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Nutrient Composition and Sensory Qualities of *Hibiscus Sabdariffa* (Sorrel) Candy

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Abstract: *Candies which are sugar confectionaries are known to be poor nutritionally. Thus, this study aimed to improve nutritional quality of candy by inclusion of Hibiscus sabdariffa extract.Candy was produced with 5% and 10% H. sabdariffa aqueous extract respectively. The nutrient composition and antioxidant activities of the samples and that of the commercial candy were determined and sensory qualities were evaluated using 10-membered panel. Data generated were subjected to one-way analysis of variance and means were separated using Duncan multiple range tests.Nutrient composition of the samples was significantly different with sample containing 10% of H. sabdariffa having the highest protein (4.53 % ± 0.06), crude fat (1.94 % ± 0.02), crude fibre (0.026 % ± 0.02), ash (0.94 % ± 0.02), gross energy (0.74 kcal/g ± 0.03) and vitamin C (1.15 % ±0.02) content. While the commercial sample was significantly different in moisture (3.05 % ± 0.15) and carbohydrate (90.31 % ± 0.06) content. There was significant difference in the antioxidant properties with samples containing H. sabdariffa being significantly different from the commercial candy sample. The phenolic content was 6.82 ± 0.03, 6.49 ± 0.03 and 1.21 ± 0.03, DPPH % scavenging activity was 3.81 ± 0.03, 3.38 ± 0.04 and 1.09 ± 0.02 while the reducing power was 0.17 ± 0.00, 0.16 ± 0.00 and 0.09 ± 0.00 for candy containing 10 % H. sabdariffa, 5 % H. sabdariffa and the commercial candy respectively. The H. sabdariffa candies compared to the commercial candy were not significantly different in sensory qualities except in texture. Addition of H. sabdariffa aqueous extract significantly increased the nutritional content and antioxidant activitiesof candy with acceptable sensory properties.*

Keywords: *Hibiscus sabdariffa Candy Nutrient Antioxidant activities Quality*

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I. Introduction

Candy can be described as a type of confectionary that features sugar as a principal ingredient and belongs to the category called sugar confectionary. Candies are available in a wide variety of textures, from soft and chewy to hard and brittle. Candy is made by dissolving sugar in water or milk. The type of candy depends on ingredients, sugar concentration, and the size of the sugar crystals, aeration, temperature, colour and type of sugar used. Candy is a convenient food usually eaten casually and despite that its nutritional benefit is hardly discussed, its consumption is on the increase going by the rate of emergence of new candy industries and different varieties of candy products in the market[1]. New trend in candy making is inclusion of natural ingredients of plant origin with health benefits.

Hibiscus sabdariffa is a multi-use plantand possible inclusion of its calyx in the production of jelly, jam, juice, wine, syrup,gelatin,pudding,cake, ice cream and flavouring has been demonstrated. *H. sabdariffa* has also been reported to have medicinal properties and its health benefit is profound when different reports about it are considered[2,3]. As a result of its health benefits,itis being utilized in nutraceuticals, cosmeceuticals and pharmaceuticals. The commercially important part of *H. sabdariffa* plant is the fleshy calyx surrounding the fruit; its brilliant red colour and unique flavour make it a valuable food product. Nnam and Onyeke[4] and Shruthi et al.[5] found that the calyx of different varieties of *H. sabdariffa* contain appreciable amount of carbohydrate, protein, fat, ash, iron, ascorbate, carotene, total phenol, flavonoids anhocyanin and antioxidant activities.The whole plant can be used as beverage, but the commonest way of utilizing the plant is the use of its calyces to make drink. Dried calyces can be soaked in water to prepare a colourful cold drink or may be boiled in water and taken as a hot drink. The juice from the calyces is claimed to be a health-enhancing drink due to its high content of vitamin C, anthocyanins and other antioxidants [6,.7].In vitroandin vivostudies as well as some clinical trials demonstrated antibacterial, anti-oxidant, nephro- and hepato-protective,renal/diuretic effect, effects on lipid metabolism (anti-cholesterol), anti- inflammatory, anti-diabetic and anti-hypertensiveeffects of the calyx extract among others[8,9,10].

Nutritional and medicinal properties of *H. sabdariffa* is well established and there have been several attempts to use *H. sabdariffa* as colouring agent in candy but there is dearth of information on the nutrient composition and functional properties of candy containing *H. sabdariffa.*

II. Material And Methods

The research was carried out in Babcock University, Nigeria between February and April 2018.

