Advance Journal of Food Science and Technology 5(10): 1266-1270, 2013
DOI:10.19026/ajfst.5.3094
ISSN: 2042-4868; e-ISSN: 2042-4876

Submitted: March 04, 2013 Accepted: April 17, 2013 Published: October 05, 2013

Research Article

Nutritional Evaluation of Yoghurt-Like Product from Baobab (*Adansonia digitata*) Fruit Pulp Emulsion and the Micronutrient Content of Baobab Leaves

[1]Eke, Mike Ojotu, [2]Olaitan, Ngozi Innocentia and [3]Sule, Haruna Iya
[1]Department of Food Science and Technology,
[2]Department of Home Science and Management, University of Agriculture,
PMB 2373, Makurdi Benue State, Nigeria
[3]Department of Food Science and Technonology, Federal Polytechnic,
Mubi, Adamawa State, Nigeria

Abstract: Baobab fruit pulp is grossly underutilised and thus this research aims at increasing the utilization of the fruit pulp which contains very high minerals and vitamins. The growing incidences of malnutrition especially in a developing country like Nigeria are quite alarming. Researchers are now being directed to exploring new and non-conventional sources of food such as baobab that is grown in the arid and semiarid regions of the world. All parts of the baobab tree are absolutely useful and can either be use as food, beverages or ingredient, Baobab leaves can provide about 13-15% protein 60-70% carbohydrate, 4-10% fat, 11% fibre, 16% Ash and the energy value varies between 1180-1900 KJ/100 g on dry wet basis. The baobab fruit pulp is an excellent source of minerals and vitamins. It contain about 240 mg/100 g of potassium, 295 mg/100 g of calcium and 190 mg/100 g of Magnesium. Similarly, it contains, about 236 mg/100 g of Vitamin C and 80 mg/100 mL of Vitamin A. Due to the high protein content, low fat content and high value of metabolize able energy baobab fruit pulp or leaves are excellent source of food to be used to curb the ugly high trend of malnutrition in developing country like Nigeria.

Keywords: Baobab fruit pulp and leaves, developing countries (Nigeria), malnutrition, micronutrients, yoghurt like product

INTRODUCTION

There is increasing demand for protein, energy and micronutrients to support the growing world population. Researchers are now being directed to exploring new and non-conventional sources of food that grow in arid and semiarid regions of the world. Baobab (*Adansonia digitata*) which belongs to the family "*Bombacaceae*" is indigenous to arid regions Magdi (2004). It is a massive, majestic tree up to 25 m high and spends only (4) months of the year in leaf and (8) months leafless. This is possible because some photosynthesis takes place in the trunk and branches during the eight months of leafless periods using water stored in the trunk (Gebeuer *et al.*, 2002). Baobab is of multipurpose, for food, beverage and medicine. The European Commission has recently authorized the import of baobab fruit pulp as a novel food and the leaves are consumed by most people in West African region through the year (Buchmann *et al.*, 2012). The leaves can be used either fresh as a cooked vegetable or dried and powdered as a functional ingredient (thickener) of soup and sauces. Baobab leaves are generally important both in terms of their nutrient content and as a means of increasing per-capital availability of food. According to Sidibe *et al*. (1996) as cited by Emmy *et al.* (2010), baobab leaves contain (expressed on dry weight basis), 13-15% protein, 60-70% carbohydrate, 4-10% fat, 11% fibre, 16% ash and the energy value varies between 1180-1900 KJ/100 g of which 80% is metabolizable energy. The amino acid content, same as contained in the 'ideal' protein are as follows: Lysine (5.7%), Arginine (8.0%), Threonine (3.9%), Valine (5.9%), Tryosine + Phenylalanine (9.6%), Tryptpphan (1, 5%), Methionine + Cysteine (4, 8%). Baobab leaves are particularly rich in calcium (307-2640 mg/100 g dw) (Chadare *et al.*, 2009). Recent studies had shown that baobab leaves exhibit a marked anti-oxidant activity both water soluble and fat soluble preventing and combating the formation of free radicals (Total phenols mg/g = 3.70; Total Flavonoids mg/g = 3.60) (BFCS, 2011) The fruit is a voluminous (35 cm long and 17 cm in diameter), ovoid capsule with a hard woody envelope containing the pulp and black seeds. Once ripe, the fruit envelop becomes brittle and the pulp has chalky consistency (Heuze *et al.*, 2011). The

