

SENSORY EVALUATION, SHELF LIFE 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 percent 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 (6) 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 percent 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 percent. The formulated cookies have significant amount of nutrients needed by the body. It is safe with guaranteed desirable sensory properties for six (6) months. It is recommended for consumption and commercialization.

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

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 for 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 is 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 percent, linolenic 14.8 percent and oleic 12.4 percent.

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, ripe breadnut fruit has a shelf life of 2-3 days and 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 conducted to formulate chocolate cookies from breadnut seed flour. Specifically, it investigated 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 two (2) min making it complete dough. About 12g of dough dropped in the prepared baking sheets spacing about five (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 five (5) treatments as shown in Table two (2) with 100 percent wheat flour that 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 (5) 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 (5) formulations. An Analysis of Variance was conducted to determine the significant difference at five (5) percent level of significance on the sensory properties being tested in the different formulations and Least Significant Difference (LSD) was used for significant results.

RESULTS AND DISCUSSION

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 five (5) cookie samples in random order in terms of color, aroma, crispness, flavor and general acceptability using descriptive and 9-point Hedonic scale with one (1) described as dislike extremely and nine (9) as like extremely.

Table 3 shows the result of the descriptive test of BCC prepared in five (5) different ratios of APF and BSF (Table 2). With regards to the mean scores pertaining to color, result showed that the control cookies (100 percent APF) was described as moderately brown (3.92) while the formulations containing 25 percent to 100 percent 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 due to chocolate added 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 AFP 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 color 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 that was increased in the wheat flour.

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 |

Legend:

| COLOR | AROMA (Breadnut) | FLAVOR (Breadnut) | CRISPNESS |
|------------------------------|-------------------------|--------------------------|-------------------|
| 4.20-5.00 - Dark Brown | Extremely Noticeable | Extremely Noticeable | Very Crispy |
| 3.40-4.19 - Moderately Brown | Very Noticeable | Very Noticeable | Moderately Crispy |
| 2.60-3.39 - Brown | Moderately Noticeable | Moderately Noticeable | Crispy |
| 1.80-2.59 - Light Brown | Slightly Noticeable | Slightly Noticeable | Slightly Crispy |
| 1.00-1.79 - Very light Brown | Unnoticeable | Unnoticeable | Not Crispy |

In terms of the perceptions on 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 percent APF (control).

Considering the crispiness of the product, the mean score ranged from 3.78 to 2.8 which is described 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 percent 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 percent 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 one (1) described as dislike extremely and nine (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 is categorized 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 (5) 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 five (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 cookie prepared with BSF up to 75 percent have similar description (LVM) as the control cookie. However cookies prepared with 75 percent 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) | 7.58 ^a | 7.28 ^a | 7.70 ^a | 7.68 ^a | 7.72 ^a |
| Tr1 (25% APF :75% BSF) | 7.40 ^a | 7.28 ^a | 7.58 ^a | 7.44 ^a | 7.68 ^a |
| Tr2 (50% APF:50% BSF) | 7.42 ^a | 7.20 ^a | 7.72 ^a | 7.40 ^a | 7.72 ^a |
| Tr3 (75% APF:25% BSF) | 7.12 ^a | 7.20 ^a | 7.7 ^a | 7.40 ^a | 7.7 ^a |
| 100% BSF) | 6.8 ^a | 6.5 ^a | 6.54 ^b | 7.02 ^a | 6.88 ^b |

| | | | | |
|---------|------------|--------------------------|------------|--------------------|
| 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 (5) formulations. This means that the five (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. It contained 100 percent BSF while the sample with a mixture of 50 percent APF and

50 percent 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 results, incorporation of BSF up to 75 percent 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 (BCC)

Shelf life is defined as the length of time that a product may be stored without deteriorating. Most shelf life testing to determines 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 (6) 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 six (6) months. Since the cookies contained fat, it may lead to oxidation resulting in the change of the products' sensory properties that affect and shorten the shelf life. However, in this study, the oxidation of fat which resulted in the rancidity marked by off odor and flavor was not observed during the storage period. Therefore, the product has the guaranteed quality sensory properties for six (6) months or even longer.

B. Chemical Analysis of the Most Acceptable Breadnut Chocolate Cookies

The most acceptable chocolate cookies formulation contained 50 percent BSF and 50 percent 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 occurrence of bacterial proliferation. This means that the product is safe for consumption during six (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 too much dryness of the product. Unwarranted dryness of cookies affect its sensory profile and may contribute to its slightly hard texture. Dryness occurred 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 with 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 six (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. The sales 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 percent.

Table 7. Cost per recipe

| Material | Amount | Cost |
|----------------------|--------|----------|
| All purpose Flour | 155 g | 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 |
| Utilities | 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 percent APF and 50 percent BSF mixture. It is safe with desirable sensory properties until six (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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