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Full Length Research paper

Production of a non-alcoholic beverage from sweet potato (*Ipomoea batatas* L.)

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Sweet potato tubers were processed into non-alcoholic beverage flavored with citrus lime and ginger. Two varieties namely *faara* and *sauti* were used. pH, total sugars, total solids, brix, total titrable acidity, vitamins C and A were determined and sensory evaluation was conducted on the products to assess the acceptance preference. Values for pH ranged from 3.81 to 4.34 and that for degree brix was from 12.00 - 13.13°.The result of total titrable acidity (TTA) ranged between 0.45 - 1.6 with lime flavored having higher TTA than the ginger flavored. Total solids varied significantly and ranged from 12.57 - 13.78% with *faara* having higher values than *sauti*. Vitamin C content was low because of heat treatment and hence the beverage was fortified with vitamin C. Vitamin A content was also low and ranged 3.28 to 10.11 µg/100 g (32.8 - 101.08 µgL^{-1}) with *faara* variety having higher vitamin A equivalent. The sensory results showed that significant differences ($p < 0.05$) existed between the different flavored samples and not between varieties. Generally the beverage had good consumer preference with the ginger flavored being the most preferred. The properties of the sweet potato non-alcoholic beverage are within the range of fruit juices; drinks and non-alcoholic beverages set by Ghana standards board thus, can serve the purpose of already existing fruit drinks/beverages.

Key words: Sweet potato, non-alcoholic, beverage, *faara*, *sauti.*

INTRODUCTION

Sweet potato (*Ipomoea batatas* L.) Lam. is the 7th most important food crop in the world (FAO, 1997). Over 95% of the global sweet potato crop is produced in developing countries, where it is the fifth most important food crop (CIP, 2006). According to Scott et al. (2000) more than two billion people in Asia, Africa, and Latin America will depend on these crops for food, feed and income by 2020.

Sweet potato is grown as a smallholder drought tolerant food security crop because of its ability to produce reasonable yields where most food crops would fail. It is a low cost carbohydrate source for urban consumers especially when it is available in a form, convenient for working urban people.

Traditionally, the sweet potato crop may be boiled and consumed like potatoes. It may also be dried and milled into flour or starch extracted from it. Utilization of sweet potato is limited to their traditional uses. Development of low and intermediate technologies that will process sweet potato into value added products at the household and village factory levels would promote its production and consumption and increase its economic value.

Publications on sweet potato studies show that the content of vitamins and minerals in it are comparable with various fruits. According to Woolfe (1992) sweet potatoes are rich in dietary fibre, minerals, vitamins, and antioxidants, such as phenolic acids, anthocyanins, tocopherol and β-carotene. They are an excellent source of vitamin A and a good source of potassium and vitamin C, B6, riboflavin, copper, pantothetic acid and folic acid (Hou et al., 2001) A red-fleshed sweet potato cultivar grown in the Andean region has been reported to have higher antioxidant activity and phenolic content than a cultivar of blueberry, a fruit with high levels of antioxidants (Cevallos-Casals and Cisneros-Zevallos, 2003). The total antioxidant capacity determined by Oxygen radical absorbance capacity (ORAC) values of purple-fleshed sweet potatoes were comparable with those of fruits (apples, apricot, avocado, cherries,

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grapefruit, orange, pears) and vegetables (broccoli, cabbages, eggplants, lettuces) (Wu et al., 2004).

The similarity in fruits and sweet potato provides a basis for a hypothesis that sweet potato can be processed into products which are traditionally made from fruits such as jam, marmalade and drinks or beverages. Yoshimoto (2001); Islam and Jalaluddin (2004) reported that sweet potato cultivars whose roots are used for a beverage, paste, powder, an alcohol drink and a natural colorant have been developed.

Consumption of non-carbonated drinks has become increasingly important. A number of fruit drinks manufactured from fruit juice and other natural ingredients are popular and are sold worldwide. Vegetable juices are also available. The demand for these drinks and beverages is largely based on their nutritive value, flavor, aroma and color (McLellan, 1990). Coggins et al. (2003) prepared juice out of sweet potato culls and reported that sweet potato juice may be consumed as a beverage or combined with other juices to form a variety of juice blends. The use of sweet potato for beverage preparation would be a viable option for processing sweet potato. The objective of this paper is to produce a non-alcoholic beverage from sweet potato.

