

Sensory Evaluation, Shelflife and Nutritional Composition of Breadnut (*Artocarpus camansi*) Cookies

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Abstract Despite its being nutritious and potential uses and food, breadnut (*Artocarpus camansi*) remains underutilized. This study aimed to develop breadnut products for its extensive use and specifically aimed to determine the acceptability of chocolate cookies formulated from the mixtures of breadnut seed flour and all purpose flour and the shelf life of the most acceptable cookie formulation. The cookies were prepared in different ratios of all purpose flour and breadnut seed flour in percent (0:100, 25:75, 50:50, 75:25, 100:0) with 100% all purpose flour served as the control. The five formulations were evaluated by the 50 consumers as to color, odor, crispiness, flavor and general acceptability using descriptive 9-point Hedonic scale. And the most acceptable cookies were evaluated for storage quality which was done for six months to determine its shelf life. Results showed that all formulated breadnut cookies were acceptable, scoring 6.5 based on the 9-point hedonic scale. The cookie with 50% BSF was the most acceptable based on general acceptability score. There were no significant ($p \leq 0.05$) differences on the sensory properties being tested to the cookies made from BSF up to 75 %. The formulated cookies has significant amount of nutrients needed by the body. It is safe with guaranteed desirable sensory properties for six months. It is recommended for consumption and commercialization.

Keywords: *Staple crops, underutilized crop, blended flour, sensory evaluation, storage study*

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INTRODUCTION

Development of food products relies so much on the staple crops which may face major problems in the near future. Thus, divergence from these crops will lead to the utilization of the underutilized crops which are potentially valuable as human foods and play a vital role towards obtaining solution of food security (Mayes et.al, 2012).

Breadnut (*Artocarpus camansi*) commonly known as “kamansi” in the Philippines has been neglected, underutilized and underdeveloped. Consequently, its utilization for a long time has been limited to vegetable stew with coconut milk and boiled seeds only. Its fruit contains numerous seeds

which have been reported to be a good source of protein, carbohydrates, and minerals as documented by Ragone (2003), Negron de Bravo et al. (1983), and Quijano & Arango (1981). Indeed Quijano and Arango 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. In addition Adeleke and Abiodun (2010) enumerated the amino acids and fatty acids content of the seeds as follows: The seed was rich in leucine 392 mg/gN and phenylalanine 312 mg/gN but low in tryptophan 24 mg/gN and methionine 95 mg/gN while the principal fatty acid components in the breadnut seeds oil are palmitic 21.4%, linolenic 14.8% and oleic 12.4%.

Breadnut is native and abundant in the Philippines particularly in Cagayan, Laguna Provinces in Luzon, Leyte and Cebu, Quezon Provinces and Manila (Stuart, 2013). However, breadnut fruit has a shelf life of 2-3 days after they ripened and they deteriorate rapidly (Williams and Bardie, 2005). Its highly perishable nature results to apparent rotten fruits during its season in the garden and the market (Adeleke and Abiodun, 2010). They further pointed out that the seeds need to be processed to avoid spoilage and wastage during its season.

One of the ways to preserve them is to dry them. The seeds according to Oshodi et al.,(1999) can be used to produce flour, resulting in a product rich in protein, similar or higher than that found in wheat. The use of breadnut seed flour and all purpose flour mixtures in food products like cookies will encourage a widespread use of the underutilized breadnut. Since very limited information is available on breadnut products especially in the Philippines, the utilization therefore of breadnut for food formulation other than the traditional one is imperative.

This study was therefore carried out to formulate chocolate cookies from breadnut seed flour, specifically this aimed to investigate the acceptability, shelf life and the nutritional quality of the formulated cookies.

MATERIALS AND METHODS

Materials

Breadnut seeds were collected from the localities of Badian and Moalboal, Cebu while all

other ingredients such as all purpose flour, sugar, butter, baking powder were purchased from the local market.

Preparation of Breadnut Seeds Flour (BSF)

The seeds were removed from its pulp and washed before roasting and peeling. The peeled breadnut seeds were sliced thinly into chips with a knife. The chips were then placed in a clean container and were sun dried for some days or oven dried until no traces of water was left, and they were then milled into flour using corn mill and then sieved to separate the fine powder from the coarse one.

Preparation of Breadnut Chocolate Cookies (BCC)

Mixture of All purpose flour (APF) and Breadnut seed flour (BSF) in different proportions were used in the formulations of BCC, and all other ingredients were kept constant as shown in Table 1. Procedure used in the formulation was adopted from www.joyofbaking.com with some modifications on the time and temperature of baking.

