Nutrient, Phytochemical Composition and Sensory Evaluation Of Soursop (Annona muricata) Pulp and Drink in South Eastern Nigeria.

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***Abstract*-- Background: Micronutrient deficiency is a public health problem. This study evaluated the nutrient, phytochemical composition and sensory evaluation of soursop (*Annona muricata*) pulp and drink.**

Methods: The soursop fruits were purchased from local market and a farm in the South Eastern Nigeria. The mature fruits were ripened for five days at room temperature. The ripen soursop fruits were peeled, the pulp handpicked, liquefied with 400mls of water to make the soursop drink. The soursop drink was then flavoured with four teaspoons of sugar syrup. The proximate composition, vitamin, mineral and phytochemical contents of the pulp and drink were determined using standard methods. The sensory evaluation of the drink was conducted using 9- point hedonic scale.

Result: The carbohydrate content of soursop pulp and drink was 72.71% and 83.47% respectively. The fibre content was 6.26% and 3.47%; retinol 192.50IU and 63.76IU; ascorbic acid was 22.59mg/100g and 34.71mg/100g for the pulp and drink respectively. The pulp and drink also contained high levels of anthocyanin 6.44 and 7.35 mg/100g; flavonoids 9.32 and 5.24mg/100g and tannin 65.98 and 53.96mg/100g respectively. The soursop with sugar syrup was more acceptable (7.58±2.04) compared to the soursop without sugar syrup (5.08±1.67) at P<0.05.

Conclusion: It was concluded that soursop pulp and drink contained appreciable amount of micronutrients and can be incorporated into the diets for the vulnerable groups to improve their nutritional status.

***Index Term*-- *Annona muricata*, nutrients, phytochemcials, sensory evaluation**

I. INTRODUCTION

Micronutrient malnutrition or "hidden hunger" is a major public health problem. There is need for long-term sustainable intervention programme that would reduce the deficiency. Food-based approach especially dietary diversification could increase consumption of micronutrient- rich locally available foods. This would be valuable in combating hidden hunger [1]. However, lack of knowledge of available foods, their usage, nutritional and health implications pose problems especially with micronutrient deficiencies. A significant proportion of indigenous fruits in West African sub region are seasonal forest products, harvested for consumption on site or for sale in urban centers [2]. The knowledge of the nutrient composition of some of these fruits will enhance their use and increase their consumption which will in turn help to improve the micronutrient needs of the population. Studies have shown that there are different varieties of wild fruits and lesser known vegetables that are in abundance in Nigeria that could be of health benefit [3]. The availability of fruits is short-lived due to seasonality and the perishable nature [4].It was therefore important to study one of those seasonal fruits and its usefulness in reducing some of the non communicable diseases in Nigeria. One such fruit is ***Annona muricata*** **(**soursop), the authors postulated that this underutilized and unexploited fruit may be of great potential in combating micronutrients deficiency and non-communicable diseases. However, very little work has been done with soursop to highlight its potential use.

Soursop tree is a small straggly fruit tree growing up to 8 meters high and it originated from tropical America and West Indies [5]. However, it is now widely grown in the tropics of both hemispheres [6]. It is grown in a wide range of soils with good drainage and elevations of up to 1000 meters and requires warm humid climate [7]. The leaves are glossy, oval to lanceolate in shape. The tree flowers and fruits all year round though there is usually a principal ripening season. The fruits are oval or irregular, 15-30 cm long, with sparse soft green curved spines. The flesh is pulppy white, stringy and sour containing shiny black seeds [8]. It has pleasant flavour and aroma. The soursop is unrivaled for sherbets, soft drinks, ice-creams, syrups and nectars [6]. Soursop juice was reported to contain 19-23% sugar and 1.10-1.71% total protein when ripe. The fruit was reported to contain 12% sugar, mostly glucose and some fructose, pectin, potassium, sodium, calcium, chloride and citrate WHO [7]. *Annona muricata* is also called prickly custard apple (English), Ebo (Yoruba), Mamphal (Indian), Guanabana (Spanish) and corossol and sappadille (French) [9].