Materials and equipment used

H. sabdariffa calyces (dark red type), glucose syrup, granulated sugar and flavour(butterscotch) with commercial candy were obtained from the market in Ilishan Remo, Ogun State. The equipment used include the following; non -stick pan and spoon, thermometer, napkins, measuring cylinder, measuring scale, cooling pans.

Extraction of the calyx

The *H. sabdariffa* calyces were rinsed thoroughly with water before extraction. The calyx was extracted by cold maceration which involved soaking for 4h using water at room temperature[11]. Percentage of the calyx in water was 5 % (w/v) which was obtained by extracting 25g of *H. sabdariffa* calyx in 475ml of water[12,13].

Candy production

For candy production, sugar syrup was first prepared by adding 1600 g of granulated sugar to 80 ml of water and boiling in the non-stick pan over moderate heat until the temperature was 143°C for 15min[14]. Two candy samples were produced, sample 1 contained 10% *H. sabdariffa* extract, while sample 2 contained 5 % *H. sabdariffa* extract. The compositions of the two samples are as follows;

Sample 1 (10 % *H. sabdariffa*)	Sample 2 (5 % *H. sabdariffa*)
50 ml of *H. sabdariffa* extract	25 ml of *H. sabdariffa* extract
100 g of glucose syrup	100 g of glucose syrup
345 ml of sugar syrup	370 ml of sugar syrup
5 ml of butterscotch flavor	5 ml of butterscotch flavor

The method of Philipswas adopted for the production of the candy with little modification[14]. All the ingredients were added together in non-stick pan and allowed to boil for 15min. After which the boiled candy was poured into cooling pan and allowed to cool rapidly for 1½ h. Then the candy was cut into pieces, packed in sealed polythene and kept in the refrigerator until analysis.

Analyses

Nutritional composition

The moisture content, crude protein, carbohydrate content, crude fat, ash content, crude fibre and vitamin C content of the sorrel candy samples and commercial candy were determined.Samples were analyzed chemically according to the official methods of analysis described by the Association of Official Analytical Chemist[15]. All analyses were carried out in triplicate.

Antioxidant activities

The phenolic content was determined by the method described by Singleton and Rossi[16], the diphenyl 1-2-picrylhydrazyl(DPPH) % scavenging activity by Mensor et al.[17]while the method of Oyaizu[18] was adopted for determination of the reducing power.

Total phenolics evaluation

Folin-Ciocalteuprocedure by Singleton and Rossi[16] was used for the determination of total phenolic content of the candy samples. Calibration curve was prepared using 500 mL of aqueous solution of gallic acid mixed with 250 mL of Folin-Ciocalteu reagent (1.0 N) and 1250 mL of sodium carbonate (75 g/L) resulting in final gallic acid concentrations of 0.57, 1.14, 2.28, 3.42, 4.56, 5.70 and 6.84 mg/L. Absorbance of the different concentrations was measured after 30 min at 760 nm and at 25 ºC .Dissolved candy samples were submitted to the same procedure. The total phenolics content was expressed as gallic acid equivalents (GAE) in milligrams per gram of extract, using the equation:

GAE (mg/L) = A x D x 7.93 x d

Where A is the sample absorbance, D is the sample dilution, 7.93 is the angular coefficient, and d is the reaction dilution.

DPPH % scavenging activity

The procedure was according to the 2-2- diphenyl- 2 – Picrylhydrazyl, DPPH assay of Mensor*et. al.*[17]. 1ml of 0.3mM of methanolic DPPH solution was added to 0.05ml zobo, made up to 2.5ml with methanol and allowed to stand at room temperature for 30 min (to ensure proper reaction). The absorbance of the mixture was read at 518nm and converted to % Antioxidant Activity using the formula,

$$AA\% = \frac{Abs_{Blank} - Abs_{Sample}}{Abs_{Blank}} \times 100$$

Reducing antioxidant power assay (FRAP)

The antioxidant power of the candy samples was determined by the method of Oyaizu[18]with slight modification[19]. Different concentrations of the candy samples (15–45 µg/mL) in 1 mL of distilled water were mixed with sodium phosphate buffer (2.5 mL, 0.2 M, pH 6.6) and potassium ferricyanide [$K_3Fe(CN)_6$] (2.5 mL, 1%). The mixture was incubated at 50 °C for 20 min. Aliquots (2.5 mL) of trichloroacetic acid (10%) were added to the mixture. The upper layer of solution (2.5 mL) was mixed with distilled water (2.5 mL) and $FeCl_3$ (0.5 mL, 0.1%), and the absorbance was measured at 700 nm in a spectrophotometer. Increased absorbance of the reaction mixture indicates an increase of reduction capability.