Butter and sugar were mixed in the bowl of an electric mixer set to 2 for 2-3 min until it became light and fluffy. Eggs and vanilla were added and were mixed for 1 minute. Then the sifted mixture of dry ingredients: flour, cocoa powder, baking powder, and salt were added and were stirred in the egg mixture for 2 min making it complete dough. About 12g of dough dropped in the prepared baking sheets

spacing about 5 cm apart and baked in the preheated oven (356°F) for 20 min and another 10 min with 180°F. The baked cookies were cooled in the baking sheet for few minutes then were transferred to a wire rack to completely cool before placed in an air tight container. The process was repeated for each treatment.

The formulation of breadnut chocolate cookies were made into 5 treatments as shown in table 2 with 100% wheat flour served as control

Sensory Evaluation

Five breadnut chocolate cookie formulations with different ratios of BSF and APF mixtures (Table 2) were subjected to sensory evaluation by the 50 consumers. Each of them was given five coded sample and a score sheet. Five coded samples were evaluated for color, aroma, crispness, flavor and general acceptability utilizing the descriptive test based on 5 point scale and 9-point Hedonic scale for preference test.

Shelf life of the Most Acceptable Breadnut Chocolate Cookies

Eighteen sealed packs (6 for sensory evaluation and 12 for chemical analyses) of 250g of the most acceptable cookie formulation baked on the same date were stored in ambient condition for 6 months. Each month, a pack of cookies was used for sensory evaluation and 2 packs for water activity and microbiological determinations

Table 1. The Ingredients of breadnut Chocolate Cookies in five formulations

Ingredients	Tr0	Tr1	Tr2	Tr3	Tr4
All purpose Flour (APF)	220g	165g	110g	55g	0
Breadnut Seed Flour (BSF)	0	55g	110g	165g	220g
Butter	112g	112g	112g	112g	112g
Light brown sugar	90g	90g	90g	90g	90g
White granulated sugar	95g	95g	95g	95g	95g
Large egg	2 pcs	2 pcs	2 pcs	2 pcs	2 pcs
Pure vanilla extract	½tsp	½ tsp	½ tsp	½ tsp	½ tsp
Cocoa powder	90g	90g	90g	90g	90g
Baking soda	5g	5g	5g	5g	5g
Salt	2 g	2 g	2 g	2 g	2 g
white chocolate chips or chunks	100g	100g	100g	100g	100g

A. Sensory Quality

The sensory properties such as color, aroma, flavor, and crispiness of the stored cookies were

assessed by 15 trained panelists at monthly basis for six months; any changes in the sensory properties were recorded.

Table 2 The Amount of APF and BSF Mixture per Chocolate Cookie Formulation

<i>Treatment</i>	<i>All Purpose flour (%)</i>	<i>Breadnut seed flour (%)</i>
0 (Control)	100	0
1	75	25
2	50	50
3	25	75
4	0	100

B. Chemical Analyses

The chemical analyses of products such as proximate composition, microbiological and water activity were analyzed in the Department of Science and Technology Laboratory Region VII.

B.1. Proximate Composition

Moisture, ash, total fat, and protein, were determined according to the standard methods of AOAC 1995. Total carbohydrates were calculated by difference. For sodium determination, the sample was digested with nitric acid added with potassium chloride solution and diluted to know the volume. The test solution was aspirated through AAS set in flame emission mode for measurement. Food energy value is calculated using physiological energy factors given in appendices 1 and 2 of FNRI Handbook.

B.2. Water Activity and Microbiological Determinations

Water activity was measured using the water activity meter. While total coliform count and mold and yeast count were determined using the methods described in Bacteriological Analytical Manual 8th edition (BAM).

Treatment of the Data

The data from the score sheets were analyzed using SPSS version 17. The treatment utilized descriptive statistics to determine the descriptions and the level of acceptability of the product's sensory properties in five formulations. An Analysis of Variance was conducted to determine the significant difference at 5% level of significance on the sensory properties being tested in the different formulations and least significant difference (LSD) was used for significant results.

Sensory Evaluation

Appearance, odor, flavor and texture are extremely important for the enjoyment of foods. Sensory evaluation is a scientific method of assessing the eating quality of food under controlled conditions. Fifty panelists evaluated 5 cookie samples in random order in terms of color, aroma, crispness, flavor and general acceptability using descriptive and 9-point Hedonic scale with 1 described as dislike extremely and 9 as like extremely.

