

Nutritional Composition and Sensory Acceptance of Boiled Breadnut (*Artocarpus camansis* Blanco) Seeds

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Abstract: Breadnut seeds (*Artocarpus camansis* Blanco) in some Caribbean countries are not consumed, but discarded. This study assessed the nutritional composition, utilization and sensory acceptance of boiled breadnut seeds by two groups of panellists. Two composite samples of fresh and boiled breadnut seeds were pooled from 6 vendors for nutrient analysis. There were significant ($p < 0.05$) differences in nutritional composition between raw and boiled breadnut seeds. A serving of 30 g boiled breadnut seeds provided 202 kJ (50 kcal) of total energy based on an 837 kJ (2000 kcal) diet and based on daily reference values was a good source of dietary fiber. From the structured survey, all Trinidadian panelists were more acquainted with consumption of boiled breadnut seeds than panelists from other Caribbean islands. Boiling (90.2%) and currying (74.8%) were two popular methods of preparation for breadnut seeds by Trinidadians. The overall sensory acceptance of boiled breadnut seeds was significantly ($p < 0.01$) higher (liked slightly to moderately) by Trinidadian panelists compared to other Caribbean panelists (neither liked nor disliked to slightly) due to familiarity. Both groups of panelists expressed high intent to purchase.

Key words: *Artocarpus camansis* Blanco, utilization, boiled breadnut seeds, consumption familiarity, sensory acceptance, nutritional composition

INTRODUCTION

The breadfruit is known in two forms as the seedless variety (*Artocarpus altilis* Fosberg), synonymous with *Artocarpus communis* and the seeded variety (*Artocarpus camansis* Blanco)^[1,2] The seeded variety of breadfruit is commonly known as breadnut (English) or pana de pepita (Spanish)^[3] kelur or kelor (Indo-Malaysia), kamansi (Philippine), chataignier (French), castaña (Guatemala and Honduras), castaño de Malabar^[4] and chataigne (Trinidad)^[2,5]. In 1793, the seedless breadfruit, *Artocarpus altilis* Fosb was initially transported to the British West Indies. It took some time before the local inhabitants acquired a taste for the fruit on the islands, before it became an integral part of their diet^[6]. The breadnut was introduced into the Caribbean region in 1782, eleven years before its seedless form^[2]. There are many constraints its commercial utilization of the breadnut fruit due to morphological characteristics of the tree, being tall trees make harvesting difficult, and poorly harvested fruits have shortened shelf-life and poor yield due to diseases under tropical ambient conditions. Fruits of the breadfruit and breadnut are seasonal with a shelf life of 2-3 days, after which they ripened and then deteriorate rapidly^[7,8]. Sankat and Harrynanan^[9] studied on the refrigerated storage of partially immature firm green stage seeded breadnut and found that fruits in polyethylene bags at

10°C showed a reduction in brown color development up to 25 days.

The breadnut fruit is spiny, being covered with narrow, conical and elongated processes, which are 5 -12 mm long with elongated stigmas^[10]. Seeds produced are numerous, ranging from as few as 12 to as many as 150 per fruit^[3,11,12] and are embedded in the fleshy pulp. Each seed contains an outer fairly rigid membrane (the aril) and an inner fragile paper-like membrane which envelope, the fleshy white, edible portion of the seed^[3]. Breadnut seeds are thin-walled, have a thickness of 1-2 cm and are irregularly compressed and embedded in the pulp^[10].

Limited information is available on the chemical composition of breadnut seeds^[3,13], particularly for boiled breadnut seeds and the data appear variable. The breadnut seeds are an important source of calories, being high in carbohydrates but low in fats and proteins^[10] and contain high quantities of calcium, potassium, iron and niacin compared to published values for other tree nuts^[3].

