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The effect of inclusion of soursop (*Annona muricata*) flour on the sensory properties of cake for household consumption

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Abstract
The study was carried out to access the effect of sour-sop flour on the sensory properties of cake made with wheat/sour-sop composite flour. The study had four objectives: processing of sour-sop fruits into flour, proximate composition on the product, physical properties and sensory evaluation on the products. Wheat/soursop flour were used at different ratios of 70:30%, 60:40%, 50:50% levels and 100% wheat flour as the control. The triplicates data results were subjected to analysis of variance (ANOVA) and mean separation using Duncan Multiple range test at $p<0.05$ using SPSS package. Results for proximate composition showed that moisture had values ranging from 17.77-23.63% with significant differences ($p\leq0.05$) among the samples, ash content increased from 2.80-3.15% while fat values decreased from 22.52-19.12% as substitution of sour-sop flour increased. Protein and fibre also increased from 3.88-6.56% and 1.76-4.35% respectively with significantly differences ($p\leq0.05$) while carbohydrates decreased from 53.27-45.19%. Sensory evaluation showed that sample B was preferred (6.52) followed by sample C for appearance (6.21), taste (6.30), aroma (6.70), texture (5.75) and sample B had overall acceptability (6.52) close to the control sample. Results for physical properties showed that heights ranged from 2.00cm- 2.60cm with sample A having the least (2.00cm) and sample D as the highest, diameter and weight ranged from 4.80cm in sample D to 5.90cm in sample A (100%) and 38.77g in sample A to 45. 57g in sample D while spread ratio decreased from 2.95 in sample A to 1.85 in sample D respectively. The substitution of sour-sop flour improved the nutritional qualities of the cake in terms of protein, fibre and ash while the carbohydrates content decreased as substitution increased. The results showed that the addition of soursop flour affected the sensory and physical properties of the cake.

Keywords: Soursop flour, proximate composition, sensory qualities, cake.

Introduction
Snacks are small chops or tiny meals eaten in order to maintain health, satisfying appetite or convenience foods that can be eaten in-between meals (Adeleye, 2015) [3]. They are smaller than the regular meals, designed to be portable, quick, easy to carry and satisfying, less perishable and more durable than prepared meals (Agbaje *et al;* 2016) [4]. Adegunwa *et al;* (2014) [2] and Adebayo-Oyetoro *et al;* (2015) [1] stated that snacks are generally referred to as junk foods due to their low nutriti1ve value. Presently, snacks are fortified to provide consumer with food products that offers the needed nutrients (Deedam *et al*., 2020) [8]. Large amount of the family budget is spent on snacks due to its convenience and accessibility. In developing countries, snacks are sometimes fortified to provide consumers with food products that offers the needed nutrients particularly children. It has been observed that some snacks are carbohydrates and cereal based and are invariably low in nutritional value including protein, minerals, vitamins, and fibre contents if not fortified to improve the food content Uzo-Peters and Ola 2020) [23]. According to Oforiwa (2012) [19], Mohammed and Abdulrasheed (2016) [17], they stated that cake is a sweet snack produced from baking a mixture of margarine, sugar, eggs and flour and other ingredients. It is an excellent source of food product which provides the body with energy (Olatunde *et al;* 2019) [20]. The use of composite flour (a combination of two or more flours in food preparations).

Flour from grains, cereals, roots etcetera are replaced with a ratio of wheat flour. These substitutes have some functional properties for health benefits and fortification (Giami *et al.*, 2004, Obinna *et al.*, 2023) [11, 18]. The production of cake using only wheat flour may be lacking in some vitamins and minerals. The inclusion of nutritious plant flour will increase the nutrients value of flour-based snacks (Eke-Ejiofor and Deedam 2015, Uzo-Peters 2020) [10, 23]. The combination of different flour from other plants food materials especially the underutilised fruits become paramount. Fruits are good sources of fibre, selected minerals, vitamins, and antioxidants, they are also rich in carbohydrates, vitamin C and carotene.

