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Chemical and Sensory Properties of Soursop Smoothie Formulated from Soursop, Tiger Nut Milk, Date Palm and Noni Juice

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ABSTRACT

The study was designed to determine the chemical and sensory properties of soursop smoothie formulated from soursop, tiger nut milk, date palm and noni juice. Matured soursop fruit was allowed to ripe for five (5) days at room temperature. It was thoroughly washed, peeled, cut into pieces, de-seeded and grinded with an electric blender to achieve the soursop pulp. Dried date palm fruits were sorted, de-seeded, washed, soaked in water for 10 minutes to soften and grinded with electric blender with 100g of water. Dried yellow tiger nut were sorted to remove spoilt ones, stones and other particles, washed to remove dust and dirt, and soaked in cold water over-night in a room temperature to soften it. The tiger-nut was wet-grinded with an electric blender using 1 litre of water to facilitate blending. The mixture was filtered using a muslin cloth to extract tigernut milk. Noni fruits were washed and placed in a sieve to air dry for 30 minutes in a room temperature. Noni fruit peels and seeds were removed and the juice was extracted. The grinded soursop and date palm pulp, tiger nut milk and noni juice were measured according to the blending ratio labeled A-D using a measuring cylinder into the blender and mixed for one second. The smoothie was analyzed for proximate, micronutrient, phytochemical and pH using standard methods. Sensory acceptability was carried out using 9 hendonicscale. Data generated was analyzed using Statistical Product for Service Solution (SPSS) version 21.0. Two way Analysis of variance was performed and means were separated using Duncan's new multiple range test. Significance level was set at $p<0.05$.Ash content was significantly ($p<0.05$) higher in sample A (2.09g) and sample B (2.22g), fibre was significantly ($p<0.05$) higher in sample A (1.90g) and sample C (1.97g), while carbohydrate was significantly ($p<0.05$) higher in sample B (11.34g).micronutrient composition revealed that vitamin C was significantly ($p<0.05$) higher in sample C (230mg), calcium was significantly ($p<0.05$)higher in sample A and B(20mg) respectively, potassium was significantly ($p<0.05$) higher in sample Band C (270mg) respectively, sodium was significantly ($p<0.05$) higher in sample D (160mg) while manganese was significantly ($p<0.05$) higher in sample B (2020mg). Phytochemical composition showed that flavonoid was significantly ($p<0.05$) higher in sample A (1.98mg), phenolic acid significantly ($p<0.05$) higher in sample B (1.71) and sample D (1.77mg), alkaloid significantly ($p<0.05$) higher in sample D (5.00mg), pH was significantly ($p<0.05$) higher in sample B (7.61) while sample D was generally accepted. Soursop smoothie contains low protein, fat, but high in micronutrient. It contains phytochemicals and is an alkaline smoothie. Production and consumption of soursop smoothie should be encouraged.

Keywords: *smoothie, soursop, tiger nut, noni, date palm.*

INTRODUCTION

Diet-related chronic non-communicable diseases such as cardiovascular diseases, cancer, obesity and diabetes mellitus prevalence both in developing and under-developing countries is increasing in recent times. This could be attributed to poor dietary diversification which predisposes individuals to inadequate intake of micronutrient rich indigenous foods. There are poor nutritional knowledge of some indigenous food sources especially fruits and vegetables which contain high quantities of minerals, vitamins and phytochemicals. Researchers have investigated on the nutrient composition of soursop juice drink (Onyechi *et al.*, 2012), tiger nut milk (Ibrahim *et al.*, 2016), date palm (Hamza *et al.;* 2014) and noni juice (Oly-Alawuba and Iwueke, 2019).

Previous studies have reported the nutritional properties of juices but studies are lacking on the nutritional evaluation of smoothie. Smoothies contain dietary fiber which makes it thicker than fruit juice. Production of juice involves the addition of milk and syrup made from sugar which increases the caloric value of the products and makes it unhealthy for some individuals. On the other hand, most adults are susceptible to lactose intolerance so, the use of tiger nut will replace milk while date palm will replace sugar.