Quijano and Arango^[11] reported on the composition of the breadnut seed in Colombia and have recommended increased cultivation and consumption of the seed in order to help alleviate nutritional deficiency in many of the developing areas of the world. The composition of canned breadnut seeds in brine was reported as 3.8% protein, 1.6% fat, 4.6% ash, 24.8% carbohydrates and 65.2% moisture^[14].

Breadnut seeds are popular only in some Caribbean islands such as Trinidad and Tobago and Guyana where the immature seeds are curried and the mature seeds are boiled in salted water, with the shell (aril) and underlying membrane^[5]. Boiled or roasted breadnut seeds are delicious with a flavor resembling that of chestnuts^[13,15] and boiled seeds make an excellent snack^[1]. Objectives of present study were to assess the nutritional composition, utilization and sensory acceptance of boiled breadnut seeds by two groups of panelists.

MATERIALS AND METHODS

Nutritional analysis: Mature breadnut seeds were purchased from 6 retail vendors located at randomly selected markets in Chaguanas and Port-of-Spain, Trinidad, West Indies. Approximately 200 seeds collected from six vendors were pooled to form two composite samples, with two analytical duplicates from each. Each composite sample comprised breadnut seeds which were purchased from three vendors and were used for separate analysis of fresh and boiled breadnut seeds. Approximately 35 breadnut seeds per trial to determine the volume of water required for boiling, quantity of salt to be added and approximate boiling time for the desired taste and texture. Breadnut seeds were removed from pulp of the fruit, washed in water and then boiled in de-ionized distilled water in a ratio of 6: 1, with 0.07 % salt for 20-25 min. The inner and outer membranes of the fresh and boiled seeds were manually removed. For boiled seeds the seed coat and aril were removed after cooking. Breadnut seeds represent 30.1 - 46.8% of the entire fruit, the rest, comprising the pulp, skin and core and the weight could vary 6.5 -7.3 g for the entire seeds or 5.2-6.0 g for seeds without skin^[3].

All proximate analysis were conducted according to the official procedures of AOAC^[16]. For dry matter (925.40), gravimetric ash and organic matter (935.40), ether extract (948.22), total dietary fiber (991.43), crude protein (950.48), Vitamin C by the 2, 6 -Dichloroindophenol titrimetric method (967.21). Phosphorus was determined by the spectrophotometric method (986.24), while Na, K, Ca, Mg, Zn, Cu, Mn and Fe were analysed by flame absorption spectroscopy method (985.35; AA-800 F-Atomic Absorption Flame Emission Spectrophotometer, Varian Techtron Pty Ltd, Victoria, and Australia according to method on the ash content. Total carbohydrate was calculated by difference between 100 and the sum of percentages of moisture, crude protein, total fat as described by Jeon^[17]. according to the Food and Drug Administration Nutrition Labeling and Education Act^[18]. Method validation and analytical quality control were

monitored through the analysis of standard reference material and duplicate analysis of digest, which agreed between 94 and 98% of each other. Each analytical sample of raw and boiled breadnut seeds was done in duplicate for macronutrients (n=8) and triplicate for micronutrients (n=12). Food energy was expressed as both kiloJoules (kJ) and kilocalories (kcal). Estimated energy content was calculated for carbohydrates, protein, and fat using 17.7, 16.7 and 37.7 kJg⁻¹ respectively. The caloric factors were based on the Atwater system of 4.0 kcal g⁻¹, 4 kcal g⁻¹ and 9 kcal g⁻¹ respectively for carbohydrate, protein and fat respectively was adapted from Paul and Southgate^[19] as described by Nielsen^[20].

Survey on utilization: Panelists were asked to indicate whether they had consumed breadnut fruit and its seeds and the preparation methods for breadnut seeds (Table 2).