Corresponding Author: Eke, Mike Ojotu, Department of Food Science and Technology, University of Agriculture, PMB 2373, Makurdi, Benue State, Nigeria, Tel.: +23480 35 723 201

baobab fruit pulp is excellent source of potassium (240 mg/100 g), calcium (295 mg/100 g) and magnesium (190 mg/100 g) (Prentice *et al*., 1993). A research carried out at Colorado State University showed that potassium, calcium and magnesium are beneficial to good health and lowering of blood pressure (PRWEB.UK, 2012). As a beverage ingredient, the University of Otago, New Zealand laboratory showed that vitamin C can kill a range of cancer cells (PRWEB.UK, 2012). Baobab fruit pulp exhibits higher antioxidant properties than the leaves (Chadare *et al*., 2009) hence have the higher ability of combating the formation of free radicals (BFCS, 2011). According to Magdi (2004), baobab fruit pulp contains high amount of carbohydrate (76.2%), low protein (8.2%), extremely low fat (0.3%) and metabolizable energy of 320 Kcal/100 g. and crude fiber content of 5.4%. The objectives of this study were to produce yoghurt-like product from the blends of baobab fruit pulp and powdered milk emulsion, to determine the blend ratio that gives the best result, to determine the proximate composition of the products, to determine the physicochemical properties of the products, to determine the microbial load of the products with the aim of improving the quality and to evaluate the micronutrient content of baobab (*Adansonia digitata*) leaves.

MATERIALS AND METHODS

Sample procurement and preparation: The baobab (*Adanisonia digitata*) fruits, sugar (Dangote Nigeria Plc), powder milk (Mikshi) were purchased from Ultra Modern Market Yola, Adamawa State and starter culture was obtained from Nagge Yoghurt Company Jimeta Yola, Adamawa State. The baobab leaves were obtained from Anguwan Hausawa New Karu Local Govt. Area of Nasarawa State. The fruit pods were opened by knocking them against hard materials to open the shell. The fruit pulp was packaged and stored. The leaves obtained were cleaned, washed thoroughly and the water properly drained. The leaves were then dried at 60°C for 90 min. The dried sample was then milled into powder using grinding machine. The ground powdered sample was kept in an air tight plastic container from where it was drawn for analysis.

Preparation of yoghurt-like product using baobab fruit pulps and powdered milk emulsion: Baobab fruit pulp emulsion was prepared by the method described by Robinson (1990) (Fig. 1). Thirty grams of sucrose was added to 1 L of reconstituted powdered milk emulsion and 50 g of sucrose was added to 1 L of baobab fruit pulp solution and they were pasteurized separately at 80-85°C for 15 min. Six samples of 100:0, 90:10, 80:20, 70:30, 60:40 and 0:100 (powdered milk emulsion: baobab fruit pulp emulsion), were then formulated and homogenized. The samples were inoculated with pure culture of *Lactobacillus*

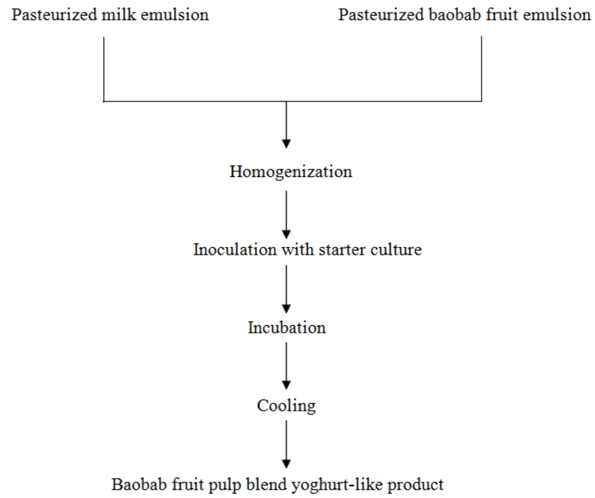

Fig. 1: Flow chart for the production of baobab fruit pulp yoghurt like product (Robinson, 1990)

bulgaricus and *Streptococcus thermophiles* at the rate of 3% by volume and incubated at room temperature (27-30°C) for 15 h.