Sour-sop is an unutilized fruit of the family Annonaceae and there are about six species (sweetsop, sugar apple, custard apple, bullock heart and cherimoya) available. Iombor and Banjo 2018) [12]. According to Oforiwa (2012) [19], Sour-sop is eaten as desert as well as an excellent drink or ice cream after straining.

It contains antioxidants properties which can be used to reduce free radicals in the body and mineral contents which act as a good dietary source of electrolytes as well as the fibre which assist in the protection against coronary heart disease risk (Mohammad 2009) [16]. It is low in sodium and helps in the prevention and management of hypertension and cancer (Chang *et al.*, 2016, Dias and Jayasooriya 2017) [6, 9]. According to Vincent *et al.*, (2009), sour-sop is highly perishable, underutilised and the industrial usage are not also available due to harvest losses resulting from poor storage facilities (Onimawo 2002, Deedam and Mbah 2020, Deedam *et al;* 2020) [21, 7-8]. Processing this seasonal fruit into flour will reduce post-harvest loss and make the products available all year round and can be used to fortify wheat flour products. Substitution with sour-sop flour will also reduce importation of wheat flour and increase utilization of local fruits in our cuisines.

Materials

Sour-sop fruits (*Annona muricata*) was bought from Fruit Garden Market in Port Harcourt. Other ingredients wheat flour, margarine, sugar, eggs, baking powder and vanilla essences were purchased from New Market Port Harcourt Township.

Methods

Processing of sour-sop flour

Matured soursop (*Annona muricata)* fruits were washed, peeled and rewashed with water. It was sliced, core and seeds removed. The pulp was cut into smaller pieces and dried at 60^0C for 48 hours and milled into flour. A US70 (180µm diameter) sieve was used. The flour obtained was stored at room temperature inside an airtight polythene bag and used for cake productions.

Formulation of samples to produce cake.

Heat and sour-sop composite flour was formulated at 70:30, 60:40, 50:50 ratios. Hundred percent (100%) wheat flour served as control.

Flow chart of sour-sop flour

Matured soursop fruit
↓
Wash with clean water.
↓
Peel with kitchen knife.
↓
Remove core and seeds.
↓
Cut pulp into smaller pieces.
↓
Air dried in an oven (60℃ for 48hrs)
↓
Milled into flour using blender.
↓
Sieve through US70 (180µm diameter).
↓
Packaged in an airtight container.

Table 1: Formation of Flour Blend

Level of substitution		
Sample	**Wheat flour**	**Soursop flour**
SCA	100	-
SCB	70	30
SCC	60	40
SCD	50	50
Level of substitution		
Sample	**Wheat flour**	**Sour-sop flour (%)**
WSA	100	-
WSB	70	30
WSC	60	40
WSD	50	50

Key: WSA= 100% wheat flour, WSB= 70 wheat/ 30% sour-sop flour WSC=60% wheat 40% soursop flour, WSD=50% wheat/50% sour-sop

List of ingredients
Wheat flour, soursop flour, margarine, sugar, eggs, baking powder, vanilla flavour.

Method for Production of Cake
Cake was prepared using creaming method
1. Weigh all ingredients.
2. Cream margarine and sugar for 30 minutes.
3. Beat the eggs.
4. Gradually incorporate the egg
5. Add soursop, wheat flour and other ingredients.
6. Grease the pan and pour the batter.
7. Bake for 40 minutes at 150 °C in an oven to golden brown.
8. Bring it out and allow to cool

Recipe for the preparation of cake

Ingredients	Quantity
Wheat flour	100g
Sour-sop flour	100g
Margarine	150g
Sugar	150g
Baking powder	5g
Egg	3 medium sizes
Vanilla flavor	10ml

Source: Kinton *et al;* (2005) [15]. Note the control was 100g wheat flour.