Sensory evaluation: Sensory evaluation was conducted under controlled environment at the Caribbean Food and Nutrition Institute. Untrained panelists were recruited from staff and students of the University of the West Indies. In the sensory evaluation session, each panelist was provided with 3 boiled breadnut seeds ~ 18 g in a random three digit-coded disposable cup. Panelists were asked to visually examine and then taste the boiled breadnut seeds. They were asked to record their evaluation by marking on a series of 15 cm line scales anchored with a positive descriptor: 'like extremely', 2.5 cm in from the far right end of the line and the negative descriptor 'dislike extremely', 2.5 cm in from the left end of the line^[21]. The middle (5 cm mark from end) was labeled as neither liked nor disliked. The subjects were asked to place a vertical line across the horizontal line at the place that best reflected the liking of the sensory attribute. The response categories were appearance, color, texture, sweetness, flavor and overall acceptability. Panelists recorded their choices directly by marking on the lines. Scores for each of the sensory attribute were determined by measuring the distance in centimeters from the negative (left) descriptor to the mark made by panelists. Also, the category marks were converted into 9-pt Hedonic scores as 9-like extremely; 8-like very much; 7-like moderately; 6-like slightly; 5-neither like nor dislike; 4-dislike slightly; 3-dislike moderately; 2-dislike very much and 1- dislike extremely^[22]. Also, panelists were asked to indicate their purchase intent for boiled breadnut seeds (yes or No)

Analysis of data: All data were analyzed by Minitab statistical package (Minitab, Version 14 for Windows

2004, Enterprise State College, Philadelphia, USA). The General Linear Model (ANOVA) was used to determine differences in the rating of sensory attributes by Trinidadian and Caribbean panelists. Two sample T test was used to determine the difference in nutritive composition (macro and micronutrients) between fresh and boiled breadnut seeds. All compositional means are represented with standard errors. Sensory scores were represented by a spider plot (1997, Microsoft Excel, Microsoft Corp.) to visualize the significant differences of mean sensory attribute scores.

RESULTS AND DISCUSSION

Nutritive composition: Table 1 shows the proximate composition of boiled and fresh breadnut seeds on a fresh weight basis. There were significant ($p \leq 0.05$) differences between fresh and boiled breadnut seeds in crude fat, total dietary fiber, total carbohydrate, K, Ca and Zn. A study of the nutritional value of breadnut seeds showed that they were a good source of protein (8%) and were low in fat (3-5%) compared to nuts such as peanuts or almonds which contain 50-60% fat^[23]. The composition (w/w) of the raw breadnut seeds was reported as 11.5% moisture, 13.3% crude protein, 6.2% crude fat, 2.5% crude fiber and 3.7% ash^[3]. Oshodi *et al.*,^[24] reported that breadnut flour contained high quality protein with essential amino acid of 55.1%, which is comparable to soya flour and egg, which is better than nuts and oil seeds. The most predominant amino acids in breadnut are valine, glutamic acid and aspartic acid while

the limiting amino acids are methionine and cysteine. Tumaalii^[25] reported that the essential amino acid content of the breadnut seed was high compared to other vegetables. Quijano and Arango^[11] reported a protein content of 19.0% for seeds of the Colombian seeded breadfruit. A lower protein value of 13.% was given by De Bravo *et al.*^[3] which they attribute to differences in the so called 'variety' of the breadnut or to some other differences in the breadnut fruits from different locations. Protein values ($\text{g } 100\text{g}^{-1}$) were 6.92 ± 0.06 and 6.89 ± 0.09 for raw and boiled breadnut seeds respectively.

De Bravo *et al.*^[3] reported higher mineral values ($\text{mg } 100\text{g}^{-1}$) for Ca (70), K (1620), Fe (8.7) and P (10) except for Mg^[18]. These variations may have been due to differences in varieties of breadnut fruit or cultural practices in the propagation of the fruit. Generally, breadnut trees in the Caribbean are not grown in abundance by individuals in backyard gardens and no systematic or serious consideration would have been given to water, fertilizer and other requirements.