Table 3 shows the result of the descriptive test of BCC prepared in five different ratios of APF and BSF (Table 2). With regards to the mean scores pertaining to color, result showed that the control cookies (100% APF) was described as moderately brown (3.92) while the formulations containing 25 % to 100% BSF were rated brown to light brown (3.16-2.14). The findings further suggest that the dark brown color of the control cookie became lighter when cookies were made from the mixture of APF and BSF at any level of substitution. The brown color of the baked cookies was not only because of the chocolate but also due to Maillard reaction. In fact (Ubbor, S.C. and. Akobundu, E., 2009) declared that the brown color resulting from Maillard reaction is always associated with baked goods. In addition, Arcelay and Graham (2005) explained that the Maillard reaction occurred with the production of a brown color is due to the carbohydrates. Since APF has slightly higher carbohydrates (76.7%) as documented by (Chowdhury, R. et.al 2012) compared to BSF (72.2%), the cookies made from pure APF were slightly darker than cookies with BSF. Also (Yahya, M.,2004) added that the brown sugar used in cookies not only contributes to sweetness but also add to the overall flavour and colour as a result of caramelization and Maillard reaction. These results contradict the result of Hussain et al,(2006) who observed more darkness in color as supplementation of flaxseed flour was increased in the wheat flour.

RESULTS AND DISCUSSION

Table 3 Descriptive Test Result of cookies with different ratios of BSF and APF

Attributes	Control(0:100)	Tr1(25:75)	Tr2(50:50)	Tr3(75:25)	Tr4(100:0)
COLOR	3.92	3.16	2.58	2.14	2.14
AROMA	2.18	2.44	2.48	2.48	2.5
FLAVOR	2.46	2.46	2.48	2.5	2.5
CRISPINESS	3.78	3.3	3.13	2.88	2.8
<div> <div> COLOR Legend: 4.20 -5.00 – Dark Brown 3.40-4.19 – Moderately Brown 2.60- 3.39 – Brown 1.80 – 2.59 – Light Brown 1.00 – 1.79 – Vey light Brown </div> <div> AROMA (Breadnut) Extremely Noticeable Very Noticeable Moderately Noticeable Slightly Noticeable Unnoticeable </div> <div> FLAVOR (Breadnut) Extremely Noticeable Very Noticeable Moderately Noticeable Slightly Noticeable Unnoticeable </div> <div> CRISPNESS Very Crispy Moderately Crispy Crispy Slightly Crispy Not Crispy </div> </div>					

In terms of the perceptibility of breadnut aroma and flavor, the BCC was described as slightly perceptible since scores ranged from 2.18 – 2.5 in all formulations including the control cookie in both attributes. Yahya, M., (2004) stated that fat also contributes to the organoleptic qualities of cookies such as flavor and aroma. Moreover, Manley (2000) cited that the flavor of a cookie is mainly influenced by the fat, sugar and flavor enhancer in its formulation. In this study, the evaluators rated the aroma and flavor of the cookie samples with BSF the same as the control cookie. This implies that fat combined with other ingredients made the cookies' breadnut odor and flavor barely discernible in any level of BSF substitution. As a result, all cookie samples had the same description as the cookie made from 100% APF (control).

Considering the crispiness of the product, the mean score ranged from 3.78 to 2.8 which likewise fall from moderately crispy to crispy. The control cookie sample got the highest mean, hence the crispiest among the formulations. However, the cookies with BSF in any level of substitution were described as crispy. Furthermore, result revealed that incorporation of BSF in cookie formulation decreases the crispness of the control cookie. According to Conforti et al, 1996 and Yahya M. (2004), about 50% of shortening is used (based on flour weight) in cookie formulation so as to achieve the preferred crispiness of cookies. In this research work, the butter used was almost 50% based on the flour's weight so as to get the desired crispiness and texture of the product.

Table 4 shows the result of the preference test using the 9 - point hedonic scale, with 1 described as dislike extremely and 9 as like extremely.

Color Acceptability

Color is very important parameter in judging the properly baked cookies. It does not only reflect the suitable raw material used for the preparation but also provides information about the formulation and quality of the product (Hussain, S. et.al, 2006). In this study, the panelists' judgment on the color of the sample cookies were in the ranged of 7.58 to 6.8 which likewise fall between LVM and LM. The substitution of 25 percent to 100 percent of BSF in

cookies had recorded the mean scores from 7.4 to 6.8 which all have the same description of LM, still highly acceptable. Statistically, there were no significant ($p \leq 0.05$) differences observed among the five formulations. This implies that the panelists perceived the formulated cookies similar to the control cookie with respect to the color. The findings agree with the result of Wekwete and Navder, (2008) but in contrast with that of Sharif et.al, (2009).