Data analysis
Proximate analysis of the sample was determined using the Association of Official Analytical Chemist (AOAC 2006) [5] methods for moisture, ash, protein and crude fiber and fat while carbohydrates were determined using the formula by James (1995), % carbohydrates = 100% - (moisture + ash + fat + protein + crude fiber).

Sensory evaluation
The sensory properties of the products were determined using simple hedonic test. Attributes such as appearance, aroma, taste, colour, texture and overall acceptability were assessed on the samples using a 9-point hedonic scale of 9 (like extremely) to 1 (dislike extremely). The criteria for selection were based on their knowledge of the products to be evaluated.
The twenty-panel list were given some instructions: Do not be distracted when the sensory commences, record correctly, rinse your mouth after every taste, and ensure you kick the appropriate column and so on.

Statistical analysis
Results were analysed statistically using analysis of variance (ANOVA) to compare differences in the means of moisture, crude protein, ash, crude fibre and total carbohydrate. The least significant difference (LSD) test and Duncan's Multiple Range Test (LSD). Duncan Multiple Range Test (DMRT) was used to determine the significant differences in mean values. A significant differences was considered at the level of (p<0.05). The data collected in this study was analyzed using the Statistical Package for the Social Sciences (SPSS) version 23.0

Results

Table 1: Proximate Composition of Cake Produced from Wheat/Soursop Flour Blends

Samples	Moisture (%)	Ash %	Fat %	Crude Protein (%)	Crude Fiber (%)	Carbohydrate (%)
WSA	17.17±0.01^{c}	2.80±0.01^{c}	22.52±1.20^{a}	3.88±0.01^{c}	1.76±0.29^{c}	51.87±0.82^{a}
WSB	18.32±0.78^{c}	2.90±0.04^{b}	22.03±4.27^{b}	5.12±0.16^{b}	3.49±0.98^{b}	48.14±6.84^{b}
WSC	19.12±0.16^{b}	2.95±0.06^{b}	20.74±0.59^{c}	6.07±0.09^{a}	3.99±0.86^{b}	47.13± 0.45^{c}
WSD	20.63±0.07^{a}	3.15± 0.06^{a}	19.12±3.80^{d}	6.56±0.6^{a}	4.35±0.01^{a}	46.19±1.73^{d}

Mean with the same superscript in the same column are significantly difference (p<0.05).
Key: WFA = 100% Wheat, WSB=70%wheat/30%soursop flour, WSC=60% Wheat 40%/soursop flour, WSD=50% Wheat50%/50% soursop flour.

Table 2: Energy index of cake from wheat/soursop blends

Samples	% Protein	Energy Kcal/100g	% Fat	Energy Kcal/100g	% Carbohydrate	Energy Kcal/100g	Total Energy (Kcal/100g)
WSA	3.88	34.92	22.52	90.08	53.27	213.08	338.08
WSB	5.12	46.08	22.03	88.12	49.54	198.16	332.36
WSC	6.07	54.63	20.74	82.96	47.13	188.52	326.11
WSD	6.56	59.04	19.12	76.48	45.19	180.76	316.28

Mean with the difference superscript in the same column are significantly difference (p<0.05). Key: WFA = 100% Wheat, WSB=70%wheat/30%soursop flour, WSC=60% Wheat 40%/ soursop flour, WSD=50% Wheat50%/50% soursop flour.

