobab (*Adansonia digitata)* seed was cleaned and roasted at different temperatures (100°C, 120°C and 150°C) for 30 min, was milled and sieved. A group of three of the sieved samples was blended with spices (cloves and ginger) at 0.5% conc. and oven dried at 30°C for 30 min while the other group of three was without spice. Sensory evaluation and microbiological analysis were carried out on these six samples. Results revealed that the group roasted at 150°C for 30 min with spices was the most generally accepted sample for baobab seed coffee-like beverage and the total mould and bacterial count decreased as roasting temperature increased. Proximate, caffeine, mineral, vitamin and anti-nutrient content determination were carried out on the most preferred sample with fresh baobab seed flour serving as control. Results revealed that roasting at 150°C for 30 min significantly ($p \leq 0.05$) increased the protein, carbohydrate, ash, crude fiber, calcium, magnesium, phosphorus and potassium content but significantly ($p \leq 0.05$) decreased the moisture, fat, energy, caffeine, iron, oxalate, phytate, tannin and saponin content of the sample. The vitamin content of the fresh baobab seed flour and roasted sample at 150°C for 30 min with spices were significantly ($p \geq 0.05$) not different.

Keywords: Baobab seed, coffee-like beverage, caffeine, chemical composition, sensory evaluation

INTRODUCTION

Coffee is one of the most commonly consumed drinks in the World. Recent research showed that moderate coffee consumption is mildly beneficial in healthy adults but can worsen the symptoms of some conditions such as anxiety due to the caffeine and diterpenes it contains (Villanue *et al*., 2006). Caffeine chemically is a member of xanthine family (Olapade *et al*., 2012). It causes the body to be less metabolically efficient: less oxygen gets to the cells therefore less waste is removed from the cells increasing the risk of every type of cancer; it directly affects the neuro-transmitters involved with memory and learning thereby decreasing mental acuity and causing brain fag; it raises blood sugar levels and disrupts the blood sugar-regulating effect on insulin; it raises homocysteine levels, increasing the risk of diabetes and cardiovascular disease; it decreases the ability of the body to absorb calcium, magnesium, sodium, zinc and chloride thereby increasing the risk of a whole host of illness including osteoporosis (Blog at Word Press.com, 2012). Coffee consumption can lead to iron deficiency anemia especially in mothers and infants by interfering with iron absorption due to its polyphenols content (Dewey *et al*., 1997). Roasted coffee bean used in brewing the beverage is approximately 2% caffeine with the remainder composed of chlorogenic acids, ferulic acid, caffeic acid, nicotinic acids as well as other unidentifiable compounds (Hodgson *et al*., 2013). Studies carried out *in-vitro* studies suggested that chlorogenic acids antagonize adenosine receptor binding of caffeine causing blunting to heart rate and blood pressure in rat (Crozier *et al*., 2012). This has necessitated the use of other roasted seeds of plants that will give similar appearance to coffee but has lower caffeine content. Baobab (*Adansonia digitata)* seeds roasted and used in the production of coffee-like beverage have become a necessity. Baobab is the most widespread of the *Adansonia* species on the African continent, found in the hot, dry savannahs of sub-Saharan Africa (Wikipedia-the Free Encyclopedia, year). It is a multi-purpose tree and belongs to the order Malvales and family Malvaceae (Donatien *et al*., 2011). The English common names include *dead-rat tree* (from the appearance of the fruits), *monkey-bread tree* (the soft, dry fruit is edible), *upside-down tree* (the sparse branches resemble roots) and *cream of tartar*