MATERIALS AND METHODS

Source of raw materials

The sweet potato tubers were obtained from the Afram plains in the Eastern Region of Ghana and the maize was obtained from the Kumasi central market.

Experimental design/ statistical analysis

Completely randomised design was used to study the effect of varietal differences on properties determined on the sweet potato non-alcoholic beverage samples. Data obtained was statistically analysed using the one-way analysis of variance (ANOVA) and least significance difference (LSD) with the microsoft excel programme. Randomised complete block design was used in the sensory study and the results analysed using two-way ANOVA without replication.

Maize malt preparation

Maize grains were sprouted according to Plahar (1976). The maize were first cleaned, washed and steeped for 24 h and sprouted for 3 days on a jute sac. Sprouted grains were then solar dried for 2 days and milled to get maize malt. The maize malt acted as a source of external β- and α-amylase enzymes (in addition to indigenous enzyme of the sweet potato root) to convert the starch of the sweet potato to sugar and extract more soluble solids. Maize malt was added to homogenized sweet potato before heating at 60°C as described under preparation of sweet potato non-alcoholic beverage.

Preparation of sweet potato non-alcoholic beverage

Sweet potato roots were sorted out, weighed and washed, knife peeled and cut into smaller pieces and immersed into 1.5% sodium metabisulfite solution for 30 min. They were rinsed with water and homogenized. Additional water (3 L kg^{-1}) and 5% maize malt (as source of external β- and α-amylase enzymes), were added and heated to a temperature of 60°C and maintained at that temperature for 1 h. The temperature was then raised to 70°C for another 2 h. The mixture was then strained with cheesecloth. The extract was formulated with 12% (w/v) sugar, 0.7% (w/v) citrus, lime or ginger to enhance the flavor, 0.05% sodium benzoate (as preservative) and 232 mg L^{-1} ascorbic acid (as vitamin C fortification). It was then pasteurised at 85 - 90°C for 10 min and bottled hot. The bottled drinks were cooled under running cold water and stored.

Titrable acidity determination

The beverage was thoroughly mixed and filtered using muslin cloth. Five millilitres of filtrate was dissolved in previously boiled distilled water and made to 50 ml mark. 5 ml aliquot of the sample solution was taken and titrated with 0.1 N NaOH using phenolphthalein solution as indicator. Titrable acidity was calculated as percent citric acid.

Total solids determination

Two grams (2 g) of the beverage was weighed into a dried and pre-weighed glass crucible. The crucible with its content was evaporated by putting it on a boiling water bath and dried to a constant weight in an oven at 70°C. The insoluble solids were calculated as a percentage of the sample.

Degree brix and total sugars determination

The concentration of soluble sugars was determined using a hand-held Bellingham and Stanley refractometer (Bellingham and Stanley limited, 61 Markfield Road, London, England) at 20°C.

Vitamin C determination

Ascorbic acid (vitamin C) content of the beverage was determined by the method of AOAC (1990).

Vitamin A determination

Reversed phase high performance liquid chromatography (HPLC) was used for the estimation of provitamin A content in the beverage. 120 µl of homogenized non-alcoholic beverage was extracted with 500 µl of hexane. The mixture was vigorously shaken on an electronic shaker for 4 min, centrifuged for 2 min at 10,000 rpm and the supernatant pooled. The extraction process was repeated. The pooled supernatant was evaporated to dryness under Nitrogen (N_2) gas and redissolved in 120 µl mobile phase (1% tetrahydrofuran in methanol). The resulting aliquot (120 µl) was then injected into the HPLC (C-R6A Chromatopaa, Shimadzu Cooperation, Japan) column with ultraviolet detection (UV-VIS spectrophotometric detector, Shimadzu, Japan) at 450 nm. A standard was prepared and chromatographed. Areas corresponding to the standard retention time were identified and used in the estimation of vitamin A content in the beverage samples.

Table 1. Characteristics of sweet potato non-alcoholic beverage.

