Development and Quality Assessment of Cassava-Sweetpotato Non-Alcoholic Beverage

Abstract

Most Non-alcoholic beverages (NABs) are produced from fruits, dairy, cocoa etc., but seldom from roots and tubers. This study aimed at producing NAB from cassava and sweetpotato roots. Four different formulations were prepared; cassava roots : sweetpotato roots - 100:0%, 90:10%, 70:30%, 50:50%. The clean, peeled, grated roots were weighed in percentages, blended and the juice extracted. The juice was allowed to stand, decanted, filtered and heated with maize malt, sugar, ginger and water and finally packaged hot. Consumer preference was done with 49 panelists and pH, total solids, total soluble solids (TSS), titratable acidity (TA) and Vitamin C were determined on all formulations. Titratable acidity ranged from 0.51 to 0.77% with the 50:50 formulation being the highest. Total solids, varied significantly and ranged from 8.96 - 12.00% and the 90:10 formulation had the highest value. Vitamin C content was low with a range from 2.43-3.99mg/100g for 100:0 and 50:50% respectively. TSS of the beverages were within 8.50 and 10.50 with the 100% having the least value. Generally, as sweetpotato percentage increased, the vitamin C content, TA, TSS increased but the pH decreased. The sensory results showed that there were no significant differences ($p < 0.05$) among the three different formulations that contained sweetpotato but rather significant differences in overall acceptability and taste between the control (100% cassava) and the other samples. Generally the beverage had good consumer preference with the most preferred being the 50:50% formulation. The quality parameters of all formulations were within the acceptable quality range specified by Ghana Standards Authority for beverages. The potential to use liquid extract from cassava and sweetpotato during processing for beverages is high. This could expand utilization base of the crops while reducing potential hazards of untreated water from root and tubers.

Keywords: Root and tuber; Maize malt; Affective sensory test; Physicochemical

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Introduction

Non-alcoholic beverages (NABs) over the past years have created a niche for themselves in the dietary pattern of most people. Almost everyone by the end of the day consumes some form of NAB ranging from the drinking water to the more sophisticated ones such as mood enhancers, non-alcoholic wines and locally prepared beverages. NABs are mainly made up of water, [1] which hydrate the body and depending on initial raw materials; they may provide essential minerals, vitamins and dietary fibre to the body [2] These materials include fruits, vegetables, milk, cocoa, herbs and cereals. Basically most of the NABs on the market are produced from the aforementioned raw materials, nonetheless less of roots and tubers have been used.

Roots and tubers have the potential to be useful as a raw material in the NAB industry. Cassava and sweetpotato roots have high moisture content with the former ranging from 60.3% to 87.1% [3,4] and the latter about 70%. During the processing of these roots into starch and or flour, over 90% of these liquids are drained away as effluent. This wastewater when not treated before disposal, pose both health and environmental hazards.

Nevertheless the liquids/water obtained from root and tubers during processing are likely to contain some dissolved nutrients hence good for human consumption. These nutrients could be in the form of calories, iron, calcium, phosphorous, potassium, dietary fiber, zinc and vitamin A, B and C depending on the variety being used. Comparatively sweetpotato roots contain more vitamin A, B and C than cassava roots [5-7] hence sweetpotato would complement the nutrient value of cassava in development of products such as beverages. sweetpotatoes are rich in beta carotene especially the orange fleshed variety with some varieties having high values than some fruits [8]. Cassava also contain beta carotene especially the varieties with yellow parenchyma [9,10].

The NAB market is constantly in demand for new/varied and trendy products such as natural beverages. Thus the use of roots and tubers for NABs could be investigated. Moreover the use of sweetpotato roots has been successfully tried [11,12]. Generally, the sweetpotato beverages had good consumer preference and their characteristics were in the range of fruit juices set by Ghana Standard Authority [12]. Also sweetpotato juice can be combined with other juices to form a variety of juice blends [11]. Therefore the aim of this study is to produce NAB from cassava and sweetpotato roots.