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tree (Wikipedia-the Free Encyclopedia, year). An average mature baobab tree produces 200 kg of fruits a year. The fruits mature 5 to 8 months after pollination. Mature baobab fruit is 35 cm long and 13 cm wide, cylindrical in shape, slightly tapered at each end, has a hard woody shell covered in yellow-grey hair and hangs on long stalks. The pericarp is 8 to 10 mm thick enclosing the whitish-pink, dry, acidic pulp which has very high vitamin C content (15 times that of orange) (Caluwe and Patrick, 2010) and is eaten on its own or mixed in porridge and also used for making soft drinks and juice (Coates, 2002). Each fruit contains over 100 seeds within it's pulp (Sacande *et al*., 2006). The seeds are dark brown, smooth and laterally flattened, oval, 1.3 cm by 9 cm, with tough husk and soft kernel. Baobab seeds have a pleasant nutty flavor and are good coffee substitute when roasted and ground (Gruenwald and Galizia, 2005). The seeds have an oil content of 14% (Sacande *et al*., 2006) and the seed protein contains about 5% lysine, 1% methionine, 1.5% cysteine (Osman, 2004) and high level of thiamine and calcium (De Caluwe *et al*., 2010). The seeds also contain digestible carbohydrate, high proportions of linoleic and oleic acid, palmitic and α-linolenic acid (Sidibe and Williams, 2002). Baobab fruit contains 50% more calcium than spinach and high in anti-oxidant (National Research Council, 2008). Baobab seeds contain high concentrations of oxalates (10%), phytate (2%) and saponins (3.7%) (Heuzé *et al*., 2013; Belewu *et al*., 2008; Nkafamiya *et al*., 2007). Whole seeds contain amylase inhibitors and tannins (Osman, 2004). Processing eliminates a number of the anti-nutritional factors present in the seed. Roasting, hot water, hot alkali and acid treatments significantly reduce the tannin content while roasting, de-hulling, cold water and hot alkali treatments reduce amylase inhibitor activity (Igboel *et al*., 1997). Baobab seeds have been in use for some purposes. Due to their long shelf-life and high energy and protein content, both the seeds and the kernel can be important food sources in times of low crop yield and natural disaster (State of the World, 2011). Baobab seeds have a pleasant nutty flavor and are a good coffee substitute when roasted and ground (Gruenwald and Galizia, 2005). It can be eaten fresh, or can be dried and ground into flour which can either be added to soups and stews as thickener or roasted and ground into a paste or boiled for a long time, fermented and dried for use (Sidibe and Williams, 2002 cited in Nnam and Obiakor, 2003). This study aimed at evaluating the sensory acceptability, microbiological, chemical analysis of the roasted baobab seed coffee-like beverage. This study would encourage the use of baobab seed for the production of coffee-like beverage.

MATERIALS AND METHODS

Sample procurement and preparation: The Baobab fruit pod, cloves and ginger were purchased from Jimeta main market, Yola, Nigeria.

The seeds were extracted from the pulp of the fruit pod, sorted, washed, sundried, put in six groups (A, B, C, D, E and F) and roasted at different temperature 100°C, 120°C and 150°C, respectively for 30 min. The seeds were milled with hammer mill and sieved with a sieve aperture of 150 micrometer (µm). Three samples were blended with spices (ginger and cloves) at 0.5% concentration, oven dried at 30°C for 30 mins and packaged while the other three samples were packaged without spices. Sample A = Baobab seed roasted at 150°C, milled, sieved and packaged without spice; Sample B = Baobab seed roasted at 150°C, milled, sieved and blended with spices at 0.5% concentration. Sample C = Baobab seed roasted at 120°C, milled, sieved and blended with spice at 0.5% concentration. Sample D = Baobab seed roasted at 120°C, milled, sieved and packaged without spice. Sample E = Baobab seed roasted at 100°C, milled, sieved and blended with spice at 0.5% concentration. Sample F = Baobab seed roasted at 100°C, milled, sieved and packaged without spice.

Sensory evaluation: The organoleptic quality assessment of the six samples (A-F) was evaluated using the 7-point rating hedonic scale (7 = like extremely, 6 = like much, 5 = like moderately, 3 = neither like nor dislike, 2 = dislike moderately, 1 = dislike extremely) based on colour, flavor/aroma, taste/mouth feel and general acceptability as described by Ihekoronye and Ngoddy (1985) and other conditions as described by Akubor and Ukwuru (2003). A fifteen semi-trained panelist were used and scores obtained were subjected to statistical analysis and mean separation using LSD test methods (Steel and Torrie, 1960; Iwe, 2002).

Microbiological analysis: This was carried out on the six samples (A-F) and on fresh baobab seed flour which served as control. One gram of each sample was separately homogenized in 10 mL of sterile 0.1% (w/v) peptone water. The resulting mixture was serially diluted with deionized water as needed (up to10^4) and 0.1 mL surface plated on agar as described by Okpokwasili and Ogbulie (1993). The Nutrient agar and MacConkey agar plates were incubated at 37°C for 48 h for bacterial isolation while Sabouraud's Dextrose Agar plates were incubated at 30°C for up to 5 days for mould isolation. Total colony forming unit (cfu/g) of bacterial and fungal isolates was counted using microscopic method as described by Isu and Onyeagba (2002). The experiments were carried out in triplicate.