Property	Sample			
	A	B	C	D
pH	4.34 (0.03)	3.81 (0.02)	3.84 (0.05)	3.88 (0.01)
Total titrable acidity (% citric acid)	0.71 (0.11)	1.10 (0.11)	0.45 (0.11)	1.60 (0.11)
Degree brix (°)	12.00 (0.00)	12.73 (0.12)	13.13 (0.12)	13.00 (0.00)
Total solids (%)	12.95 (0.06)	12.57 (0.11)	13.78 (0.04)	13.68 (0.10)
Total sugars (mg/100)	10.77 (0.06)	11.80 (0.00)	11.83 (0.029)	12.00 (0.00)
Vitamin C (mg)	1.72×10^{-5}	1.72×10^{-5}	1.97×10^{-5}	2.46×10^{-5}
Vitamin A (ug/100 g)	4.58	3.26	4.48	10.11

Sensory

Twenty four panelists assessed the beverage samples using the acceptance preference test. They compared the 4 samples [*sauti* (ginger flavored) (A); *sauti* (lime flavored) (B); *faara* (ginger flavored) (C); and *faara* (lime flavored) (D)] for selected attributes of taste, colour, flavor and general acceptability. A seven point hedonic scale ranging from 'like very much' to 'dislike very much'. Each panelist was asked to give a general comment on the beverage samples.

RESULTS AND DISCUSSION

Table 1 shows the results of laboratory analysis on the beverage samples. pH of the beverage varied significantly ranging from 3.81 - 4.34 with sample A and B having the highest and lowest values respectively. Significant difference ($P < 0.05$) existed between A and B. Total titrable acidity ranged between 0.45 - 1.6% citric acid with B and D (lime flavored) having higher values than that of A and C (ginger flavored). The difference may be due to the lime, which is acidic. Ghana Standards Board (1995) reported that non-alcoholic beverages should have acidity between 0.5 - 1.9% calculated as anhydrous citric acid (Ghana standards board, 1995). Values obtained are fairly within the acceptable range.

Total solids varied significantly and values ranged from 12.57 - 13.78% with C and D (*faara* varieties) having higher values than that of A and B (*sauti* varieties). Brix or degree brix, by refractometry, ranged from 12.0 - 13.130 with C and D having higher values than A and B just as in the total solids. Ghana Standard Board specifies that non-alcoholic beverage shall have a refractive value of not less than 8° brix (8% w/w). Degree brix of commonly used fruit juices range from 9 - 150. Obtained values are within the range of the Ghana Standards Board Specifications. Total sugars of the beverages ranged between 10.77 - 12.00 mg/ 100 g. The relatively high sugar content is due to the addition of refined sugar to the formulation. Sweet potato provides a considerable amount of vitamin C (about 29.51 mg/ 100 g) and it has been reported to provide more than one-third of the daily requirements of vitamin C (Hou et al., 2001). However, vitamin C content of the beverage was very low (1.72×10^{-5} mg/100 g - 2.46×10^{-5} mg/100 g), which was expected after pasteurization. To make the beverage a good source of vitamin C, it was fortified with 232 mg L^{-1} ascorbic acid. Apart from increasing the nutritional content of the beverage, the ascorbic also acts as an antioxidant to help prevent molecular changes caused by oxidation and acid a promoter of iron absorption (Wardlaw, 1999).

Vitamin A content ranged between 3.28 to 10.11 µg/100 g (32.8 - 101.08 $\mu g L^{-1}$) with *faara* varieties having higher vitamin A equivalent. Collins (1981) reported that juice prepared from high Beta- carotene sweet potato cultivars contained approximately 1 mg beta-carotene 100 g^{-1} and could furnish more than 40% of the adult RDA of vitamin A. The content in commercial drinks ranged from 0.8 mg/100 g in canned mango juices to only 0.012 mg/100 g in aseptically packaged orange juice (Collins, 1981). Vitamin A deficiency is one of the major public health problems in developing countries, Ghana inclusive. Even though the vitamin A content in the beverage samples are very low, selected yellow and orange sweet potato varieties that contain high beta-carotene would serve as very good material for sweet potato non-alcoholic beverage in combating vitamin A deficiency.