Table 3: Sensory properties of cake produced from wheat/soursop flour blends

Samples	Appearance	Taste	Aroma	Texture	Overall Acceptability
WSA	7.45± 0.94^{a}	7.80^{a} ± 1.15	7.25^{a} ± 0.98	7.35^{a} ± 0.93	7.46^{a} ± 1.01
WSB	6.45 ±1.37^{c}	6.30^{c}± 1.15	6.70^{a} ± 1.37	5.75^{a} ± 0.91	6.52^{b} ± 1.11
WSC	6.35^{b}±1.83	6.25^{bc} ± 1.48	6.65^{b} ± 1.38	5.60^{b} ± 1.35	6.21^{b} ± 1.51
WSD	6.20^{b}±1.07	6.10^{b}±1.10	6.45^{b} ± 1.08	5.55^{b} ± 1.50	6.06^{c} ± 1.36

Mean with the difference superscript in the same column are significantly difference (p<0.05).
Key: WFA = 100% Wheat, WSB=70%wheat/30%soursop flour, WSC=60% Wheat 40%/ soursop flour, WSD=50% Wheat50%/50% soursop flour.

Table 4: Physical properties of cake produced from wheat/soursop flour blends.

Samples	Height (cm)	Diameter (cm)	Weight (g)	Spread ratio
WSA	2.00± 0.00^{c}	5.90±0.14^{a}	38.77±0.04^{c}	2.95±0.07^{a}
WSB	2.30±0.14^{b}	5.70±0.00^{a}	39.37±0.04^{c}	2.48±0.00^{b}
WSC	2.40±0.00^{b}	4.90±0.00^{b}	43.13±0.14^{b}	2.04±0.10^{c}
WSD	2.60±0.28^{a}	4.80±0.28^{b}	45.57±0.00^{a}	1.85±0.09^{c}

Mean with the difference superscript in the same column are significantly difference ($p<0.05$).

Key: WFA = 100% Wheat, WSB=70%wheat/30%soursop flour, WSC=60% Wheat 40%/ soursop flour, WSD=50% Wheat50%/50% soursop flour.

Discussion

The result of moisture content was in line with the results of Yetunde and Chnma (2015) [25] with moisture values ranging from (18.31-21.66). Increase ($p<0.05$) in the moisture content was observed as substitution increased. This agreed with the result reported by Iombor and Banjo (2018) [12] in evaluation of bread production and Mohammed and AbduIrasheed, (2016) [17] in cake made from bambara groundnut and wheat flour. Similar increase was reported by Oforiwa (2012) [19] who noted that moisture content of food is a quality parameter that shows reduction in the shelf life. It is one of the many environmental conditions that support microbial growth and spoilage Sampson, *et al.* (2018) [22]. Yetunde and Chinma (2015) [25], also observed that moisture increased as substitution of cocoyam increased. The increase in ash could be attributed to the mineral content of soursop flour. This study agreed with the findings of Deedam and Mbah, (2020) [7] who noted that soursop flour can enhance minerals needed to support metabolic activities and improve development of the tissues. Ash values were lower than values (2.90-4.46%) recorded by Mohammed and Abdulraheed in proximate composition of cakes made from bambara groundnut and wheat flour. The fat content decreased as substitution of soursop flour increased. The decrease in fat observed may be due to the substitution with soursop flour, which is low in fat. Fruits generally are not good sources of fat except avocado pear. (1omber *et al*., 2014) [13]. Iombor and Banjo (2018) [12] also observed a decrease in fat content of bread substituted with soursop flour from 8.50 to 4.00% as substitution of increased.

There were significant differences

($p<0.05$) in the protein content from 3.88% to 6.56% as substitution increased. This increase could be due to the substitution of wheat flour with soursop flour. Chang *et al;* (2016) [6], Mohammed and AbduIrasheed (2016) [17], Dias *et al;* (2017) [9], reported that soursop has a high protein content of 15.62% as compared to other fruits.