Aroma Acceptability

Aroma is another property that influences the acceptance of baked cookies even before they are tasted (Ubbor, S.C. and Akobundu, E.N.T 2009). In terms of aroma mean scores, the control cookies got the highest score of 7.28 and the cookies with 25 percent up to 75 percent BSF had documented the scores of 7.28, 7.2 and 7.20 respectively and perceived as LM as the control cookie. While the cookie prepared with pure (100%) BSF was described as LS, with the score of 6.4. However, statistical test shows that there were no significant ($p \leq 0.05$) differences among the 5 cookie samples. This implies that the incorporation of BSF to APF in any proportions have perceived similar aroma as the control. This further explains that supplementation of breadnut seed flour in cookie formulation does not affect the aroma of the product. The findings corroborate that of Ubbor and Akobundo (2009).

Flavor Acceptability

Flavor is the main criterion that makes the product to be liked or disliked (Hussain, S. et al., 2006). As to its mean scores, it can be gleaned from the table that the ratings of the panelists ranged from 7.72 to 6.54. The cookies prepared with BSF up to 75% have similar description (LVM) as the control cookie. However cookies prepared with 75% BSF obtained the highest score. On the other hand, cookies prepared with 100 percent BSF documented the scores of 6.54 and described as LM. Moreover, statistical test exposed that there were significant ($p \leq 0.05$) differences among the control cookie and the cookies prepared with 100 percent BSF. Thus, the incorporation of BSF up to 75 percent has no impact on the flavor of the formulated cookies compared to the control.

Mean Result of cookies formulated from APF and BSF mixtures

Treatment	Colour	Aroma	Flavour	Crispness	General Acceptability
Control (100% APF)	7.58a	7.28a	7.70a	7.68a	7.72a
Tr1(25% APF :75% BSF)	7.40a	7.28a	7.58a	7.44a	7.68a
Tr2 (50% APF:50% BSF)	7.42a	7.20a	7.72a	7.40a	7.72a

Tr3(75% APF:25% BSF)	7.12a	7.20a	7.7a	7.40a	7.7a
100% BSF)	6.8a	6.5a	6.54b	7.02a	6.88b

Legend: Scale	Description	Scale	Description
8.5 – 9.0	Like extremely	3.5 – 4.49	Dislike slightly
7.5 – 8.49	Like very much	2.5 – 3.49	Dislike moderately
6.5 – 7.49	Like moderately	1.5 – 2.49	Dislike very much
5.5 – 6.49	Like slightly	1.0 – 1.49	Dislike extremely
4.5 – 5.49	Neither like nor dislike		

*Means with the same superscript within the column are not significantly difference ($p \leq 0.05$)

Crispiness Acceptability

Crispiness is a desirable quality of cookies (Ubbor and Akobundu 2009). Crispiness will determine consumer acceptability and represent the critical factor in limiting cookies shelf-life (Piazza and Masi, 1997). In this study, the evaluators perceived the control cookie sample as LVM and all other formulations were perceived as LM since the mean score ranges from 7.68 – 7.02. The slight changed in the crunchiness has decreased the acceptance score compared to the control. However, the rating was still acceptable. Furthermore, statistics test revealed that there were no significant differences among the five formulations. This means that the 5 different formulations obtained similar acceptance scores compared to the control. This further implies that the crispiness of the product was not affected by the supplementation of BSF in the formulation compared to the control. The results are in contrast with that of Hussain et.al (2006)

General Acceptability (GA)

The general acceptability of BCC refers to the holistic view of the product as affected by all sensory properties being considered. Based from the average weighted means, the GA of BCC in different formulations ranged from 6.88 to 7.72 which likewise fall from LM to LVM signifying that the different formulations were highly acceptable to the panelists. The cookie sample got the lowest score contained 100% BSF while sample with a mixture of 50% APF and 50% BSF got the highest mean score of 7.72 same as the control cookie. Hence, it was considered as the most acceptable cookie sample formulated with BSF. Based on statistical result, incorporation of BSF up to 75 % has no significant ($p < 0.05$) difference with the control cookie. These results are similar with that of Wekwete and Navder, (2008).

Shelf life of the Most Acceptable Breadnut Chocolate Cookies

Shelf life is defined as the length of time a product may be stored without deteriorating. Most

shelf life testing aims to determine how rapidly microbiological, chemical and physical changes occur in the food during distribution and storage (Sewald, M. and Devries, J.). This is important to a new product like the BCC. Airani, S. (2007) stated that the existence of any product without any change in its quality and sensory profile can be analysed by the process of storage study.

The shelf life of a product depends on the raw materials, product formula, process conditions, packaging, and storage. In the present investigation, the storage quality was determined by assessing the sensory profile as well as the water activity and microbiological of BCC for six months.