The prevalence of chronic non-communicable diseases like cancer, obesity, cardiovascular diseases, coronary heart disease, diabetes mellitus in developing and developed countries has generated interest on food like soursop which can be of great importance. In contrast, the consumption level of soursop has dwindled, and could become extinct. In Nigeria, little industrial value is attached to this fruit. It is only consumed locally in the fresh state and there are no known commercial products available from Soursop. Little or no commercial value is attached to this fruit because it is rarely displayed for sale in the market. Utilization of fruits in Nigeria and most developing countries is limited due to inadequate processing and preservation methods [10]. The quantity that can

be consumed by eating the fruit is less compared with the quantity that can be consumed from the juice. Soursop juice could provide more micronutrients than the pulp [11]. To increase the demand and reduce the wastage of this fruit, juice could be produced. The aim of this work therefore was to formulate a soursop drink, determine the nutrient and phytochemical composition of soursop (*Annona muricata*) pulp and drink. Sensory evaluation of soursop (*Annona muricata*) drink was also conducted to determine the acceptability.

II. MATERIALS AND METHODS

Collection of materials: Mature soursop fruits were sorted from a selection of several mature fruits. The fruit's maturity was determined by its dark green skin with smooth numerous fleshy spines.

Preparation of pulp and formulation of drink:

The pulp was obtained by allowing the mature fruits for five (5) days at room temperature to ripen. The drink was formulated with the use of the pulp. Below is the recipe for the drink and a flow chart showing the steps involved in the formulation of Soursop drink

TABLE I
INGREDIENTS AND QUANTITY USED IN THE FORMULATION OF SOURSOP DRINK

Ingredients	Quantity
Syrup	4 table spoons
Water	400mls
Soursop pulp	200g

Procedure:

(i) The sugar syrup was prepared by dissolving 100g of sugar in 200mls of water and boiling over a source of heat for 3 minutes than left to cool
(ii) Two hundred grammes of soursop pulp was weighed out into an electric blender
(iii) Four hundred millimeters of water was added into the blender, then blend for 4 minutes to formulate the drink.
(iv) Four tables of sugar syrup was added into the blender and then blended for 2 minutes
(v) The formulated drink was poured in different sterilized bottles and then cooled.

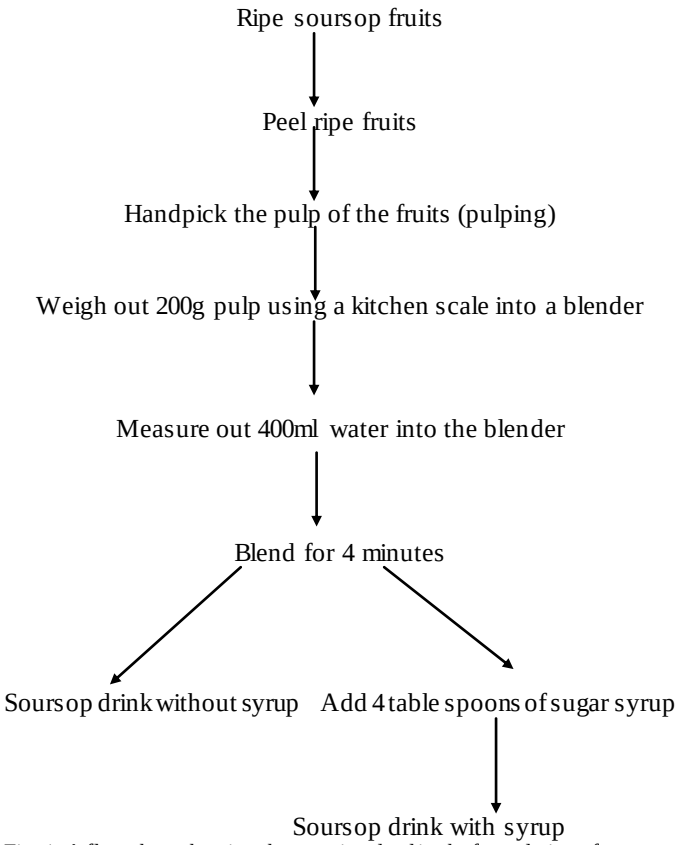

Fig. 1. A flowchart showing the steps involved in the formulation of soursop drink

Chemical Analysis

The moisture, ash, fat, protein and crude fibre content of the samples were determined using the method of AOAC [12] methods. Carbohydrate content was obtained by difference. Beta carotene, thiamin, riboflavin and vitamin C content of the samples were determined using the method of Pearson [13]. The AOAC [12] method was used to determine calcium, phosphorus, potassium and magnesium using the atomic absorption spectrophotometric method. Flavoniods and alkaloids were determined using the Pearson [13] method, saponin was determined using the Obadoni and Ochuko [14] method, anthocyanin and tannin content was determined using the method of Harborne [15].