Soursop (*Annonamuricata*) is one of the exotic fruits priced for its very pleasant, mild- acid, aromatic and juicy flesh (Umme *et al*., 1997). It is commonly found in the southern part of Nigeria and mostly eaten as fresh fruit. However, it softens very rapidly during ripening and becomes mushy because of external injury (Umme *et al*., 2001). Soursop is used as potential source of raw material for pure juice, jam etc. Freshly expressed juice is subjected to raid microbial growth as well as enzymatic deterioration.

Tiger nut (*Cyperusesculentus* L.) belongs to the Division Magnoliophyta, Class–Liliopsida, Order–cyperales and Family–Cyperaceae and was found to be a cosmopolitan, perennial crop of the same genus as the papyrus plant. The tubers are about the size of peanuts and are abundantly produced in Nigeria. It has many other names like Zulu nut, yellow nutgrass, ground almond, chufa, edible rush and rush nut**.** In Nigeria, the Hausas call it "Aya", Yorubas "imumu", the Igbos "aki Hausa", "ofio" in southern Nigeria (Osagie and Eka, 1998). Tiger nut has been cultivated since early times (chiefly in south Europe and West Africa) for its small tuberous rhizomes which are eaten raw or roasted, used as hog feed or pressed for its juice to make a beverage. Non-drying oil (usually called chufa) is equally obtained from the rhizome.

Noni (*Morindacitrifolialinn*) also called Indian mulberry was used for the study. *Morindacitri-folialinn*, Indian mulberry is the plant that can be used as a raw material for nutraceutical and functional food products. Nutraceutical and functional food (NNF) products are increasingly becoming health products of choice. Nutraceutical offers medical or health benefits to the consumer by providing means for the maintenance of health and well-being and protection from disease, on the other hand a functional food provides the body with the required amounts of vitamins, fats, protein, carbohydrates and many other compounds that are needed for its survival (Karla, 2003). There are more than 120 nutraceutical compounds identified in noni (Solomon, 1999). Recently noni juice extract has been commercially processed and distributed internationally as a dietary supplement. Literature revealed that noni can be used in the management of cancer, bacterial and ulcer in animals (Zhang *et al.,* 2016; Assi*et al.,* 2015 and Anekpankul *et al.,* 2007). Noni contains 90% water and 10% dry matter but high in vitamin C (Samoylenko *et al.,* 2006).

Date palm fruit (*Phoenix dactylifera L*) locally called debino in Hausa language, from the family of Arecaceae (Al-daihanand Bhat, 2012) is a sweet edible fruit. The fruit is a drupe in which an outer fleshy part consists of pulp and Pericarp surrounding a shell of hard endocarp with a seed inside (Farheena *et al.;* 2015). Date fruit contains more than 70% sugar mainly glucose and fructose and therefore are high energy food sources (Dada *et al.,* 2012), thus making it an ideal replacement for sugar (sucrose) in the cookies recipe, which is also of great nutritional benefit to diabetics and other metabolic health related patients. Besides, date fruit is rich in fibre (Hamza *et al.,* 2014), very rich in antioxidant flavonoids such as beta-carotene, lutein and zeaxanthin. They are also excellent source of iron, calcium, copper, magnesium, potassium, and minor source of vitamins A, and B2 (Dada *et al.,* 2012; Farheena *et al.,* 2015).There is paucity of literature on nutritional evaluation of smoothies produced with mixed fruits and vegetables. Therefore, this study sought to evaluate the nutritional and sensory properties of soursop smoothie produced from soursop, tigernut, date palm and noni concentrate.

Sample Procurement

Freshly harvested soursop fruits, tigernut, and datepalm were obtained from Eke-Ukwu market, Owerri, Imo State, while noni fruit was obtained from Green Health Farms Ohi, Imo State.

Sample Preparation

Soursop pulp

One hundred grams (150g) of matured soursop fruit was allowed to ripe for five (5) days at room temperature. It was thoroughly washed, peeled, cut into pieces, de-seeded and grinded with an electric blender to achieve the soursop pulp. It was stored in the refrigerator for further use.