A. Sensory Quality of stored BCC

The stored samples did not reveal any change in sensory profile in terms of color, aroma, crispiness, and flavor for 6 months. Since the cookies contained fat, it may lead to oxidation which may result to change in products' sensory properties which affects and shorten the shelf life. However, in this study, the oxidation of fat which result to rancidity marked by off odor and flavor was not observed during the storage period. Therefore, the product has the guaranteed quality sensory properties for 6 months or even longer.

B. Chemical Analysis of the Most Acceptable Breadnut Chocolate Cookies

The most acceptable chocolate cookies formulation contained 50 % BSF and 50 % APF. The sample was analyzed in the regional standards and Testing Laboratory of the Department of Science and Technology, Region VII.

B.1. Proximate Composition

The result of the proximate analysis of the most acceptable breadnut chocolate cookies is presented in Table 6. The result shows that breadnut chocolate cookies have significant amount of nutrients. Consequently, it has the potential to contribute for the alleviation of malnutrition problem

in the country and improve food security. Furthermore, the results confirm that breadnut is feasible as raw material use for substitution to

imported wheat flour in different food products with enhanced nutritional value.

Table 6. Proximate Composition of the most Acceptable Cookie Formulation

COMPONENTS	RESULT
Moisture	1.33%
Ash	2.04%
Protein	6.97%
Total Fat	22.10%
Sodium (as Na)	4633 mg/kg
Food Energy Value	497 kcal/100g
Total Carbohydrates	67.60%

B.2. Water Activity and Microbial Analysis for Six (6) months

Based from the result of a_w there was an increase in a_w from 0.220 to 0.295. However, these values were lower than the accepted a_w for cookies of 0.3. From the standard a_w , 0.5 and below, indicates that there is no bacterial proliferation occurs. This means that the product is safe for consumption during 6 months of storage. Also, food can be made safe to store by lowering the water activity to a point that will not allow dangerous pathogens to grow in it (<http://www.fda.gov/ICECI/Inspections/InspectionGuides/default.htm>). However, low a_w than what is accepted may result to too much dryness to the product. Unwarranted dryness of cookies affects its sensory profile and may contribute to its slightly hard texture. Dryness is obtained due to long exposure to heat since the cookies were baked for 30 min. Hence, time and temperature of baking the product must be

adjusted so as to conform to the standard a_w and improve the texture and other sensory properties.

On the other hand, the result of the microbiological test of the most acceptable BCC has conformed to the standard microbiological limits as follows: 10^3 cfu/g for mold and yeast count, and 10^2 cfu/g for total coliform count set for processed foods under the food description Breakfast Cereals and Snack Foods (Draft standards for ethnic flour-based confectioneries, 2011). This implies that the stored breadnut chocolate cookies are safe for consumption until 6 months.

Cost –Benefit Analysis

Table 7 shows the benefit-cost analysis per recipe. The total cost of materials and labor sum up to P139.64. While the sales obtain per recipe is P 210.00 with 70 pieces of cookies yield per recipe @ P 3.00 each. The benefit per recipe is 50.39%.

Table 7. Cost per recipe

Material	Amount	Cost
All purpose Flour	155 g	P 6.98
Breadnut seed flour	155 g	6.20
Butter	1 pc	42.00
Brown sugar	100 g	4.00
White sugar	100 g	5.00
Baking soda	5g	0.40
Salt	2 g	0.10
Egg	2 pcs	13.00
Vanilla	5 ml	0.08
Cocoa powder	10 g	4.00
Chocolate chips	10g	2.88
Total Variable Cost		P 84.64
Add: Fixed Cost		
Utilities	P 30.00	
Labor	25.00	55.00
TOTAL COST/ RECIPE	P 139.64	

Yield per recipe-----70 pieces Cookies @ P3.00/ each
Sales: 70 * 3.00-----P 210.00
Benefit-----P 210.00 – P139.64 = P 70.36

Benefit / Cost = 70.36 / 139.64 x 100 = 50.39%

Based on the result of the cost benefit- analysis, it has been determined that the cost of the product has been maximized thus it is feasible for mass production. As a result, it is possible that it could capture a bigger market share not only to the urban but to rural settings. In the part of the would-be entrepreneurs, it is viable for it requires only a minimum start-up capital.

CONCLUSION

The cookies with BSF in any level of substitution were highly acceptable to the panelists, since there were no cookie sample rejected by them based on the 9-point hedonic scale. But, the most acceptable formulation based on general acceptability score was the cookie with 50% APF and 50% BSF mixture. It is safe with desirable sensory properties until 6 months or even longer and contain significant amount of nutrients making it an ideal raw material for food production. Hence, breadnut is highly recommended for cultivation, consumption and commercialization.

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