The observed natural color of the sweet potato non-alcoholic beverage, light yellow to orange is similar to that of fruit drinks/juices and this may be a promotional advantage to the enhanced artificial color in most commercial drinks. Thus, sweet potato non-alcoholic beverage will be more welcomed by consumers who are now more conscious about the nutritional content of what they consume.

Sensory

Panelists preference for taste, color, flavor and overall acceptability were in the following order; C, A, D and B; C, A, B and D; C, A/D (same degree of preference) and B; and C, D, A and B, respectively (Figure 1). Sample C (*faara* variety, ginger flavored) was the most preferred in all the attributes followed by A (*sauti* variety, ginger flavored). This suggests that consumers preferred ginger

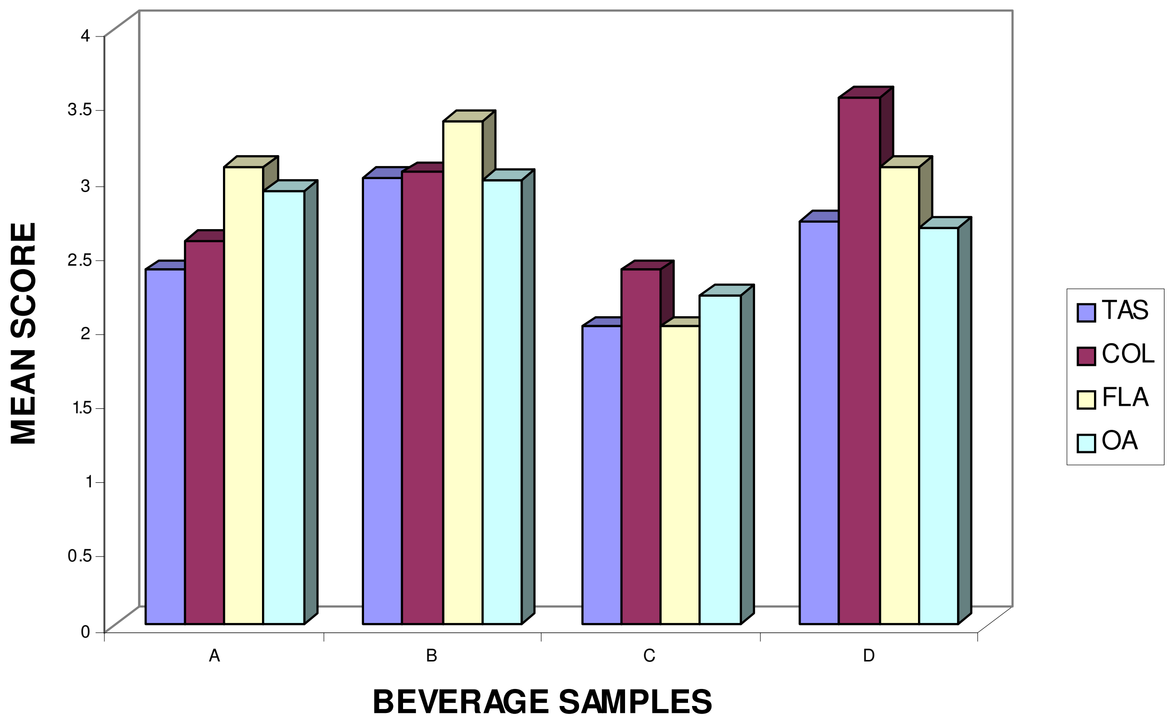

Figure 1. Mean Score for sensory evaluation of beverage samples. A: *sauti* (Ginger flavored), B: *sauti* (lime flavored), C: *faara* (ginger flavored) and D: *faara* (lime flavored).

flavored sweet potato non-alcoholic beverage to lime flavored. The beverage had a high rating sensory score in consumer test, thus can be prepared for commercial purpose to serve as a special beverage with similar constituents as other already existing commercial beverages.

Conclusion

The quality of the sweet potato non-alcoholic beverage is within the acceptable quality range specified by Ghana Standards Board for beverages. Potential consumers rated the beverage high with ginger-flavoured being the most preferred. Thus, production of sweet potato beverage comparable to existing fruit juices/beverages is possible and this will increase sweet potato economic value.

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