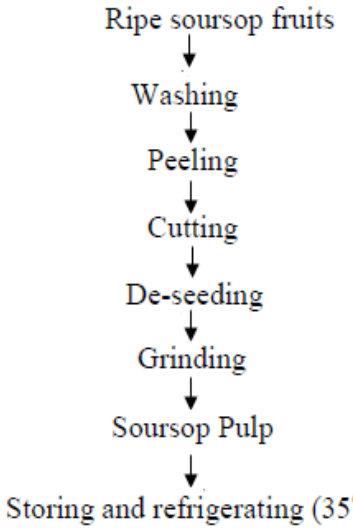

Figure1. *Flow Chart for soursop pulp extraction*

Preparation of Date Palm Fruit

Eighty grams (80g) of dried date palm fruits were sorted, de-seeded, washed, soaked in water for 10 minutes to soften and grinded with electric blender. Three hundred grams (100g) of water was added to the mixture during grinding. Date palm paste was extracted and stored in the refrigerator for further use.

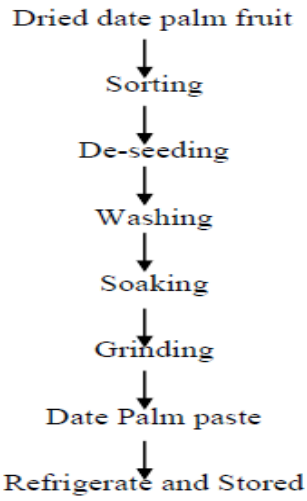

Figure2. *Flow Chart for Production of Date Palm paste*

Preparation of Tiger-Nut Milk

The method as described by Obasi and Ugwu (2015) was adopted little modification. One hundred kilogram(1kg) of dried yellow tiger nut were sorted to remove spoilt ones, stones and other particles, washed to remove dust and dirt, and soaked in cold water over-night in a room temperature to soften it. The tiger-nut was wet-grinded with an electric blender using 1litre of water to facilitate blending. The mixture was filtered using a muslin cloth and stored in refrigerator for further use.

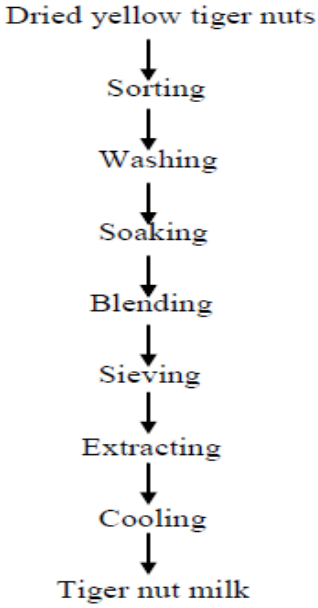

Figure3. *Flow chart for the production of Tiger nut Milk*

Preparation of Noni Juice

Fresh matured ripe noni fruits were washed and placed in a sieve to air dry for 30 minutes in a room temperature. Noni fruit peels and seeds were removed and the juice was extracted using Lisan whole fruit and vegetable juice extractor with product code 468312.

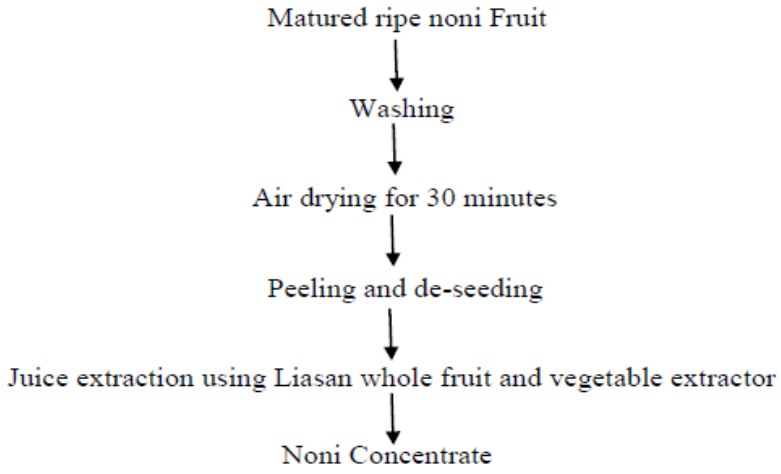

Figure4. *Flow chart for the extraction of noni juice*

Table1. *Blending ratio (ml) of soursop smoothie*

Samples	A	B	C	D	Total
Sour sop	50	40	30	30	100
Tiger nut milk	30	30	40	30	100
Date palm	10	20	20	30	100
Noni juice	10	10	10	10	100

Method of Smoothie Formulation

The grinded soursop and date palm pulp, tiger nut milk and noni juice were measured according to the blending ratio (table 1) using a measuring cylinder into the blender and mixed for one second.