Methodology

Sources of materials

The cassava roots (*Afisiafe* variety) and the sweetpotato (*Apomoden* variety) were obtained from the Council for Scientific and Industrial Research - Crop Research Institute (CSIR-CRI), Fumesua - Ashanti Region, Ghana. The rest of the materials: sugar, ginger, maize (*obaatanpa*) and lemon fruits were obtained from the Ayigya market - Ashanti Region, Ghana.

Preparation of malt

The procedure was a modified version of Iwouno & Ojukwu [13]. The maize, 500 kg was sorted and washed with clean water. The grains were steeped for 48 hr in water (500kg: 700 ml of water). The steeping water was changed after every 24 hr. The steeped grains were spouted for two days on a jute sac and sprinkled with water after every 12 hr and stirred to aerate. It was dried at 50 °C for the first 2 hr, then increased to 55 °C for 2 hr and finally increased to 60 °C for another 2 hr. The malt was milled and added to juice extracted from the cassava and sweetpotato roots before heating of the juice.

Preparation of Cassava-Sweetpotato drink

Cassava and sweetpotato (SP) roots were weighed, washed, knife peeled and washed again. The peeled cassava roots were soaked in water (1 kg: 3.5 L) for 2 hr to reduce cyanogenic compounds while the SP (1 kg) was soaked in 2% lemon solution (40 ml lemon juice: 2 L water) for 5 min to control browning. The roots were grated separately and homogenized together (1 kg composite root per 1 L water). Using a cheese cloth, the roots extract was obtained through squeezing. Additional 1 L of water was added to achieve more extraction. Five percent (5%) maize malt was added to the juice as source of external β- and α-amylase enzymes to convert starch to sugars. Sugar 11% (w/v) and 100 ml of 25% (w/v) ginger were added and heated to a temperature of 67 °C (optimum temperature for amylase) and maintained at that temperature for 20 min using a water bath (Buchi, B-480, Germany). The temperature was then raised to 70°C and maintained for 10 min to pasteurize the beverage. The mixture was strained with a 2-layer cheesecloth, allowed to stand for 15 min and decanted. This step was repeated to reduce settling of the juice particles. The drinks were bottled hot and stored in a refrigerator. One kilogram of raw roots produced 1.8 L Cassava-Sweetpotato drink.

Beverage Composition Analysis

Vitamin C Determination: Ascorbic acid (Vitamin C) content of the beverage was determined by Iodometric titration [14]. Iodine solution of 0.125% iodine and 1% potassium iodide was prepared as well as 125 ml of 1.00 mg/ml ascorbic. The iodine solution was standardized with the ascorbic acid solution. Thus 2 ml of 6 M Acetic acid and 3 ml of 1% of starch solution were added to the ascorbic acid solution. The iodine solution was titrated against it to a blue endpoint. Using standard formula, the amount of vitamin C in each sample was calculated.

Titratable acidity determination: The beverage was thoroughly mixed and filtered using muslin cloth. Ten millilitres of filtrate was measured into a beaker and titrated against 0.1 N Sodium hydroxide (NaOH) using phenolphthalein solution as indicator. Titrable acidity was calculated as percent citric acid.

$$\textbf{Percentage acid} = \frac{(\textit{Titre} \times \textit{acid factor})}{(10\ \textit{ml juice})} \times 100$$

Total Solids Determination: The beverage (40 ml) 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 was calculated as a percentage of the sample [12] thus

$$\frac{\textit{Final weight of sample}}{\textit{Initial weight of sample}} \times 100$$

Total Soluble Solids Determination: The total soluble solids content was determined using a refractometer (Reichert digital refractometer, 13950000, USA). The refractometer was first calibrated using distilled water. About four drops of the beverage were placed onto the cleaned, dry prism surface and the button "READ" was pressed to show the recorded value.

pH Determination: The pH meter, (Mettler Toledo, 51302910, USA) was used to determine the pH of all the formulations. The probe was put into a beaker containing the beverage and "READ" was pressed on the meter to show the reading.

Sensory evaluation: Sensory Evaluation was conducted using 49 panelists. Each panelist was given 25 ml each of the four beverages. The panelists assessed their preference for colour, taste, flavour, viscosity and overall acceptability of each beverage using a 7-point hedonic scale ranging from "dislike very much" to "like very much. Water was provided to rinse the mouth after each sample assessment.