Proximate analysis of the yoghurt-like samples: The moisture content was determined by method described by AOAC (2005). The protein content was determined by Kjeldahl method as described by AOAC (2005). The crude fat was determined by method described by Onwuka (2005). Ash content was determined by A.O.A.C. (2005) method. Carbohydrate content was obtained by difference according to Ihekoronye and Ngoddy (1985) method.

Determination of the physicochemical properties of the yoghurt-like samples: The pH was determined by the method described by Onwuka (2005). The viscosity was determined by method described by AOAC (2005). The vitamin C content was determined using the titration method as described by Onwuka (2005) while vitamin A content was determined by Spectrophotometric method as described by Ekong (2005). Total solids (dry matter) were determined by subtracting % moisture content from the mass (100) as described by AOAC (2005). Titratable acidity was determined by method described by Kirk and Sawyer (1991).

Microbiological analyses of the yoghurt-like samples: The microbial estimation was by pour plates method described by Harrigan and Margaret (1976). Serial dilution of the yoghurt sample was done up to 10^{-5} dilutions followed by pour plates. After incubation, the colonies in each plate were counted and the colony counted was calculated by multiplying the average number of colonies counted per countable plate by the reciprocal of the dilution factor and reported as "colony forming unit per gram" (cfu/g).

Micronutrient composition of baobab leaves: The mineral analysis was done using the Atomic Absorption Spectrophotometer (Perkin Elner 2280, USA, 1976) as described by AOAC (2005). The vitamin analysis was done by high performance liquid chromatography, (AOAC, 2005). The proximate composition of the leaves was done according to AOAC (2005) methods.

Sensory evaluation of the yoghurt-like products: A fifteen semi-trained member panelist were used to evaluate the products on a 5-point hedonic scale for appearance, flavor, taste, texture and overall acceptability.

Statistical analysis: The data obtained from the sensory analysis were subjected to Analysis of Variance (ANOVA) as described by Ihekoronye and Ngoddy (1985). The means were separated using Turkeys test.

RESULTS AND DISCUSSION

Table 1 showed the proximate composition of the yoghurt-like product. Moisture content of the yoghurt-like samples ranged between 83.73-90.76% depending on the proportion of milk emulsion to baobab fruit pulp solution and most of them fell within the range of most commercial yoghurt (80-85%). The protein content was between the ranges of 1.96-3.27%. The protein content decreased as the proportion of the baobab fruit pulp increased in the product, with the highest of 3.27% in the 100% milk yoghurt to 1.96% in the 100% baobab fruit pulp yoghurt. The fat content ranged between 0.65-3.05% which fell within the standard for low fat yoghurt (<3.5%). The product with 100% baobab fruit pulp had the lowest fat content (0.65%). The carbohydrate content of the samples was low, between 5.25-10.01%, probably due to the fact that the carbohydrate moiety was fermented by the lactic acid bacteria. The ash content ranged from 0.86 to 1.38%. The ash content increased as the proportion of baobab fruit pulp was increased in the product. This could be due to the fact that baobab fruit pulp has high ash content (Conceptual, 2008). The high ash value in the produced samples agreed with the ash content (0.89-1.13%) of non-fat skimmed yoghurt (Mistry and Hassan, 1992).

Table 2 showed the physiochemical properties of the yoghurt-like product.

The pH values were between 3.41-3.82 which is slightly below the recommended range of 3.9-4.5 for yoghurt. The yoghurt with 100% milk has the highest pH of 3.82 and the one with 100% baobab fruit pulp has the lowest pH of 3.41. The low pH of the 100% baobab fruit pulp product may be due to the presence of some organic acids in the fruit pulp such as tartaric, succinic, citric and malic acids. The Titratable acidity ranged from 0.71-1.11% which agreed with 0.6% minimum according to Mistry and Hassan (1992). The vitamin C content was between 104-236 mg/100 mL. The vitamin C content increased with increase in the proportion of the baobab fruit pulp. This could be due to the fact that the raw baobab fruit pulp is particularly rich in vitamin C (Chadare *et al*., 2009). The vitamin A content ranged from 18-80 mg/100 mL, with the highest in the 100% baobab fruit pulp yoghurt. The total solids ranged between 9.24-16.27% as compared to 13.88% as reported by Mistry and Hassan (1992). The lowest total solid of 9.24 was recorded in the 100% baobab fruit pulp product. The samples of the various blends were fluid/free-flowing having a viscosity range of 80-170 centipoises which compared favorably with that reported by Mistry and Hassan (1992). Thus followed the rheological behavior of Newtonian fluids. The highest viscosity of 170 cp was recorded in the product with 100% milk and the lowest viscosity of 80 cp was recorded in the product with 100% baobab fruit pulp.