Chemical Analysis of the Smoothie

Association of Analytical Chemistry (AOAC) (2012) was used to carry out proximate analysis (moisture, protein, ash, crude fibre, crude fat and carbohydrate), flavonoid and alkaloid. Micronutrient determination; sodium, manganese, calcium, potassium and magnesium were determined according to AOAC (2000) while vitamin C was carried out using atomic absorption spectrophotometer absorbance method as described by AOAC (2000). Total phenolic acid was carried out as described by Nabavi *et al.* (2008). The pH value was determined using a pH meter (model ARCHICE, Myron L Company, U.S.A). The smoothie samples were diluted with distilled water in the ratio of 1.5 for use at each pH determination of the smoothie samples.

Sensory Analysis

Twenty trained panelist were selected based on their ability to discriminate and reproduce the results on sensory properties of smoothies. The samples were served using clean glass cups and stainless spoons. The panelists were provided with clean water to rinse their mouth after each rating. The scored the smoothie for flavour, colour, taste, mouth feel and general acceptability using 9 hedonic scale (1=dislike extremely, 2= dislike very much, 3=dislike moderately, 4=dislike slightly, 5= neither like nor dislike, 6=like slightly, 7=like moderately, like very much, 9=like extremely).

Statistical Analysis

Data generated was analyzed using Statistical Product for Service Solution (SPSS) version 21.0. Two way Analysis of variance was performed and means were separated using Duncan's new multiple range test. Significance level was set at $p<0.05$.

Results

The table2 shows the proximate composition of soursop smoothie. Moisture content of the smoothie ranged from 84.2±1.31g(sample A) to 86.07±1.48g (sample B),protein content ranged from 0.89±0.09g (sample B) to 1.33±0.01g (sample C), crude fiber content ranged from 1.04±0.08g (sample B) to 1.97±0.08g(sample C).Fat content of the smoothie ranged from 0.99±0.01g (sample A) to 1.07±1.07g (sample C), ash content ranged from 1.50±0.11g (sample C) to 2.22±0.23g (sample B) and carbohydrate content ranged from 8.49±1.01g (sample A) to 11.34±0.95g (sample D). There was significant ($p<0.05$) difference in fibre, ash and carbohydrate. Micronutrient composition of the smoothie was presented on table 3. Vitamin C content ranged from 140±0.00mg (sample B) to 230±0.01mg (sample C), calcium content ranged from 20±0.00 mg (samples A and B respectively) to 15±2.09 mg (sample D), magnesium content ranged from 20±0.00mg (sample A, C and D respectively) to 30±0.00mg (sample B). Sodium ranged from 30±0.00mg (sample A) to 160±0.18 (sample D), potassium ranged from 220±2.12mg (sample D) to 270±2.32mg (sample B and C), while manganese ranged from 750±0.35mg (sample D) to 3000±0.70 mg (sample A). Phytochemicals and pH composition of the smoothie was presented on table 4. Flavonoid ranged from1.21±0.13mg (sample D) to 1.98±0.03mg (sample A), phenolic acid ranged from 1.00±0.02mg (sample C) to 1.77±0.10mg (sample D), alkaloids ranged from 3.06±0.13mg to 5.00±0.06 (sample D) and pH of the smoothie ranged from 7.30±0.02 (sample A) to 7.61±0.03 (sample B). Sensory properties of the smoothie were presented on table 4. Flavour (7.78±0.99), colour (7.78±1.07) and mouth feel (7.46±0.97) was significantly ($p<0.05$) higher in Sample D. Taste was significantly higher in sample A (7.46±1.38) and sample D (7.97±0.97) while overall acceptability was significantly ($p<0.05$) higher in sample A (7.22±1.56) and sample D (7.46±1.04).

