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Research Article

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Development of Non-Alcoholic Beverage from Sweet Potato (*Ipeoma Batata*) and the Effect of Crude Spice Extracts on Quality and Consumer Acceptability

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Abstract This study determines the effect of crude spice extracts on the quality and consumer acceptability of non-alcoholic beverage produced from sweet potato. Sweet potato tubers were processed into non-alcoholic beverages with different formulations. Sample GGS was treated with 1% ginger extract, sample GRS was treated with 1% garlic extract, sample APS was treated with 1% alligator pepper extract, sample AGS was treated with 0.5% each of ginger and garlic extracts, and sample GAS was treated with 0.5% each of garlic and alligator pepper extracts while sample CCS which serves as control was not treated with any spice extract. Chemical and macromineral composition, Microbiological quality and consumer acceptability were evaluated. Results of chemical analysis indicated pH ranging from 4.40-5.80 and titratate acidity ranged from 0.82-1.42% citric acid. Significant difference ($P>0.05$) existed in the total solid while no significant difference ($P<0.05$) existed in the specific gravity of the beverage. The beverage samples were relatively low in vitamin C while vitamin A was high with values ranging from 12.04-12.42 µg/100g with sample GRS having the highest value. Result of macro mineral analysis indicated that addition of crude spice extracts significantly increase calcium, magnesium, sodium, potassium and iron contents of the beverage. Microbiological analysis of the beverage showed absent of conform bacteria while the total viable courts were within acceptable limit as specified by regulatory agencies. Sensory evaluation indicated significant difference ($P<0.05$) between the samples formulated with spices and the control. Beverage samples formulated with ginger (GGS) and alligator pepper (APS) were preferred.

Keywords Sweet potato, chemical properties, macrominerals, beverage, crude spice

Introduction

A beverage is any liquid other then water which can be consumed in order to quench thirst. Some may however be consumed as a substitute in filling human nutritional deficit as well as a source of stimulant[1]. Various beverages are consumed world wide ranging from exotic beverage to the indigenous or locally produced beverage which may be alcoholic or non-alcoholic. Advances in scientific research in recent years have resulted to changes in global beverage market. For instance researches have shown the possible presence of carcinogenic substance such as Benzene in some carbonated beverages due to the reaction of Sodium benzoate (chemical preservatives) with ascorbic acid and the possible allergenic effects of sulphites and benzoates [2]. These have resulted to a shift where more consumers favour minimally processed products from natural ingredients thereby reducing the effects of chemical preservatives with its attendance negative health consequences. Also the simplicity in the production process, availability of raw materials locally and new economy revamping polices of self sufficiency have resulted in increased production and consumption of many traditional foods and beverages and cottage level in Nigeria.

Sweet potato (*Ipomoea batata* L.) is an important food crop in the tropical and subtropical countries and belong to the family convolulaceae [3]. Sweet potatoes are highly nutritious vegetables and are especially rich in calories and biologically active phytochemicals such as β-carotene, polyphenols, ascorbic acid and dietary fibre. [3]. Sweet potato is also an excellent source of vitamin A and C, and a food source of potassium, riboflavin, pantothetic folic acids [4]. Sweet potato represent the sixth most important food crop in the world. Worldwide, production of sweet potato is 1076 million tones in 2010 with china accounting for 90% of the global production. Ugarda and Nigeria are the largest producers in Africa [5]. More than two billion people in Asia, African and Latin America will depends on sweet potato for food, feed and income by 2020 [6].

The antioxidant proprieties of crude spice extracts of some parts such as those from Ginger (*Zingiber officinale*), Garlic (*Allium sativum*) and Alligator pepper (*Aframomum melegnata*) have been known about six decades ago when it was demonstrated that spices effectively increased the antioxidant capacity of foods and that their effects depends on foods matrics. Studies on culinary herbs identified the superiority of spices in both antioxidant and antimicrobial activities and medicinal spices are believed to have medicinal value especially in African settings as well as determinative influences on the overall organsolptic properties of foods when used. [7].

With the consumption of alcoholic beverage being on the decrease in some areas due to the increasing religious and health campaigns against such beverages, the demand for non alcoholic and non-carbonated beverages have been on increase. Also the non-alcoholic beverage market is constantly in demand for new and trendy products such as natural beverage and those without chemical preservatives the possibility of processing non-alcoholic beverage from sweet potatoes with nutritive value, taste and aroma similar to those from fruits and vegetables have been demonstrated to be technically feasible. It is therefore important to further exploit locally available spices in the formulation of non-alcoholic beverage for the benefit of the farmers, consumers and nation at large. The objective of this study is to develop a non-alcoholic beverage from sweet potato and assess the effects of crude spice extract from ginger, garlic and alligator pepper on the quality and consumers acceptability of the beverage. It is hoped that the result of this findings will cause a distinct shift towards sweet-potato-based beverage for obvious advantages of higher nutritional value and better organoleptric properties over cereal-based beverages and enhances it higher utilization.