Statistical Analysis

All analysis were performed in duplicate and the means and standard deviations of the results determined. Using IBM SPSS version 20 software, One-way ANOVA was used to determine statistical significance of all results obtained at 95% confidence level with the Duncan test. Also TA was correlated with the other physicochemical parameters to determine their relationships.

Results and Discussion

Physicochemical Properties

The titratable acidity of the Cassava-Sweetpotato beverages from Table 1 ranged from 0.51 - 0.77% in the order of sample 50:50>70:30>90:10>100:0% which signifies that sample 50:50% has the highest amount of acids compared to the other formulations. These values are significantly different ($p < 0.05$). Increased sweetpotato percentage increased the acidity. The observed higher acidity in 50:50% could be as a result of the increased acidity in sweetpotato roots. This occurred as a result of the soaking of peeled sweetpotato in lemon solution during the processing as well as inherent acids in the sweetpotato that adds to the cassava and other ingredients. These values are higher than the results obtained from NABs prepared by Sohail et al. [15] which had a range of 0.183 -0.196% even though lemon juice was added to two of the samples in that study. The difference to this study results may be due to varietal differences, differences in geographical location or soil types used to grow the raw materials used. However the TA of the 50:50% (containing highest percentage of sweetpotato) was closer with the sweetpotato (sauti variety) ginger flavored beverage from Wireko-Manu et al. [12]. The specified acidity range for non-alcoholic beverages is between 0.5 - 1.9% calculated as anhydrous citric acid [16]. Values obtained fall within the acceptable titrable acidity range for NABs.

From Table 1 the pH of the formulations ranged from 5.96 to 6.20 in the increasing order of sample 50:50, 70:30, 90:10 and 100:0%. There were significant differences ($p < 0.05$) in all the formulations and a strong negative correlation between the acidity and pH. This means that acidity increased as the pH decreased and this conforms to literature which explains that an increase in titratable acidity reduces the pH value since acids have pH lower than 7. Also as the percentage of sweetpotato increased, the pH reduced and this may probably be as a result of the soaking of the sweetpotato in lemon solution prior to homogenizing. Generally, all the formulations are considered slightly acidic and may prevent the growth of certain microbes. However, to enhance shelf life, acidulants such as citric acid could be added and packaging improved. The results does not agree with that of Wireko-Manu et al. [12] & Sohail et al. [15] who reported lower pH values (3.81-4.34 and 4.08-4.23 respectively) possibly because both studies were done on the production of non-alcoholic beverages from sweetpotato roots only. The higher values obtain in this study may be as a result of the cassava roots added as the 100% cassava product had the highest pH (least acidic).

From Table 1, the Vitamin C content of the beverages ranged from 2.43 - 3.99mg/100g. As the percentage of sweetpotato increased, the vitamin C content also increased. There were significant differences among the values which could be attributed to the difference in sweetpotato content. Table 2 showed a strong positive correlation between titratable acidity and vitamin C. This means that as the titratable acidity increased, the vitamin C also increased. This is probably because the ascorbic acid being acidic in nature adds to the overall acidity of the beverages hence increasing the TTA values. The results obtained are higher than the result obtained from the 100% sweetpotato beverage [12] even though there was no vitamin C fortification in this study. Apart from increasing the nutritional content of the beverage, vitamin C also serve as an antioxidant to help prevent molecular changes and prevents scurvy disease [17]. The obtained beverages have low vitamin C and needs to be fortified to satisfy consumer vitamin C RDA.