Table 1: Proximate composition of the yoghurt-like products produced from baobab fruit pulp emulsion and powdered milk

Samples	(%)				
PME:BPS	Moisture	Protein	Fat	Ash	Carbohydrate
100:0	83.73	3.27	3.05	0.86	9.09
90:10	83.42	3.14	2.50	0.93	10.01
80:20	85.00	3.07	2.15	0.95	8.83
70:30	85.20	3.00	1.85	1.10	8.75
60:40	86.33	2.81	1.45	1.23	8.18
0:100	90.76	1.96	0.65	1.38	5.25

PME: Powdered milk emulsion; BPS: Baobab fruit pulp solution

Table 2: Physicochemical properties of the yoghurt-like products produced from baobab fruit pulp emulsion and powdered milk

Samples	Parameters					
PME:BPS	pH	% lactic acids	Vit. C mg/100 mL	Vit. A mg/100 mL	Total solid %	Viscosity (cp)
100:0	3.82	1.11	104.0	18.0	16.27	170.0
90:10	3.81	0.99	126.0	21.0	16.58	150.0
70:30	3.76	0.83	170.0	55.0	14.80	140.0
60:20	3.70	0.77	186.0	55.0	13.67	90.0
0:100	3.41	0.71	236.0	80.0	9.24	80.0

PME: Powdered milk emulsion; BPS: Baobab fruit pulp solution

Table 3: Sensory scores of the various yoghurt-like product from baobab fruit pulp emulsion and powdered milk

Sample code PME:BPS	Parameters Appearance	Flavor	Texture	Taste	Overall-acceptability
100:0	1.67^b	2.30^b	2.40^b	2.00^b	1.53^b
90:10	1.93^b	2.40^b	2.50^b	1.93^b	2.07^b
80:20	2.00^b	2.60^b	2.60^b	1.67^b	2.20^b
70:30	2.00^b	2.70^b	2.80^b	1.87^b	2.33^b
60:40	2.20^b	3.10^b	2.90^b	2.53^b	2.67^b
0:100	3.93^a	3.60^a	3.40^a	4.13^a	4.60^a

PME: Powdered milk emulsions; BPS: Baobab fruit pulp emulsion; Value in the same column with different superscript are significantly different at ($p\leq0.05$)

Sensory properties of the yoghurt-like product: Result as presented in Table 3 showed that there is no significant difference $p\leq0.05$ between the various blends but there is a significant difference at $p\geq0.05$ between the 100% (central) baobab fruit pulp emulsion yoghurt.

Micronutrient content of baobab leaves: The Zinc content of the baobab leaves ranged from 0.90-0.11 mg/100 g, iron content ranged from 1.76-1.80 mg/100 g and copper content ranged from 0, 26-0.30 mg/100 g Calcium content ranged between 4.10-4.30 mg/100 g, magnesium from 1.24-1.32 mg/100 g, manganese from 0.54-0.58 mg/100 g, phosphorus from 1.70-1.90 mg/100 g, respectively. This result agrees slightly with the findings of Sidibe *et al*. (1996). The difference in result may be due to soil topography, species of the baobab tree, maturity stage and climatic conditions.

The vitamin content analysis showed that the B-carotene ranged between 2.12-2.19 mg/100 g and vitamin C (Ascorbic acid) ranged between 21.00-25.00 mg/100 g. The high content of vitamin A precursor i.e., B-carotene indicates that baobab leaves are very good for the young and elderly, for good vision (Sidibe *et al*., 1996). Vitamin A has been implicated to support spermatogenesis in the male and prevent foetal re-absorption in the female.

Proximate composition of baobab leaves: The proximate value of baobab leaves on dry wet basis shows that the protein content ranged between 13.9-14.3%, crude fiber ranged between 5.9-6.3%, carbohydrate content ranged between 64.5-62.9%, ash content ranged between 4.9-5.3% and fat content between 10.8-11.2%. The high protein content of baobab leaves indicates that it is an excellent vegetable to reckon with. This result agrees closely with Sidibe *et al*. (1996).