Materials and Methods

Source of raw materials

Yellow-fleshed sweet potato tubers, garlic cloves, ginger rhizomes and dry fruit of alligator pepper were purchased from Akpan-Ndem market in Uyo metropolis. Akwa Ibom State. The material were sorted and only those in good conditions were used for the experiment. Industrial enzymes such as fungamyl and amylex BT2 were obtained from champion Breweries Plc Uyo.

Preparation of Ginger, Garlic and Alligator Pepper Extracts

Ginger rhizomes. Garlic cloves were sorted cleaned and peeled while fully dried fruit alligator pepper was aspirated to remove the seeds. They were all dried in an oven at 45 °C for 48 hrs. They were grinded sieved, weighed separately and prepared an extracts with distilled water at 0.5 and 1.0% concentrations [7-8].

Preparation of Sweet Potato non-Alcoholic Beverage

Sweet potato tubers were sorted peeled, wished trimmed and immersed in 1.5% sodium metabisulphite solution for 30 minutes. They were then rinsed with distilled water and milled to fine puree with the aid of a grinder. 500 ml of distilled water at 50 °C was added to 200g of puree and was then placed on a temperature regulated water bath. 5% Amylex BT2 (as α-amylase) was then added at 75 °C and held for 30minutes for liquefaction of starch and staired continuously with glass rod. Fungamyl (as β-amylase) was added at 60 °C for 1 hour to facilitate saccharification before filtration [9]. The beverage was then formulated as follows.

CCS= Sweet potato beverage only as a control
CGS= 1% ginger extract
GRS= 1% garlic extract

APS= 1% alligator pepper extract
AGS= 0.5% ginger + 0.5% garlic extract
GAS= 0.5% garlic + 0.5 alligator pepper extract

Chemical Analysis

The prepared beverage samples were analysis for the pH, Total titratable acidity total sold (%), specific gravity, vitamin A (µg/100g), and vitamin C (mg) using standard methods [10]. The determination of degree brix 0 and concentration of soluble sugars were determined using Digital handheld Bellingham and Stanley refractometer at 20 °C.

Analysis of Macromineral

Standard method of analysis [9] was used to determine the macroelements contained in the beverage. The macromineral elements determined were calcium, magnesium, sodium, potassium, iron, and Zinc using Atomic Absorption spectrophotometer. Determinations were carried out by direct aspiration of sample solution into air acetylene flame. The concentration of mineral elements in the samples was then determined from the calibration curves.

Microbiological Analysis

The total viable court (TVC) was determined by weighting 2.8g of Nutrient agar into 100ml of distilled water and sterilized in an autoclave at 121 °C for 15 mins at 15psi [11], the total fungal court (TFC) was determined using 6.3g of potato dextrose agar into 100ml of distilled water while 5.3g of molten Mac-konkey agar in 100ml distilled water sterilized at 121 ° C for 15 mins, 15psi was used for determination of total coliform counts (TCC) in the beverages. The petri dishes were incubated at 37 °C for 24-48 hrs for the TVC and TCC while 5-7days for mould and yeast colonies to developed. Counting was carried out using colony counter and result expressed in colony forming unit per milliliter (cfu/ml).

Sensory Evaluation

Sensory evaluation was carried out with 20 semi-trained panelists using the acceptance preference test. They assessed the organoleptic attributes of the beverage samples under 9 point nedonic scale ranging from 9 (like extremely) to 1 (dislike extremely). The six beverage samples were assessed for colour, taste, favour, consistency, aroma, and overall acceptability.

Statistical Analysis

The data obtained from the chemical analysis, macromineral composition and sensory analysis were analysed using SPSS version 16.0. The analysis of variance (Anova) was performed to determine significant differences between mean ($P<0.05$) while the mean were separated using the Duncan multiple Range test. All the determinations were carried out in triplicate.

Results and Discussion

Chemical Composition

Table 1 shows the chemical composition of non-alcoholic beverage produced from sweet potato. The pH of the beverage sample ranged from 4.40-5.84 with the sample CCS (Control sample) having the highest pH while sample GAS with low pH and highest acidity. Significant difference ($P<0.0.5$) exists between samples but non existed between sample GGS and AGS. The total titratable acidity of the sample ranged from 0.82 -1.41% citric acid with the control (CCS) with the highest value of 1.42 citric and sample GGS with 1% crude ginger extract and sample GRS with 1% garlic extracts recorded lowest values of 0.84 and 0.82% of citric acid respectively. Ginger and garlic extract weekly acidic with volatile oils and chemical compounds responsible for its flavours (12). The effect of this crud spices on the acidity level of the beverage could be attributed to their antioxidant effect. The acidity level of non-alcoholic should range between 0.05-1.90 % calculated as anhydrous acid. (13). This pH is therefore necessary to preserve the beverage and prevent the growth of some undesirable micro-organisms.