The results for total soluble solids of the beverages produced ranged from 8.50-10.50 obrix and were statistically different ($p<0.05$). There was an increasing trend as the percentage of sweetpotato increased. Also there was a strong positive correlation between the acidity and the total soluble solids, thus the acidity increased with the total soluble solids. This is indirectly influenced by the titratable acidity but directly related to the increase in sweetpotato. The sweetpotato roots added more total soluble solids to the beverage, therefore the lesser the sweetpotato roots, the lower the total soluble solids content, and thus the lesser the sweetness of the beverage. The acceptable brix value for non-alcoholic beverages should not be less than 8 oBrix [16] and as shown in Table 1, all formulations are in accordance with it. The brix range in this experiment 8.50-10.50 obrix was lower than results obtained for whole sweetpotato beverage, Wireko-Manu et al. [12] which was 12.00 - 13.13 °Brix. This may be due to the cassava roots which naturally are very low in sweetness compared to the sweetpotato roots diluting the beverage and thus reducing the overall brix of the beverage. Furthermore in the work done by Wireko-menu et al. [12], 12% w/v sugar was used in the beverage preparation while 11%w/v was used in this current study, hence the lesser brix. The amount of sugar was reduced in this project from 12% to 11% based on comments received from a preliminary work which showed that the sweetness was high. The amount of sugar to add may depend on the sweetness desired by consumers and the sweetness of the sweetpotato root.

Table 1: Quality characteristics of cassava-Sweetpotato non-alcoholic beverage.

Sample	pH	°Brix	Vitamin C mg/100g	Total Solids %	TTA %
50/50	5.96±0.0071^{a}	10.50±0.0000^{a}	3.99±0.245^{a}	10.96±0.028^{a}	0.77±0.0000^{a}
70/30	6.10±0.0000^{b}	10.20±0.1410^{b}	3.47±0.000^{b}	11.01±0.007^{b}	0.62±0.0266^{b}
90/10	6.14±0.0071^{c}	9.75±0.0701^{c}	2.95±0.245^{c}	12.00±0.050^{c}	0.58±0.0000^{c}
100/0	6.20±0.0141^{d}	8.50±0.0000^{d}	2.43±0.0000^{d}	12.00±0.050^{d}	0.51±0.0000^{d}
GSA specs	_	Not less than 8	_	_	0.5-1.9%

The superscripts denoted by different letters in the same column are significantly different ($p< 0.05$)

*GSA Spec=Ghana Standard Authority specifications.

Table 2: Correlation of Titratable Acidity with pH, Brix and Vitamin C.

		TA	Vitamin C	pH	Brix
TA	Pearson Correlation	1	.944**	-.993**	.862**

*TTA=Titratable Acidity

Total solids ranged from 8.97-12.00% with control sample having the least and the 90:10 sample having the highest (Table 1). There was no significant difference ($p < 0.05$) between 50:50 and 70:30 formulations but there were significant differences ($p < 0.05$) in the sample 90:10 and 100:0. These results are lower than the results obtained from whole sweetpotato beverages [12], which ranged from 12.57-13.78. The difference may be as a result of double decantation and filtration of the beverage before bottling in the present study. Total solids comprise of dissolved solids plus suspended and settleable solids such as starch, sugars etc in the beverage. The higher its value, the higher the ability of the beverage particles to settle when left to stand for sometime (APHA, 1992). It also affects some properties of the product such as viscosity, clarity and even taste.

Sensory Evaluation

Generally, from Figure 1 all formulations had good preference score with the 50:50 cassava-Sweetpotato formulation being the most preferred, followed by the 70:30 then 90:10 and 100:0 being the least preferred in almost all of the attributes tested. Statistically, there were no significant differences ($p > 0.05$) in terms of all the sensory parameters evaluated among the NABs with sweetpotato (i.e. 90:10, 70:30, 50:50) whereas there were significant differences ($p < 0.05$) between the control and the other formulations in terms of taste and overall acceptability. Comparing Figure 1 with results of 100% sweetpotato beverage [12], colour is one of the most preferred attributes in both studies. The preference of the whole cassava beverage (100:0%) compared to the 100% sweetpotato beverage samples [12] is generally lower and this means that sweetpotato inclusion greatly influenced the sensory parameters of the beverages produced by improving the color. This is because the sweetpotato variety used is orange flesh, a more preferred color in drinks. The sample 50:50% was mostly preferred for its colour, viscosity and overall acceptability. It had the most preferred colour which was the brightest orange colour by observation.

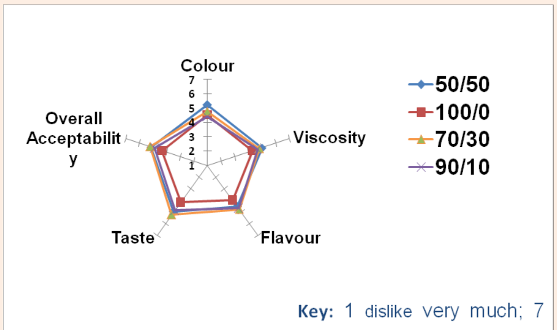

Figure 1: Preference sensory evaluation of four different cassava-sweetpotato drink formulations.