Table 1 shows the nutrition facts for a 30 g serving of boiled breadnut seeds according to 21CFR 101.12 NLEA^[18]. A serving size was low in fat (3 g or less per 50 g reference amount) and sodium (140 mg or less per 50g reference amount) but good in dietary fiber and Vitamin C (10% DV). Generally panelists had 2 servings (~ 60g) of boiled breadnut seeds at oneeating occasion and, thus, providing a good source (10% or more daily value) of K, Mg, Cu and Mn. Comparing the nutrition facts for a serving (28g) of our raw breadnut seeds to other nutrition facts^[28] indicated similar values for total fat (2g), protein (2g) and Vitamin C (3%) based on a daily value of 837 kJ (2000 kcal).

Table 1: Proximate nutritive composition and of fresh and boiled breadnut seeds

Components	Fresh breadnut seeds	Boiled breadnut seeds	p value	* %Daily value for boiled breadnut seeds Serving size <1/4 cup (30 g)
Macronutrients mg /100g n=8				
Moisture	60.15±0.75	61.59±1.41	0.05	-
Crude protein	6.92±0.06	6.89±0.09	0.06	4
Crude fat	3.65±0.08	4.20±0.08	0.00	2
Ash	3.62±0.28	3.42±0.20	0.53	-
Total dietary fiber	10.99±0.37	8.30±0.65	0.03	10
Total carbohydrate by difference	25.67±0.30	23.90±0.35	0.04	2
Micronutrients mg 100g ⁻¹ n=12				
Na	119.18±3.99	204.61±13.61	0.42	3
K	599.97±31.19	734.62±10.95	0.03	6
Ca	10.70±0.33	9.62±0.19	0.03	*
Fe	1.24±0.04	1.18±0.04	0.33	2
P	4.30±0.11	4.28±0.03	0.08	*
Mg	44.78±0.42	46.66±0.77	0.21	5
Zn	0.74±0.02	0.69±0.01	0.04	*
Cu	0.34±0.01	0.34±0.00	0.98	6
Mn	0.34±0.02	0.36±0.02	0.05	6

Means ± SE

Total carbohydrate difference based on section 101.9 (C) (6) NLEA^[18]

*Contains less than 2% of the daily value of these nutrients based on a 837 kJ (2000 Kcal) diet

Total calories per serving size of boiled breadnut seeds: 202 kJ (50 kcal); Calories from fat: 47 kJ (10 kcal)

Table 2: Demographics of panelists and utilization methods for breadnut seeds

Demographics of panelists	Trinidadian(%)	Caribbean(%)
Age group		
16-25 yrs	36.6	74.3
26-35 yrs	34.2	20.0
> 35 yrs	29.3	5.8
Nationality	100	-
Trinidadian	-	58.2
Jamaicans	-	18.6
Barbadian	-	9.3
Dominican	-	7.0
St. Lucian	-	2.4
St. Vincentian	-	2.4
Antiguan	-	2.4
Guyanese	-	2.4
Utilization questions	Responses (% by panelists)	
Is this the first time you have ever seen or heard of the breadnut fruit? Yes	0	66.0
Have you ever eaten seeded breadnut fruit? Yes	86.0	14.0
Have you eaten only the breadnut seeds? Yes	100.0	34.0
In what preparation form/s have you eaten the breadnut fruit or breadnut seeds?:		
boiled	90.2	32.0
curried	74.8	0
roasted	9.9	0
boiled and curried	68.0	2.0
other	2.0	0
no preparation form	0	64.0
For those who consume boiled breadnut seeds, how before, how often per year are they eaten ?		
once	0	34.0
> once	100	2.0
After sensory evaluation of boiled breadnut seeds, would you purchase these seeds? Yes	82.0	70.0