The total soluble solid content of the beverage ranged from7.07-9.29% with sample AGS having the highest value of 9.29% and sample APS with alligator pepper extract having the lowest. There was no significant difference (P>0.05) in the specific gravity level of the beverage while significant difference existed in the degree brix sample CCS which is the control and other samples. The total sugar content of the beverage ranged from 13.04 to 13.24 (mg/100g) there was no significant differences in the total sugar were similar is reported by several studies [7,14] and fall within the limit stipulated by regulatory agency [13].

The non-alcoholic beverage produced from sweet potato was low in vitamin C with values ranging from 1.56 x 10^{-5}mg. the low value was expected considering various treatments given to the raw materials. The result as obtained is similar to what is reported by other authors [14,7]. To make the beverage of good source of vitamin C fortification with ascorbic acid is recommended. The vitamin A content ranged between 12.04-12.31µg/100g. There was significant difference (P<0.05) between samples GGS, GAS formulated with ginger and garlic and with other sample. The yellow-fleshed sweet potato is rich on vitamin A though not as that of orange-fleshed potato variety. The results reported is similar to that reported by other authors [14,7] hence the beverage can make a major contribution in alleviating vitamin A malnutrition.

Table 1: Chemical Composition of sweet potato non alcoholic beverage

Parameters	CCS	GGS	GRS	APS	AGS	GAS
pH	5.84^{a}	4.90^{a}	4.40^{d}	4.52^{d}	4.94^{c}	5.00^{b}
TTA (% Citric acid)	1.42^{a}	0.84^{c}	0.82^{c}	1.32^{b}	0.85^{c}	1.30^{b}
Total Solid (%)	8.74^{b}	8.60^{c}	8.82^{b}	7.07^{d}	9.29^{a}	8.81^{b}
Specific gravity	1.02^{a}	1.03^{a}	1.03^{a}	1.02^{a}	1.03^{a}	1.01^{a}
Degree Brix (^{0})	13.54^{a}	13.24^{b}	13.26^{b}	13.28^{b}	13.20^{b}	13.24^{b}
Total sugars (mg/100g)	13.24^{a}	13.15^{a}	13.14^{a}	13.09^{a}	13.08^{a}	13.04^{b}
Vit C (mg)	$1.68x10^{5c}$	$1.84x10^{5a}$	$1.86x0^{5a}$	$1.68x10^{5c}$	$1.74x10^{5b}$	$1.76x10^{5c}$
Vit A µg/100g	12.04^{b}	12.42^{a}	12.42^{a}	12.06^{b}	12.08^{b}	12.06^{b}

Values in the same row with different superscript are significantly different at (P<0.05) CCS= Control sample, CGS= with 1% ginger extract, GRS= with 1% garlic extract APS=with 1% alligator pepper extract, AGS= with 0.5% ginger + 0.5% garlic extract, GAS= with 0.5% garlic + 0.5 alligator pepper extract

Macromineral Composition

The macromineral composition of sweet potato non-alcoholic beverage is presented in Table 2. The additions of crude spice extracts to the non-alcoholic beverage significantly increased the mineral content of the beverage. Several reports have indicated the richness of spices in sodium calcium, potassium, magnesium, iron, zinc and others [16-17]. There were significantly differences (P<0.05) in macromineral content of beverage where crude spices were added and the control sample. The mineral elements contained in these spices are very important in human nutrition. Sodium, potassium, calcium and magnesium play a central role in the normal regulation of blood pressure and the control of arterial resistant [18]. The formulated beverage could help in the regulation of fluid balance of the body and hence influence the cardiac output. It is increasingly being realized that a lower the than normal dietary intake of magnesium and potassium can be a strong risk factor for hypertension, cardiac arrhythmias and other complications [18].

The beverage sample formulated with crude garlic extracts (GRS, AGS) recorded higher Iron content (7.36 mg/100g, 6.80 mg/100g) while the control had the least (3.12 Mg/100g) Iron is essential macronutrient for human growth. Its deficiency symptoms are anemia dizziness, amenorrhea and fatigue [19]. Iron content of 7.36 mg/100g in sample GRS is sufficient to meet the daily required intake for human which varies from 7-18 mg/day.