Table2. *Proximate composition (g) of soursopsmoothie*

Proximate composition	A	B	C	D
Moisture	85.49^{a}±0.90	85.92^{a}±1.48	84.60^{a}±.63	84.21^{a}±1.31
Protein	1.04^{a}±0.02	0.89^{a}±0.09	1.33^{a}±0.01	1.10^{a}±0.07
Crude fibre	1.90^{b}±0.01	1.04^{a}±0.08	1.97^{b}±0.08	1.05^{a}±0.08
Ash	2.09^{b}±0.11	2.22^{b}±0.23	1.50^{a}±0.15	1.26^{a}±0.11
Crude fat	0.99^{a}±0.01	1.04^{a}±0.05	1.07^{a}±0.07	1.04^{a}±0.07
Carbohydrate	8.49^{a}±1.01	8.68^{a}±1.01	9.55^{a}±0.65	11.34^{b}±0.95

Values are means of triplicate determinations. Mean values with different superscripts in the same column are significantly different ($p<0.05$). LSD = least significant difference. Key: Sample A = soursop (50%) + Tiger nut

(30%) + Date palm (10%) + noni juice (10%). Sample B = soursop (40%) + tiger nut (30%) + date palm (20%) + noni juice (10%). Sample C = soursop (30%) + tiger nut (40%) + date palm (20%) + noni juice (10%). Sample D = soursop (30%) + tiger nut (30%) + date palm (30%) + noni juice (10%).

Table3. *Micronutrient composition (mg/100g) of the smoothie*

Micronutrient composition	A	B	C	D
Vitamin C	180^{a}±0.01	140^{a}±0.00	230^{c}±0.01	200^{b}±0.00
Calcium	20^{b}±0.00	20^{b}±0.00	10^{a}±1.40	15^{a}±2.09
Magnesium	20^{a}±0.00	30^{a}±0.00	20^{a}±0.00	20^{a}±0.00
Potassium	230^{a}±0.00	270^{b}±0.00	270^{b}±0.00	220^{a}±0.00
Sodium	30^{a}±0.00	50^{a}±0.00	50^{a}±0.00	160^{b}±0.18
Manganese	3000^{a}±0.70	2020^{b}±0.03	1250^{a}±0.35	750^{a}±0.35

Values are means of triplicate determinations. Mean values with different superscripts in the same column are significantly different ($p<0.05$). LSD = least significant difference. Key: Sample A = soursop (50%) + Tiger nut (40%) + Date palm (10%) + noni juice (10%). Sample B = soursop (40%) + tiger nut (30%) + date palm (20%) + noni juice (10%). Sample C = soursop (30%) + tiger nut (40%) + date palm (20%) + noni juice (10%). Sample D = soursop (30%) + tiger nut (30%) + date palm (30%) + noni juice (10%).

Table4. *Phytochemicals and pH composition of the smoothie*

Phytochemical/pH composition	A	B	C	D
Flavonoid (mg/100g)	1.98^{c}±0.03	1.54^{a}±0.07	1.92^{b}±0.05	1.21^{a}±0.13
Phenolic acid (mg/100g)	1.02^{a}±0.04	1.71^{b}±0.10	1.00^{a}±0.02	1.77^{b}±0.06
Alkaloids (mg/100g)	3.99^{c}±0.03	3.06^{a}±0.13	3.57^{b}±0.15	5.00^{d}±0.06
pH	7.30^{a}±0.02	7.61^{c}±0.03	7.32^{a}±0.03	7.41^{b}±0.02

Values are means of triplicate determinations. Mean values with different superscripts in the same column are significantly different ($p<0.05$). LSD = least significant difference. Key: Sample A = soursop (50%) + Tiger nut (40%) + Date palm (10%) + noni juice (10%). Sample B = soursop (40%) + tiger nut (30%) + date palm (20%) + noni juice (10%). Sample C = soursop (30%) + tiger nut (40%) + date palm (20%) + noni juice (10%). Sample D = soursop (30%) + tiger nut (30%) + date palm (30%) + noni juice (10%).

Table4. *Sensory properties of the smoothie*

Sensory properties	A	B	C	D
Flavour	6.96^{a}±1.59	6.78^{a}±1.34	6.68^{a}±1.96	7.78^{b}±0.99
Color	6.92^{a}±1.36	6.62^{a}±1.58	6.78^{a}±1.59	7.78^{b}±1.07
Taste	7.46^{b}±1.38	6.46^{a}±1.75	6.56^{a}±1.83	7.98^{b}±0.97
Mouthfeel	6.54^{a}±2.15	6.56^{a}±1.47	6.90^{a}±1.94	7.46^{b}±0.97
Overall acceptability	7.22^{b}±1.56	6.46^{a}±1.85	6.58^{a}±2.20	7.46^{b}±1.04

Values are means of triplicate determinations. Mean values with different superscripts in the same column are significantly different ($p<0.05$). LSD = least significant difference. Sample A = Sours sop (50%), Tiger nut (40%), Date palm (10%) and Noni concentrate (10%). Sample B = Sours sop (40%), Tiger nut (30%), Date palm (20%) and Noni concentrate (10%).Sample C = Sours sop (30%), Tiger nut (40%), Date palm (20%) and Noni concentrate (10%).Sample D = Sours sop (30%), Tiger nut (30%), Date palm (30%) and Noni concentrate (10%).