Data Collection

A nine point Hedonic scale rating form was used, where 9 were the highest score, and 1 was the least score. This was used to test for colour, taste, flavor, mouth feel and overall acceptability. The degree to which a product was liked was expressed as ; like extremely much (9), like very much (8), like moderately (7), like slightly (6), neither like nor dislike (5), dislike slightly (4), dislike moderately (3), dislike very much (2), dislike extremely much (1).

Like extremely much to like slightly constituted good, while dislike slightly to dislike extremely much constituted poor. Neither like nor dislike shows that the product was neither good nor bad. The judges were randomly chosen from second and final year students of the department of Home Science,

Nutrition and Dietetics, University of Nigeria, Nsukka. A total of 50 students were chosen, and the judges were selected from 50% of the sample population. Thus, 25 judges were randomly selected for participation from 25 YES options and 25 NO options. Those who picked the YES options constituted the judges. The judges were trained on how to taste the samples and grade their responses. The sensory evaluation test was conducted in the diet laboratory of the department of Home Science, Nutrition and Dietetics, University of Nigeria. The arrangement was such that the judges did not see the grading of others to avoid bias. The samples were coded.

Statistical analysis

The statistical analysis was done using SPSS (Statistical Package for Social Science) version 17. The mean and standard deviation were calculated. The mean and standard error of mean was calculated using Analysis of Variance separated by Duncan's new multiple range test. Significance would be accepted at (P< 0.05).

RESULTS

TABLE II
PROXIMATE COMPOSITION OF SOURSOP (ANNONA MURICATA) PULP AND DRINK (%)

Parameter	AMP	AMJ
Protein	2.89^{d}±0.04	5.85^{d}±0.04
Fat	-	-
Ash	0.92^{a}±0.02	0.95^{b}±0.01
Fibre	6.26^{a}±0.06	3.47^{a}±0.04
Moisture	17.22^{c}±0.03	6.23^{c}±0.04
Carbohydrate	72.71^{b}±0.04	83.47^{b}±0.06

Mean and standard deviation values. Values with different superscripts are significantly similar at the same row (P<0.05)
Key:
AMP = Soursop pulp
AMJ = Soursop drink with sugar syrup

Table II presented the proximate composition of soursop pulp and soursop drink with sugar syrup. The crude protein content of soursop pulp and drink was 2.89% and 5.85% respectively, which was significantly (P<0.05) different. Fat was not present in both the soursop pulp and drink. The ash content for soursop pulp and drink was 0.92% and 0.95% respectively and was significantly (P>0.05) similar. The fibre content of the soursop pulp (6.26%) was significantly (P<0.05) higher than the drink (3.47%). The moisture content was significantly (P<0.05) higher in the pulp compared in the drink. The carbohydrate content of the soursop drink (83.47%) was significantly (P<0.05) higher than that of the drink (72.71%).

TABLE III
VITAMIN COMPOSITION OF SOURSOP (ANNONA MURICATA) PULP AND DRINK

Parameter	AMP	AMJ
Retinol (IU)	192.50^{d}±0.70	63.76^{d}±1.07
Thiamin(mg/100g)	2.10^{a}±0.35	1.25^{b}±0.14
Riboflavin(mg/100g)	0.20^{d}±0.01	0.14^{c}±0.01
Niacin(mg/100g)	0.21^{b}±0.01	0.95^{b}±0.08
Ascorbic acid(mg/100g)	22.59^{c}±1.41	34.71^{c}±2.58

Mean and standard deviation values. Values with different superscripts are significantly similar at the same row (P<0.05)
Key:
AMP = Soursop pulp
AMJ = Soursop drink with sugar syrup

Table 3 showed the vitamin composition of soursop pulp and soursop drink with sugar syrup. The retinol content of soursop pulp and soursop drink with sugar syrup were 192.00IU and 63.73IU which varied significantly (P<0.05). The thiamin content of the soursop pulp (2.10mg/100g) was significantly (P>0.05) similar with the drink (1.25mg/100g). The riboflavin content in soursop pulp was significantly (P> 0.05) similar with that of the drink. The niacin content of the soursop drink (0.95 mg/100g) was significantly (P<0.05) higher than the soursop pulp (0.21mg/100g). The ascorbic content of the soursop drink (34.71mg/100g) was significantly (P<0.05) higher than the soursop pulp (22.59mg/100g).