Chemical analysis: The moisture content, crude protein, crude fat, crude fiber and ash content of the most acceptable roasted baobab seed beverage and the control were determined using (AOAC, 2005) methods. Energy value was calculated using the Atwater factor while the carbohydrate was determined by difference (Ihekoronye and Ngoddy, 1985). Caffeine content of the samples was determined by modified method of Mumin *et al*. (2006). The concentration of some selected minerals was determined using atomic absorption spectrophotometer (AAS model: Perkin Elmer 2380, USA 1976) according to AOAC (2005) method. Vitamin content was determined by High Performance Liquid Chromatography (HPLC) as described by Lu *et al*. (2010).

Anti-nutrient content evaluation: Oxalate and phytate were determined by method described by Onwuka (2005). Tannin content was determined using the modified Vanilln-HCL assay method as described by Price and Butter (1980). Saponin was determined using the method as described by Makkar and Becker (1996).

Statistical analysis: Data obtained were subjected to Analysis of Variance (ANOVA) as described by Ihekoronye and Ngoddy (1985) while comparism means was performed using Fisher's Least Significant Difference (LSD) test at 5% of coefficient of variation.

RESULTS AND DISCUSSION

The result of the sensory evaluation as shown on Table 1 revealed that though the sample with baobab seed roasted at 120°C had the highest value of acceptability in taste, the sample of baobab seeds roasted at 150°C and blended with spices (Sample B), had the highest value of general acceptability in the production of baobab coffee-like beverage. This could be due to the addition of spices and higher temperature used for the roasting which enhanced the flavor and taste (Ihekoronye and Ngoddy, 1985). In terms of colour, the baobab seed roasted at 150°C without spices had the highest acceptability while the one roasted at 100°C without spice had the least (Table 2).

Results of the proximate analysis, (Table 3) revealed that the value for mean moisture content showed significant difference ($p \leq 0.05$) between the fresh baobab seed flour [Sample A], (5.29±0.03%) and the roasted baobab seed flour [Sample B], (2.58±0.07%). The low mean moisture content of sample B prevents microbial spoilage and pest attack hence makes it have a longer shelf life and good for use in the production of coffee-like beverage. There was significant difference ($p \leq 0.05$) in the mean protein content of Sample A and Sample B, (10.43±0.07% and 13.28±0.10%, respectively). The higher mean protein content of Sample B could be attributed to lose of moisture content during roasting. Increased protein content of Sample B makes it suitable for the control of protein deficiency diseases. Results showed that Sample B had higher mean ash content (8.20±0.10%) than Sample A (6.32±0.07%) The increase in ash content in Sample B could be attributed to the added spices and this implies increase in mineral element content, (as revealed on Table 3), which could help in healthy body functioning. The mean crude fiber content of Sample B (6.17±0.1%) was significantly ($p \leq 0.05$) higher than that of Sample A (4.20±0.1%). In the digestive tract, dietary fiber exerts a buffering effect that links excess of acid in the stomach, increases the fecal bulk, stimulates the intestinal evacuation, provides a favorable environment for the growth of the beneficial intestinal flora and can also bind diverse substances including cholesterol. It could also help to protect against excessive weight gain, obesity and their associated diseases as it controls blood glucose levels in normal and diabetic individuals. Results also showed that significant difference ($p<0.05$) existed between the carbohydrate content of Sample A (55.13%) and Sample B (61.642%). This was calculated by difference. The mean fat content of Sample B

Table 1: Sensory scores of roasted baobab seed coffee-like beverages

	Samples						
Parameter	A	B	C	D	E	F	LSD
Color	8.80^{a}	7.60^{b}	6.13^{c}	6.07^{c}	6.00^{c}	4.93^{d}	0.929
Flavor	7.20^{a}	6.87^{ab}	6.60^{ab}	5.40^{d}	5.47^{d}	5.47^{d}	1.441
Taste	6.00^{b}	6.27^{b}	6.87^{a}	6.20^{b}	6.20^{b}	5.87^{b}	1.375
Gen. Accept.	7.27^{a}	7.53^{a}	6.27^{abc}	5.67^{cd}	5.67^{cd}	5.53^{d}	1.336