Conclusion

Cassava and sweetpotato non-alcoholic beverage (NAB) has been produced with good consumer preference. The quality of the cassava-Sweetpotato NAB is within the acceptable quality range for NABs specified by Ghana Standards Authority. This could expand utilization base of the crops while reducing potential hazards of untreated water from root and tubers during processing. The products acceptance and commercialization would add variety to already NABs.

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References

1. Osuntogun B, Aboaba OO (2004) Microbiological and physio-chemical evaluation of some Non-alcoholic beverages. Journal of Nutrition 3(3): 188-192.
2. European Food Safety Authority (2009) The setting of nutrient profiles for foods bearing nutrition and health claims pursuant to Article 4 of the Regulation (EC) No 1924/2006: Scientific Opinion of the Panel on Dietetic Products, Nutrition and Allergies.
3. Padonou W, Mestres C, Nago MC (2005) The quality of boiled cassava roots: instrumental characterization and relationship with physicochemical properties and sensorial properties. Food chemistry 89(2): 261-270.
4. Zvinavashe E, Elbersen HW, Slingerland M, Kolijn S, Sanders JPM (2011) Cassava for food and energy: exploring potential benefits of processing of cassava into cassava flour and bioenergy at farmstead and community levels in rural Mozambique. Biofuels, Bioproducts and Biorefining 5(2): 151-164.
5. Antia BS (2006) Effect of texture modifiers on the physicochemical and sensory properties of dried fufuo. Food Science and Technology International 11: 373-382.
6. Woolfe J (1993) sweetpotato: An untapped food resource. Cambridge: Cambridge University Press, USA, p. 643.
7. Montagnac JA, Davis CR, Tanumihardjo SA (2009) Nutritional Value of Cassava for Use as a Staple Food and Recent Advances for Improvement. Comprehensive Reviews in Food Science and Food Safety 8(3): 181-194.
8. Hagenimana V, Carey E, Low J, Gichuki S, Owori C, et al. (1993) SweetPotato Post Harvest in East Africa. CIP Sub-Project Annual Progress Report, CIP Library, Peru. p. 24-50.
9. Rodriguez-Amaya DB, Nutti MR, Viana de Carvalho JL (2011) Carotenoids of SweetPotato, Cassava, and Maize and their Use in Bread and Flour Fortification. Research for Development pp. 301-311.
10. Brimer L (2015) Cassava Production and Processing and Impact on Biological Compounds. Victor Preedy, Amsterdam: Academic Press, Netherlands, p. 81-87.
11. Coggins PC, Kelly RA, Wilbourn JA (2003) Juice yield of sweetpotato culls. Session 104C, Fruit and Vegetable Products: Vegetables (Processed). 2003 IFT Annual Meeting - Chicago, USA.

12. Wireko-Manu FD, Ellis WO, Oduro I (2010) Production of a non-alcoholic beverage from sweetpotato (Ipomoea batatas L.). African Journal of Food Science 4(4): 180-183.
13. Iwouno JO, Ojukwu M (2005) Effects of experimental variables on the malting quality of Nigerian yellow maize (zea Mays), farz 27 variety. African Journal of Food Science and Technology 3(10): 252-259.
14. University of Cantebury (2015) Determination of Vitamin C concentration by Titration (Lab manual). New Zealand.
15. Sohail M, Khan RU, Afridi SR, Imad M, Mehrin S (2013) Preparation and quality evaluation of sweetpotato ready to drink beverage. Asian Research Publishing Network (ARPN) 8(4): 279-282.
16. Ghana Standards Board (2003) Non-alcoholic beverages - General specifications for fruit juices preserved exclusively by physical means.
17. Iqbal K, Khan A, Khattak MMAK (2004) Biological significance of ascorbic acid (vitamin C) in human health. Pakistan Journal of Nutrition 3(1): 5-13.

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