Utilization: Table 2 shows that the Caribbean panelists comprised of Jamaicans (58.2%), Barbadians (18.6%), Dominicans (9.3%), St. Lucians (7.0%), St. Vincentians (2.4%), Antiguans (2.4%) and Guyanese (2.4%) who were students of the University of the West Indies. While most Trinidadian panelists had consumed the breadnut fruit (86%) and breadnut seeds (100%), only 14% of Caribbean panelists had eaten breadnut fruit and 34% the breadnut seeds (Table 1). Also, the frequency of consumption of breadnut seeds was more than once per year for all Trinidadian consumers. Boiling of breadnut seeds was practiced by Trinidadian (90.2%) and Caribbean (32.0%) panelists. Currying of breadnut fruit and seeds was popular among Trinidadian panelists only. This could have been due to the strong East Indian population influence (~ 40% of the population of 1.3 million persons in Trinidad and Tobago) in the cuisines.

Sensory acceptance: Figure 1 shows significant differences ($p \leq 0.01$) in sensory scores for boiled breadnut seeds by the two groups of panelists.

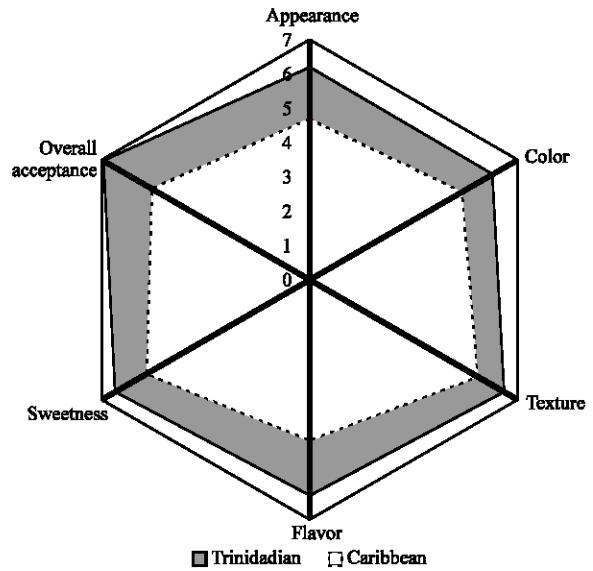


Fig. 1: Sensory scores ($p < 0.01$) for boiled breadnut seeds given by two groups of panelists

Trinidadian panelists, who were familiar with consumption of breadnut seeds rated all sensory attributes with higher hedonic scores (6-7: liked slightly to moderately) for appearance, color, texture, flavor, and sweetness compared to the Caribbean panelists (4-6: disliked slightly to liked slightly). These differences may have been associated to the unfamiliarity of the breadnut seeds by the Caribbean panelists, as the trees are not commonly found in some islands. In Jamaica, Trinidad and Tobago, the Windward islands and Barbados, breadfruit trees are popular for backyard planting in urban areas and scattered trees are found island-wide^[27]. The boiled breadnut seeds were rated with higher ($p < 0.01$) overall sensory acceptability score of liked slightly to moderately (6.95 ± 0.21) by Trinidadian consumer panelists compared to neither liked nor disliked to liked slightly (5.30 ± 0.21) by Caribbean panelists. Lowest sensory attribute rating was given to appearance (4.70 ± 0.23) and flavor (4.71 ± 0.23) both being disliked slightly to neither liked nor disliked by Caribbean panelists.

CONCLUSIONS

The higher ($p \leq 0.05$) overall sensory acceptance score given to boiled breadnut seeds by Trinidadian consumer panelists compared to the Caribbean panelists could be linked to the familiarity of consumption by the former. However, after sensory evaluation, both groups of panelists indicated they would purchase the boiled breadnut seeds ($\geq 70\%$). A 30 g serving of boiled breadnut seeds would provide 202 kJ (50 kcal) of total energy, of which 47 kJ (10 kcal) was from total fat and 120 kJ (29 kcal)

was from protein based on a 837 kJ (2000 kcal). A serving of boiled breadnut seeds was low in fat and sodium and good in dietary fiber.

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