Table 2: Macromineral Composition (mg/100g) of Sweet Non-Alcoholic Beverage

Parameters	CCS	GGS	GRS	APS	AGS	GAS
Calcium	20.32^{d}	22.42^{c}	23.32^{a}	22.26^{c}	23.20^{a}	22.82^{b}
Magnesium	16.42^{d}	17.82^{b}	18.24^{b}	17.24^{b}	18.94^{a}	18.82^{a}
Sodium	14.42^{c}	15.24^{a}	14.89^{b}	14.43^{c}	15.20^{a}	15.40^{a}

Potassium	5.24	14.40^{a}	12.28^{b}	18.26^{d}	14.10^{a}	10.02^{c}
Iron	3.12^{d}	6.24^{b}	7.36^{a}	6.02^{c}	6.30^{b}	6.80^{b}
zinc	0.06^{c}	0.16^{b}	0.32^{a}	0.10^{c}	0.22^{b}	0.20^{b}

Values in the same row with different superscript are significantly different at (P<0.05)
CCS= Control sample, CGS= with 1% ginger extract, GRS= with 1% garlic extract APS= with 1% alligator pepper extract, AGS= with 0.5% ginger + 0.5% garlic extract, GAS= with 0.5% garlic + 0.5 alligator pepper extract

Microbiological Analysis

The result of microbiological analysis of non-alcoholic beverage shows absence of coliforms as indicted in Table 3. The total viable counts ranged from 2. $X10^2$ – 4 x 10^2 cfu/ml with the control sample (CCS) having the highest values. The values are within the range of regulatory agency (15). Fungal Counts of 3.2x10 cfu/ml was only noticed in the control sample. Absence of coliforms in the beverage sample implies that the beverage was produced under hygiene condition and hence safe for human consumption. Also low level of microbial counts in the beverage in general could be attributed to heat treatment such as pasteurization. It is also important to note that the addition of the crude spices extracts to the beverage formulations exert antimicrobial properties which are capable of destroying pathogenic micro-organisms. (20).

Table 3: Microbiological Counts of Sweet Potato Beverage (cfu/ml)

Samples	CCS	GGA	GRS	APS	AGS	GAS
TVC $X10^2$	4.0	2.2	2.4	2.0	2.2	2.0
TFC $X10^2$	3.2	-	-	-	-	-
TCC $X10^2$	-	-	-	-	-	-

CCS= Control sample, CGS= with 1% ginger extract, GRS= with 1% garlic extract APS= with 1% alligator pepper extract, AGS= with 0.5% ginger + 0.5% garlic extract, GAS= with 0.5% garlic + 0.5 alligator pepper extract

Sensory Evaluation

The results of sensory evaluation carried out on the formulated beverage sample is presented in Table 4. The sweet potato beverages were rated very high in terms of colour, taste, flavor consistency and overall acceptability by the panelists. The colour of the control sample as well as those formulated with crude spices extract were rated high through significant differences (P<0.05) existed between samples. The observed colour of the control sample and those with crude spice extract were light yellow which is similar of that of fruit drink/juice and can offer an advantage to the product. The taste and flavor of beverage formulated with crude alligator pepper extracts was most proffered by the panelist while sample with crude ginger and alligator peppers were most preferred in term of overall acceptability. The control sample (CCS) recorded the least ratings in all the sensory attributes evaluated. This indicated the potential of the spice extracts in producing acceptable beverage from sweet potato. The beverage had a high rating which indicate high consumer acceptability and thus it can be prepared for commercial purpose to serve as a special beverage with similar constituents as other commercial beverages in the market.

Table 4: Sensory scores of sweet potato non alcoholic beverage

Samples	Colour	Taste	Flavor	Consistency	Aroma	Overall acceptability
CCS	6.65^{c}	5.45^{d}	6.30^{d}	6.30^{d}	5.40^{c}	6.40^{c}
GGS	6.90^{a}	6.25^{c}	7.18^{a}	6.80^{a}	7.16^{a}	7.30^{a}
GRS	6.80^{a}	5.50^{d}	6.39^{c}	6.86^{a}	4.80^{d}	6.44^{c}
APS	6.70^{b}	7.40^{a}	7.20^{a}	6.46^{c}	7.20^{a}	7.32^{a}
AGS	6.75^{b}	5.60^{d}	6.42^{c}	6.64^{b}	6.80^{b}	6.80^{b}
GAS	6.68	6.80	6.94^{b}	6.74^{a}	7.10^{a}	6.82^{b}

Values in the same column bearing different superscripts are significantly different at (p<0.05)

CCS= Control sample, CGS= with 1% ginger extract, GRS= with 1% garlic extract APS= with 1% alligator pepper extract, AGS= with 0.5% ginger + 0.5% garlic extract, GAS= with 0.5% garlic + 0.5 alligator pepper extract

Conclusion

This Study showed the potential of sweet potato and local spices in the formulation of nutrition and health. promoting non-alcoholic beverage, Non-alcoholic beverage produced and formulated with crude spice extracts of ginger, garlic and alligator pepper were rich in vitamin A, micro nutrient and well acceptable by consumers. The production of sweet potato non-alcoholic beverage in quite visible and will expand sweet potato tubers utilization.

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