TABLE IV
MINERAL COMPOSITION OF SOURSOP (ANNONA MURICATA) PULP AND DRINK

Parameter (mg/100g)	AMP	AMJ
Potassium	0.81^{b}±0.04	0.68^{d}±0.06
Calcium	0.01^{a}±0.00	0.02^{b}±0.00
Magnesium	0.04^{d}±0.00	0.02^{e}±0.00
Phosphorus	0.30^{b}±0.01	0.22^{c}±0.02

Mean and standard deviation values. Values with different superscripts are significantly similar at the same row (P<0.05)
Key:
AMP = Soursop pulp
AMJ = Soursop drink with sugar syrup

Table 4 showed mineral composition of Soursop (Annona muricata) pulp and drink. The potassium content of the soursop pulp (0.81mg/100g) was significantly (P>0.05) similar to that of soursop drink (0.68mg/100g). The calcium content of the pulp (0.01mg/100g) was significantly (P>0.05) similar to that of soursop drink (0.02mg/100g). The magnesium of the soursop pulp (0.04mg/100g) was significantly (P>0.05) similar to that of soursop drink (0.02mg/100g). The phosphorus content of the soursop pulp (0.30mg/100g) was significantly (P>0.05) similar to that of soursop drink (0.22mg/100g).

TABLE V
PHYTOCHEMICAL COMPOSITION OF SOURSOP (ANNONA MURICATA) PULP AND DRINK

Parameter (mg/100g)	AMP	AMJ
Anthocyanin	6.44^{b}±0.10	7.35^{b}±0.06
Flavoniods	9.32^{a}±0.45	5.24^{a}±0.45
Tannin	65.98^{e}±2.11	53.96^{e}±1.02
Alkaloid	1.90^{s}±0.04	1.72^{s}±0.05
Saponin	0.17^{a}±0.01	0.22^{a}±0.02

Mean and standard deviation values. Values with different superscripts are significantly similar at the same row (P<0.05)
Key:
AMP = Soursop pulp

AMJ = Soursop drink with sugar syrup

Table 5 presented the phytochemical composition of soursop pulp and soursop drink with sugar syrup. The anthocyanin content of the soursop drink (6.44mg/100g) was significantly (P>0.05) similar to that of the pulp (7.35mg/100g). The flavonoids content of the soursop pulp (9.32mg/100g) was significantly (P<0.05) higher than the drink (5.24mg/100g). The tannin content was significantly (P<0.05) higher in the soursop pulp (65.98mg/100g) compared to the drink (53.96mg/100g). The alkaloid content of the soursop pulp (1.90mg/100g) was significantly (P>0.05) similar to that of the drink (1.72mg/100g).The saponin content of the soursop pulp (0.17mg/100g) was significantly (P>0.05) similar to that of the drink (0.22mg/100g).

TABLE VI
SENSORY EVALUATION OF FORMULATED SOURSOP (ANNONA MURICATA) DRINK

Sensory attributes	Sample A	Sample B
Colour	7.19^{a}±0.31	7.76^{a}±0.25
Taste	5.96^{a}±0.23	8.26^{b}±0.18
Mouth feel	6.04^{a}±0.23	7.58^{a}±0.24
Flavour	6.09^{a}±0.39	7.86^{a}±0.20
General acceptability	5.08^{a}±1.67	7.58^{b}±2.04
Willingness to buy	14%	86%

Mean and standard deviation value but percent for willingness to buy parameter. Values with different superscripts in row are significantly similar at the same row (P<0.05).

Key:

Sample A: Soursop (Annona muricata) drink without sugar syrup

Sample B: Soursop (Annona muricata) drink with sugar syrup

Table 6 showed the sensory evaluation of formulated soursop (*Annona muricata*) drink. Sample A and Sample B had colour values of 7.19 and 7.76 respectively. The value for the taste of the products varied from 5.96-8.26. It was significantly (P<0.05) higher in Sample B (8.26) compared with Sample A (5.96). The mouth feel of Sample A (6.04) was lower than Sample B (7.58) though their differences were not significant (P>0.05). Sample A and Sample B had flavor values of 6.09 and 7.86 respectively. The values for general acceptability of the products varied from 5.08-7.58. It was significantly (P<0.05) higher in Sample B (7.58) when compared with Sample B (5.08). Majority of the respondents (86%) were willing to buy Sample B while 14% of the respondents were willing to buy Sample A.