Superscript in the same row denotes significant difference at 5% level; Key: A = Coffee-like beverage produced from baobab seed roasted at 150°C without spice; B = Coffee-like beverage produced from baobab seed roasted at 150°C with spice; C = Coffee-like beverage produced from baobab seed roasted at 120°C with spice; D = Coffee-like beverage produced from baobab seed roasted at 120°C without spice; E = Coffee-like beverage produced from baobab seed roasted at 100°C with spice; F = Coffee-like beverage produced from baobab seed roasted at 100°C without spice; LSD = Least Significant Difference

Table 2: Microbiological properties of the coffee-like beverages produced from baobab seed

Parameter	Samples						
(cfu/g)	A	B	C	D	E	F	G
Mould	TNTC	1.9×10^{3}	2.0×10^{2}	7.0×10^{2}	7.0×10^{2}	11.0×10^{2}	5.0×10^{1}
Bacteria	TNTC	3.5×10^{2}	1.2×10^{2}	2.0×10^{2}	1.1×10^{2}	1.5×10^{5}	1.0×10^{2}

Key: A = Fresh baobab seed flour (Control); B = Coffee-like beverage produced from baobab seed roasted at 150°C with spices; C = Coffee-like beverage produced from baobab seed roasted at 150°C without spices; D = Coffee-like beverage produced from baobab seed roasted at 120°C without spices; E = Coffee-like beverage produced from baobab seed roasted at 120°C with spices; F = Coffee-like beverage produced from baobab seed roasted at 100°C without spices; G = Coffee-like beverage produced from baobab seed roasted at 100°C with spices; TNTC = Too Numerous to be Counted

Table 3: Proximate composition of roasted baobab seed coffee-like beverage and fresh baobab seed flour and fresh baobab seed flour

Parameter (%)	Sample A	Sample B
Moisture	5.29±0.03[a]	2.58±0.07[b]
Protein	10.43±0.07[b]	13.28±0.10[a]
Fat	18.63±0.61[a]	8.16±0.16[b]
Crude fiber	4.20±0.10[b]	6.17±0.10[a]
Ash	6.32±0.0 7[b]	8.20±0.10[a]
Carbohydrate	55.13	61.642
Energy (kj/100 g)	1803.88	1575.58
Caffeine	1.41±1.75[a]	0.25±0.0[b]

Values are mean±standard deviation of triplicate determination; Different superscript in the same row denotes significant difference ($p<0.05$); Key: A = Fresh baobab seed flour; B = Roasted baobab seed coffee-like beverage

Table 4: Mineral composition of roasted baobab seed coffee-like beverage and fresh baobab seed flour

Parameter (mg/100 g)	Sample A	Sample B
Calcium	180±0.02[a]	192±0.02[b]
Magnesium	277±0.441[b]	281±0.03[a]
Phosphorus	15.32±0.07[b]	17.52±0.06[a]
Potassium	416±63.24[b]	425±7.01[a]
Iron	0.67±0.03[a]	0.50±0.01[b]

Values are means±standard deviation of triplicate determination; Key: Sample A: = Fresh baobab seed flour; Sample B: = Roasted baobab seed coffee-like beverage

Table 5: Vitamin composition of roasted baobab fruit seed coffee-like Beverage and fresh baobab fruit seed powder

Parameter (mg/100 g)	Sample A	Sample B
Vitamin A	38.10±0.28[a]	39.42±0.02[b]
Vitamin D	3.24±0.05[b]	4.45±0.05[a]
Vitamin E	36.01±0.01[b]	37.29±0.53[a]
Vitamin K	1.30±0.10[b]	1.53±0.15[a]
Vitamin B_1	3.25±0.05[a]	7.45±0.05[b]
Vitamin B_2	8.63±0.25[b]	11.23±0.21[a]
Vitamin B_6	12.60±0.30[b]	14.23±0.15[a]
Vitamin B_9	6.70±0.26[b]	8.47±0.31[a]
Vitamin B_{12}	7.37±0.15[a]	10.50±0.02[a]
Vitamin C	3.40±0.07[b]	4.67±0.05[a]

Values are mean±standard deviation of triplicate determination; Different superscript in the same row denote significant difference $p<0.05$; Key: A = Fresh baobab seed flour; B = Roasted baobab seed coffee-like beverage

Table 6: Anti-nutritional factors of roasted baobab seed coffee-like beverage and fresh baobab seed flour