Zabidi and Yunus (2014) [26], added that soursop flour could be utilized in enhancing the protein content of various food products. The protein content of the samples was higher than 3.38 to 4.04% of protein recorded for cakes formulated with wheat and soy flour blends by Sampson *et al*., (2018) [22]. The values were lower than the values reported (9.50 to 16.80%) for cakes produced from Bambara groundnut and wheat by Mohammed and AbduIrasheed (2015). Cake samples had an increased in crude fibre with soursop flour increase. This implied that soursop is a rich source of fibre and its utilization to produce cake will be of health benefits such as reduced constipation and ease in digestion. Values recorded was higher than the values (0.17-0.86%) reported by Mohammed and Abdulrasheed (2016) [17], Iombor and Banjo (2018) [12] also reported increase in crude fibre content of bread (2.45 to 2.85%) on substitution with soursop flour. The increase in the ratio of soursop flour led to the decrease in the carbohydrate content of the cake samples. The result was not in line with Sampson *et al*., (2018) [22] who reported an increased in carbohydrate as substitution of soy flour increased with contents ranging from 45.50% to 60.00%. Olatunde *et al*., (2019) [20] reported an increase in cakes produced from blends of pigeon pea, sweet potatoes/wheat flours (40.12-45.07%) and supports the findings of this study.

Sensory result of the Cake

Appearance of the control sample was most preferred with mean score of 7.45 while sample substituted with 30% soursop flour (WSD) was the least (5.15). Appearance of the control sample was significantly

($p<0.05$) different from all others. For taste, the control sample was most preferred with mean score of 7.80 while sample substituted with 50% WSD was least preferred with mean score of 5.30. Taste of samples substituted with 30 and 40 were significantly similar ($p<0.05$). A decrease in the taste of the cake was observed on substitution with 50% soursop flour, the decrease in mean taste scores may be because of sweet-sour taste of soursop fruit which may have resulted to changes in the taste of the cake (Deedam and Mbah, 2020, Olatunde *et al*., 2019) [7, 20]. Texture and aroma of the cake samples ranged from 5.45 to 7.35 and 6.20 to 7.25 with control samples as most preferred for both texture and aroma, while sample substituted with 50% WSD was observed for decrease in the texture. Similarly, aroma and texture of samples from 30% WSB, 40% WSC and 50% WSD were significantly ($p<0.05$) similar. Substitution with soursop flour led to a significant ($p<0.05$) decrease in mean aroma and texture scores of the cake. The decrease in texture might be attributed to the high moisture content of soursop flour as reported by (Deedam and Mbah, 2020; Sampson *et al*., 2018) [7, 22] which may have led to the loss of texture of the cake as substitution increased.

Overall acceptability of the cake ranged from 5.52 to 7.46 with control sample as most preferred and sample substituted with 50% WSD as the least. Overall acceptability of samples substituted with 30% and 40% WSC were significantly ($p<0.05$) similar. The appearance, taste, aroma, and texture of the blend constituents contributed to the overall acceptability of the cake samples. The mean sensory scores from this study therefore suggest that acceptable cake product can be formulated with soursop flour at levels up to 30%. Result of the energy content of the cake showed that sample B had the highest Kcal/10g (332.36) apart from a (338.08Kcal/100g). The result of the physical properties of the cake shows that height, diameter, and weight of the cake samples ranged from 2.00 to 2.6cm, 4.8 to 5.9cm and 38.77 to 45.57g respectively. The lowest value of height (2.00cm), weight (38.77g), diameter (4.8cm), were obtained. The highest diameter of the cake was 5.9cm for control sample because of the bulk density of wheat flour. The highest weight of the cake was 45.57g for cake sample from wheat flour of 70% and 30% of soursop flour because of the moisture content of soursop flour

(Deedam and Mbah, 2020, Mohammed and Abdulrasheed, 2016) [7, 17].

Conclusion

This study revealed that substitution of soursop in cake preparation showed that there was increased in ash, protein and fiber in the formulated samples. Soursop flour can be utilized in food production with regards to protein and ash enhancement. The proximate composition of the cake showed a high significance difference in nutritional values on the samples with regards to appearance, taste and aroma and overall acceptability. It was recommended that a proportion of soursop flour can be utilized for snacks production for fortification of wheat flour and use of local plants. Despite the changes in colour, texture and appearance, the protein, ash and fiber contents of the product increased substitution of soursop flour.

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