DISCUSSION

The moisture content of soursop pulp (17.25%) was higher than the soursop drink (6.20%). This indicated that the soursop pulp is more prone to spoilage than the soursop drink. The pulp can be preserved and processed to improve its availability and diet diversification. The low moisture content of the soursop pulp and its drink could also have affected some of the value of other nutrients present. The moisture content obtained in this study was higher than that of conventional fruits such as pineapple (0.86%) and banana (0.03%) [16]. The comparable ash values of soursop pulp (0.92%) and soursop drink (0.95%) indicated that both are good sources of minerals and therefore can be used in diet supplementation which will improve the mineral quality of diets. Soursop pulp and its drink do not contain fats as obtained from the result of this study, which is an indication that both had low risk of rancidity and thus offer better nutritional benefits. The higher protein content of soursop drink than that of the pulp is an indication that the soursop drink had concentrates of protein than the pulp. The low moisture content of the soursop pulp and its drink suggest that the level of other nutrients might be high. This accounts for the high fibre content (3.43% and 6.26% for soursop drink and pulp respectively) and the carbohydrate content (83.47% and 72.71% for soursop drink and pulp respectively).

The lower vitamin A content of the soursop drink (63.71IU) than the soursop pulp (192.50IU) suggests that processing technique reduces the retinol content, though it was higher than the values reported by the USDA [15] for pineapple (57IU) but lower than that of banana (248IU). There were also the presence of thiamin, riboflavin, niacin and ascorbic acid in the soursop pulp and drink. This suggests that consumption of soursop pulp and drink could provide a lot of health benefits. β-carotene and vitamin C are antioxidants which are known to protect the cells by reacting with oxidizing factors and neutralizing their effects [16]. They help protect the body from cell damage caused by free radicals and peroxides. The enhancing effect of ascorbate has been attributed to its reducing and chelating properties during the digestion of food [17]. The presence of ascorbate in foods overcomes the negative effects of all major inhibitors of iron absorption, including phytate and polyphenols to increase iron absorption two to three folds [18]. Ascorbate also enhances iron absorption by reducing the iron III ions to ferrous (Fe^{2+}) state, a form in which iron is absorbed. β-carotene improves absorption of iron possibly by forming a complex with iron, keeping it soluble in intestinal lumen and preventing the inhibitory effect of phytates and polyphenols on iron absorption [19]. β-carotene is precursor of vitamin A, which is important in strengthening and boosting the immune system to fight infection. Vitamin A is necessary for good eye health. It improves iron status possibly by reducing levels of infection, improving production and proliferation of red blood cells in bone marrow, increasing the absorption of iron from food in the intestine and mobilization from body store [20].

The potassium, calcium, magnesium and phosphorus contents of soursop pulp and drink were quite low when compared with the values obtainable from conventional fruits (USDA) [16]. Potassium is useful in the prevention of hypertension. Calcium and phosphorus are known to be helpful in the formation of strong bones and teeth, preventing osteoporosis and osteomalacia. A study revealed that magnesium functions as a co-factor of many enzymes involved in energy metabolism, protein synthesis and maintenance of the electrical potential of nervous tissues and cell membranes [21].

The presence of flavonoids in the soursop pulp and drink is desirable. Flavonoids are large group of compounds widely

distributed in plant foods. They have antioxidant properties to protect the body against cardiovascular diseases and some form of cancer [22]. Other phytochemicals found in soursop pulp and drink has been shown to be beneficial to human health. Saponins identified in the soursop pulp and drink has the potential to lower cholesterol levels in humans due to their hypocholesterolemic effect [23]. Saponins form complexes with cholesterol to reduce plasma cholesterol levels. The other compounds such as anthocyanin, alkaloids and tannins have been studied especially for their potential of anti-parasitic, anti-rheumatic, astringent and emetic effect and anti-hyperglycemic property [24].

The sensory evaluation for colour, taste, mouth feel, flavor, general acceptability and willingness to buy showed that soursop with sugar syrup was more acceptable than soursop without sugar syrup.

CONCLUSION

The soursop pulp and its drink contain appreciable quantities of nutrients with health-promotion benefits. Further work is recommended to standardize portion sizes for dietary management of diet related diseases based on the nutrients and health promoting substances of soursop and also processing of soursop in the powdered form for availability all year round.

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