CONCLUSION

Sensory scores results showed that 100% Baobab fruit pulp yoghurt was generally more acceptable when compared to the powdered milk yoghurt. Similarly, the yoghurt produced from baobab fruit pulp had a higher vitamin A and C values when compared to the powdered milk yoghurt. This implies that Baobab fruit pulp yoghurt if promoted and commercialised will help reduce the incidence of cholesterol in animal milk based yoghurt and also reduces micronutrient deficiency.

REFERENCES

AOAC, 2005. Official Method of Analysis. 15th Edn., Association of official Analytical Chemist, Washingtom D.C.

BFCS (Baobab Fruit Company Senegal), 2011). Baobab leaves Micronised 40 Micron-Instant Mask- for Cosmetic Formulation. Retrieved from: http://www.baobabfruitco.com/ products /cosmeticbaobab/baobabcosmeticpowder/ baobab leavesmicronised.html.

Buchmann, C., S. Prehsler, A. Harth and C.R. Vogl, 2012. The impotance of baobab (*Adanosia digitata* L.) in rural west african subsistence-suggestion of a cautionary approach to international market export of baobab fruit. Ecol. Food Nut., 49(3).

Chadare, F.J., A.R. Linnemann, J.D. Hounhouigen, M.J. Nout and M.A. Van Boekel, 2009. Baobab food product: A review on their composition and nutritive value. Crit. Rev. Food Sci. Nutri., 49(3): 254-74.

Conceptual, L.L.C., 2008. Baobab fruits Baobab Red Fibre Microbiology. Retrieved from: www.baobabfruit.com, (Accessed on: February 19th, 2010).

Ekong, U.O., 2005. Hand Book of basic Food and Beverage Analysis. Etovin Publishers Uyo, Nigeria, pp: 15-99.

Emmy, D.C., K. Halamora and P. Van Damme, 2010. *Adonsonia digitata* L.: A review of traditional uses, photochemistry and pharma cology. Africa Focus, 23(1): 11-51.

Gebeuer, J., K. El-Siddig and G. Ebert, 2002. Baobab (*Adansonia digitata* L.): A review on a multipurpose tree with promising future untlo sudan. Gartenbauwissenschaft, 67(4): 155-160.

Harrigan, W.F. and E.M. Margaret, 1976. Laboratory Method in Food and Dairy Microbiology. 2nd Edn., Academic Press Ltd., London, pp: 25-38.

Heuze`, V., G. Tran, D. Bastianelli and H. Archimede, 2012. African Baobab (*Adansonia digitata*) Feedipedian. Org. A Project by INRA, CIRAD, AFZ and FAO, Retrieved from: http://www. trc,Zootechnie.fr/node/525.

Ihekoronye, A.I. and P.O. Ngoddy, 1985. Integrated Food Science and Technology for the Tropics. Macmillian Press, London, pp: 165-357.

Kirk, R.S. and R. Sawyer, 1991. Pearson's Composition and Analysis of Foods. 9th Edn., Longman Scientific and Technical Publishers, London, pp: 530-608.

Magdi, A.O., 2004. Chemical and nutrient analysis of baobab (*Adansonia digitata*) friut and seed Protein solubility. Plant Foods Human Nutr., 59: 29-33.

Mistry, V.V. and H.N. Hassan, 1992. Manufacture of non fat yoghurt from a high milk protein powder. J. Dairy Sci., 75: 947-957.

Onwuka, G.I., 2005. Food Analysis and Instrumentation: Theory and Practice. Naphthali Prints, Surulere, Lagos, Nigeria, pp: 30-203.

Prentice, A., M.A. Laskey, J. Shaw, G.J. Hudsen, B. Dibba and A.A. Paul, 1993. The calcium and phosphorus intake of rural gambian woman during pregnancy and lactation Br. J. Nutr., 69: 885-896.

PRWEB.UK, 2012. Baobab Fruit. (*Adonsonia digitata* L.) a Unique Super Fruit with High Level of Natural Vit C, Potassium, Calcium and Much More, Retrieved from: http:/www.prweb.com /release/2012/6/prweb 9549269. html London United Kingdom.

Robinson, R.K., 1990. Dairy Microbiology. 2nd Edn., Champman and Hall, London, pp 142-371.

Sidibe, M., J.F. Scheuring, D. Tembely, P. Hofman and M. Frigg, 1996. Baobab: Home grown vitamin C for African. Agro-Forestry Today, 8(2): 13-15.