DISCUSSIONS

The moisture content of the smoothie was high. Moisture content of papaya-beetroot smoothie reported by Owolade and Arueya, (2016) were lower but similar with93.6% in jamun-water melon smoothie reported by Broadway *et al.* (2017). The smoothie can be used as a thirst-quenching drink (Aderinola, 2018). The high moisture content of the smoothies indicates a high water activity (Aw) which may enhance the activities of microorganisms that brings about spoilage. Therefore refrigeration method as a preservative method is necessary to prolong its shelf-life. The low protein content of the smoothies accounts that fruits are generally low in protein and may contribute little protein to the diet.

Fiber content of the smoothies was high and consistent with Ukwuru *et al.* (2008). However, sample A and B recorded higher fiber content which could be attributed to the fact that soursop pulp (50% and 40% respectively) was the highest in the above samples. Fruits are excellent sources of fibre. Fiber is necessary in the diet to promote gastric emptying, enhance bowel movement and involved in some metabolic processes. Ash content of the smoothies was also high. However, the results obtained were lower than Walking-Ribeiro *et al.*, (2010) for soursop, pine apple and

date smoothie. There was no significant difference in the fat content of the smoothies. Fat content of the smoothie was low across the smoothie samples. This suggests that other food sources should be taken to get the required amount of fat per day. Carbohydrate content of the smoothies was low; this is because most fruits and vegetables are low in carbohydrate. The smoothie may be beneficial to low calorie diet individual like weight reduction, metabolic and cardiovascular diseases.

Vitamin content of the smoothies was high. This could be attributed to the varieties of fruits selected for smoothie production. Date palm pulp is a rich source of vitamin C. Vitamin C is needed for collagen formation, normal healing of wounds and repair of tissues. It enhances iron absorption and act as antioxidant. Calcium content of the smoothie was low this could be explained by the low content and quantity of the fruits used. Magnesium, manganese, and potassium were high in the smoothie and may provide more than half of recommended nutrient intake. The smoothie may be good for cardiovascular health because of its potassium content. Another good thing is that the sodium content of the smoothie is significantly low. Flavonoid and phenolic acid content was highest in sample A [sours sop (50%), tiger nut (30%), date palm (10%) and noni concentrate (10%)]. This may be attributed to the fact that there is higher percentage of soursop in the sample. Flavonoid and phenolic acid are essential anti-oxidants that help fight against cell damage by free radicals and super-oxide molecules. The pH of the smoothie was above 7.00 and consistent with previous works reported by Balaswamy *et al.* (2013) and Keenan *et al.*(2011). This suggests that smoothies are slightly alkaline which has some health benefits. Sensory properties of the smoothies are consistent with previous works reported by Broadway *et al.*, (2017), Ukwuru *et al.*(2008) and Belewu, (2007). The study showed that sample D (soursop (30%), tiger nut (30%), date palm (30%) and noni concentrate (10%) recorded the highest sensory attributes in terms of flavor, aroma, taste, mouth-feel and also the highest overall acceptability rating. This could be attributed to the quantity of date palm and tiger nut milk added. Consumers tend to accept products that are sweet irrespective of the nutritional content of the product. Date palm may be used as sugar replacement ready to eat (RTE) smoothies. Date palm also contains other nutritional benefits which is an added advantage over table sugar.

CONCLUSION

The Smoothie had low protein, fibre, fat and carbohydrate contents but was high in micronutrient such as vitamin C, potassium, magnesium, and manganese. It contains flavonoid, phenolic acid and alkaloid. The smoothie had alkaline pH and sample D [soursop (30%), tiger nut (30%), date palm (30%) and noni juice (10%)] was generally accepted. Production and consumption of soursop smoothie should be encouraged.

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