Sensory quality

The sorrel candy samples were compared with the commercially produced candy and a ten- membered untrained panel which consists of students of Babcock University was used to evaluate the sensory parameters (colour, aroma, texture, sweetness and overall acceptability). The scores were based on a hedonic scale ranging from 1 representing dislike extremely to9 representing like extremely.

Statistical analysis

Data obtained were subjected toone-wayAnalysis of Variance (ANOVA) at $P< 0.05$ and means were separated using the Duncan multiple range tests (SPSS 20.0).

III. Results

The results of the nutrient composition of the sorrel candy samples are as presented in the Table no 1. The values for the sorrel candy samples and commercial candy rangedfrom 2.67 ± 0.15 – 3.05±0.15 for moisture content, 3.92 ± 0.04 - 4.53 ± 0.06 for protein, 0.14 ± 0.02- 0.26 ±0.02 crude fibre, 1.79 ± 0.02- 1.94 ± 0.02 crude fat, 0.78 ± 0.01- 0.94 ± 0.02 ash content, 89.64 ±0.06-90.31± 0.08 carbohydrate, 0.65±0.02 - 0.74± 0.03 gross energy and 0.86 ± 0.01- 1.15 ± 0.02 for vitamin C. The values were significantly significant at $P<0.05$.

Table no 1: Nutrient composition of sorrel candy

Nutrients	Samples		
	A	B	C
Moisture Content (%)	$2.67^{c} \pm 0.15$	$2.73^{b} \pm 0.02$	$3.05^{a} \pm 0.01$
Crude protein (%)	$4.53^{a} \pm 0.06$	$4.23^{b} \pm 0.06$	$3.92^{c} \pm 0.04$
Crude fat(%)	$1.94^{a} \pm 0.02$	$1.85^{b} \pm 0.03$	$1.79^{c} \pm 0.02$
Crude fibre(%)	$0.26^{a} \pm 0.02$	$0.20^{b} \pm 0.02$	$0.14^{c} \pm 0.02$
Ash content(%)	$0.94^{a} \pm 0.02$	$0.84^{b} \pm 0.02$	$0.78^{c} \pm 0.01$
Carbohydrate(%)	$89.64^{c} \pm 0.06$	$90.12^{b} \pm 0.04$	$90.31^{a} \pm 0.08$
Gross Energy(kcal/g)	$0.74^{a} \pm 0.03$	$0.65^{b} \pm 0.02$	$0.65^{c} \pm 0.02$
Vitamin C(%)	$1.15^{a} \pm 0.02$	$1.01^{b} \pm 0.04$	$0.86^{c} \pm 0.01$

Means with the same superscript across the row are not significantly different ($p<0.05$).
A= sorrel candy with 10% of *H. sabdariffa*
B= sorrel candy with 5% of *H. sabdariffa*
C= commercial candy

Antioxidant properties of the sorrel candy

The phenolic content was 6.82 ± 0.03, 6.49 ± 0.03 and1.21 ± 0.03, DPPH % scavenging activity was 3.81 ± 0.03, 3.38 ± 0.04 and 1.09 ± 0.02 while the reducing power was 0.17 ± 0.00, 0.16 ± 0.00 and0.09 ± 0.00 for candy containing 10% *H. sabdariffa*, 5% *H. sabdariff*a and the commercial candy respectively. The results are as presented in Table no2.