Parameter %	Sample A	Sample B
Oxalate	2.033±0.15[a]	1.20±0.20[b]
Phytate	0.80±0.10[a]	0.50±0.10[b]
Tannin	2.73±0.20[a]	2.27±0.31[b]
Saponin	7.23±0.15[a]	3.26±0.53[b]

Values are means±standard deviation of triplicate determination; Different superscript in the same row denotes significant difference at ($p<0.05$) Key: A = Fresh baobab seed flour; B = Roasted baobab seed coffee-like beverage

(8.16±0.16%) was significantly ($p\leq0.05$) lower than that of Sample A (18.63±0.61%). The low fat content could be attributed to high temperature treatment that could have caused decomposition of the nutrient. The low fat content of sample B could have contributed to the lower energy content of Sample B (1575.58 kj/100 g) as against 1803.88 kj/100 g) of Sample A. The mean caffeine content of sample B (0.25±0.0%) was significantly ($p<0.05$) lower than that of sample A (1.41±1.75%) as could be seen on Table 3. Caffeine content reduced with increase in roasting temperature as also reported by Olapade *et al*. (2012).

The mean values for the mineral content in Table 3 showed that Sample B significantly ($p\leq0.05$) had higher calcium, magnesium, phosphorus and potassium values than Samples A. This could be due to the enrichment of Sample B with spices. High mineral content makes for ideal dietary source of electrolytes. Several clinical studies have shown potassium, magnesium and calcium to be effective pressure lowering agent (Adubiaro *et al*., 2011). Baobab seed is poor source of iron, zinc and copper (Osman, 2004). The mean values of the fat and water soluble vitamins of sample B were significantly ($p<0.05$) higher than those of sample A as could be seen on Table 4.

Results on Table 5 revealed that sample [B] had significantly ($p\leq0.05$) lower mean values for oxalate (1.20±0.20%), phytate (0.50± 0.10%), tannin (2.27± 0.31%) and saponin (3.26±0.53%) than Sample A whose mean values for oxalate, phytate, tannin and saponin were 2.033±0.15%, 0.80±0.10%, 2.73± 0.20% and 7.23±0.15%, respectively. The mean phytate content of sample B (0.50±0.10%) was well below the level acceptable in foods which is 5 g/100 g, while that of tannin (2.27±0.31%) corresponds with the level acceptable in foods which is 2 g/100 g (Munro and Bassir, 1969). Tannins have the capability of decreasing the digestibility and palatability of proteins because they form insoluble complexes with them (Osagie, 1998). The saponin mean value for Sample B (3.26±0.53) agreed with that of Adubiaro *et al*. (2011) (3.27%) (Table 6). Processing eliminates a number of anti-nutritional factors present in the seed (Caluwe and Patrick, 2010). The presence of high concentration of anti-nutritional factors can interfere with nutrient utilization. Oxalates, like phytates limit the availability of calcium in the body (being calcium binders) by forming insoluble calcium oxalate, hence decreasing the utilization of the mineral (calcium) by the bones and tissues (Eka and Osagie, 1998) in Ojinnaka *et al*. (2013). Ekpedeme *et al*. (2000) in Adubiaro *et al*. (2011) reported that high ingestion of an excessive amount of oxalate could cause gastro-intestinal irritation, blockage of the renal tubules by calcium oxalate crystals, muscular weakness or paralysis while phytate could chelate di-and trivalent mineral ions such as Ca^{2-}, Mg^{2-}, Zn^{2-} and Fe^{3-} resulting in reduced bioavailability of trace minerals to consumers. Tannin-protein complexes are insoluble and this decreases the protein digestibility (Carnovale *et al*., 1991). The saponins are diverse groups of compounds containing an aglycone linked to one or more biological effects in animals including erythrocyte haemolysis, depressed growth, reduced feed intake and effect on nutrient absorption and bile acid metabolism (Adubiaro *et al*., 2011).

CONCLUSION

Sensory evaluation scores revealed that baobab seed roasted at a high temperature of 150°C, ground, sieved, mixed with 0.5% spices (ginger and cloves) and oven-dried at 30°C for 30 min, made a generally acceptable baobab coffee-like beverage which could be taken instead of coffee. Roasting of the baobab seed at that temperature increased the ash, crude protein, crude fiber, water and fat soluble vitamins, calcium, magnesium, phosphorus and potassium content and decreased the fat, moisture, anti-nutrient, caffeine content and microbiological load making the coffee-like beverage more nutritious and with longer shelf life.

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