Table no 2: Antioxidant properties of sorrel candy

Antioxidant activity	Samples		
	A	B	C
Total phenolic (mg gallic acid eq/g)	$6.82^{a} \pm 0.03$	$6.49^{b} \pm 0.03$	$1.21^{c} \pm 0.03$
DPPH(µ Mole Troloxeq/g)	$3.81^{a} \pm 0.03$	$3.38^{b} \pm 0.04$	$1.09^{c} \pm 0.02$
Reducing power	$0.17^{a} \pm 0.00$	$0.16^{b} \pm 0.00$	$0.09^{c} \pm 0.00$

Means with the same superscript across the row are not significantly different (P<0.05).
A= sorrel candy with 10% of *H. sabdariffa*
B= sorrel candy with 5% of *H. sabdariffa*
C= Commercial candy

Sensory qualities of the candies

The result of the sensory evaluation of the sorrel candy samples are as presented in table 3. Values for colour were between 7.10 ± 2.13 and 8.10 ± 1.10, aroma was 6.70± 0.56 to 8.10± 1.69. While for texture and sweetness it was 5.20± 2.31 - 7.70 ± 2.26 and 7.00± 2.11- 7.60 ± 1.64 respectively.The overall acceptability for the sorrel candy samples ranged from 6.90 ± 1.10 - 7.60 ± 1.17 while for the commercial sample it was 7.90 ± 2.18.

Table 3: Sensory qualities of the candies

Samples	Colour	Aroma	Texture	Sweetness	Overall Acceptability
A	$8.10^{a} \pm 1.10$	$8.10^{a} \pm 1.69$	$5.90^{ab} \pm 1.79$	$7.50^{a} \pm 1.71$	$7.60^{a} \pm 1.17$
B	$7.10^{a} \pm 2.13$	$6.70^{a} \pm 0.56$	$5.20^{b} \pm 2.31$	$7.00^{a} \pm 2.11$	$6.90^{a} \pm 1.10$
C	$7.70^{a} \pm 1.70$	$7.50^{a} \pm 1.82$	$7.70^{a} \pm 2.26$	$7.60^{a} \pm 1.64$	$7.90^{a} \pm 2.18$

Means with the same superscript along the column are not significantly different (p<0.05).
A= sorrel candy with 10% of *H. sabdariffa*
B= sorrel candy with 5% of *H. sabdariffa*
C= Commercial candy

IV. Discussion

The results of the nutrient composition showed that increased concentration of *H. sabdariffa* extract increased the nutrient composition of the candy with sample containing 10% of *H. sabdariffa* having the highest values. The nutrient composition of the two sorrel candy samples produced were significantly different (P< 0.05) from one another and from the commercial candy. The sorrel candy samples were significantly different in protein content, crude fat , crude fibre, ash content, energy and vitamin C. This finding collaborate the reports of Puro et al.[20]and Kilimaet al.[21] that blending of sorrel juice with tropical fruit juices give products with high nutritional value and functional activity. Also in support of this finding is the results obtained by Manjula and Suneetha[22] for the inclusion of pumpkin in candy.

However, the moisture content of the sorrel candy samples and the commercial candy (2.65-3.05%) was low compared to 77.3- 92.5% reported by Ifesanet al.[23] and Mamatha and Prakash[24].

Significant difference (P<0.05) exist in the antioxidant properties of the candies with candy samples containing *H. sabdariffa* extract having higher antioxidant properties[21,22].

The antioxidant activities increased with increased *H. sabdariffa* extract concentration which corroborates the report of Soto et al.[25] of the antioxidant activities of *H. sabdariffa*. The phenolic content, DPPH % scavenging activity and reducing power for sample containing 10% *H.sabdariffa* was the highest compared to the control and candy containing 5 % *H. sabdariffa.* The report of Clydesdale et al.[6] and Pougetet al.[7,26]described the antioxidant property of *H. sabdariffa* which collaborate these findings.

However, when the mean scores for sensory evaluation was considered the sorrel candies were not significantly different from the commercial candies in colour, aroma, sweetness and overall acceptability[22]but there was significant difference in the texture.*The* report of Mamatha and Prakash[23] for tamarind candy also suppotr this finding.The comparative assessment between the commercial candy and the candies containing *H. sabdariffa* could be attributed to the conversion of polyphenols(which includes anthocyanin) into compounds which are important in determining the organoleptic properties like appearance and taste of foods and beverages during processing[27, 28].

Though, anthocyanin is relativelyunstable and because of its high reactivity it may beeasily degraded and form colourless or undesirable brown– coloured compounds during extraction processing andstorage [29]. However, different methods are been researched for stabilization of anthocyanin and many are with substantial success[30]. With success in the stabilization of anthocyanin, inclusion of *H. sabdariffa* in candy will be highly beneficial.

V. Conclusion

Inclusion of*H. sabdariffa*aqueous extractproduced candy withbetter nutritional content and acceptable sensory qualities. The candy also had increased antioxidant activities which is beneficial for protection against diseases.

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