UTILIZATION OF BREADFRUIT (*ARTOCARPUS ALTILIS*) ON TART DOUGH PRODUCTION

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ABSTRACT: *Flour and flesh from the fruit of breadfruit trees can serve as a replacement for gluten-free product formulations. This study evaluated the sensory and other characteristics of breadfruit tart dough. It involved manipulating conditions to study the relative effects of the product made using a Randomized Completely Block Design. Experimental formulas were mixed with varying breadfruit flour inclusions (0%, 10%, 20%, and 30%) for breadfruit tart dough. The assessment of Breadfruit tart dough was through sensory parameters. Characterization involved microbial, proximate, and shelf life analyses. The return of investment was computed. Results showed that breadfruit tart dough is safe for human consumption. Breadfruit tart dough containing 10% breadfruit flour is very much acceptable in the sensory attributes. A significant difference existed between and among treatments of breadfruit tart dough as to its qualities. The addition of breadfruit enhanced the tart dough's nutritional quality as the supplementation increased its ash and fiber contents. Also, the shelf life of breadfruit tart dough was six days. The breadfruit tart dough with the highest return of investment was the formulation with 30% supplementation. Hence, breadfruit flour (10%) can be used as gluten-free to replace wheat flour and has the potential as a fiber supplement. During breadfruit flour processing, it is recommended to blanch the sliced breadfruit to eliminate enzyme activity that affects the product's browning reactions. Future studies may include the utilization of breadfruit flour in yeast-leavened pieces of bread, the use of cooked and uncooked breadfruit in making breadfruit products, and assessing the effect of breadfruit flour on the quality of other gluten-free product formulas.*

Keywords: computer and internet skills, age, educational attainment, local government employees

1. INTRODUCTION

With a world population rapidly approaching 9 billion, new opportunities for providing sustainable and nutritious food must be considered [7]. In reality, there is an inevitable struggle to produce enough food to meet this tremendous demand. World hunger is a crippling social issue since 2016. According to the World Food Programme, "Some 795 million people in the world do not have enough food to lead a healthy, active life," which can increase to 2.5 billion more to feed. With that, different studies researched on the microbial properties of varied plants such as Betel Nut (1), Silag (2), Mexican Turnip (3), Papaya and Madre de Cacao (4), Banana (5), and Parasol (Bañez, 6) for food, medicine, etc. Amazingly, a relatively unknown tropical tree has a chance to help eliminate world hunger and address food insecurity while simultaneously meeting demands for healthy gluten-free, and delicious products [8].

There are classes of essential nutrients that must be combined in an appropriate portion to ensure an adequate food intake. These include carbohydrates, proteins, fats and oil, vitamins, and minerals. Therefore, it is needed to promote good health, a cheap protein source to the rural poor who cannot afford to buy meat or other animal protein sources. Also, an attempt to achieve food security by increasing output requires increasing food processing and preservation to avoid food losses [9].

Eighty percent of people afflicted by hunger live in a region with ideal ecological conditions for growing breadfruit trees. For a family of five people, One 7-pound breadfruit provides enough carbohydrates for one meal to have a sense of proportion. A single breadfruit tree can provide a family of four for decades, promoting self-reliance and food security. The potential of breadfruit to stop world hunger is distressing when considering how far the plant can be stretched to fulfill essential nutritional needs in poverty-stricken communities [8].

Like breadfruit, untapped resources may just hold the key to alleviating hunger and feed our growing world (7). Breadfruit belongs to a group of vegetables. It is a tropical tree that originated in Papua New Guinea with a rich history. This starchy staple crop has been grown for about 3,000 years in the Pacific and was the first to present to other tropical regions more than 200 years ago. The trees grow easily and thrive under a wide range of ecological conditions, producing abundant, nutritious food for decades without the labor, fertilizer, and chemicals used to grow field crops.[10]

According to the Food and Agriculture Organization, subtropical and tropical regions are suitable for growing breadfruit host to the vast majority of the poor and hungry worldwide. What makes these trees even more attractive is that they are highly efficient but low-maintenance. Trees start bearing fruit in 3 to 5 years and are considered to be productive for several decades. Unlike other staple food crops, they don't require yearly replanting, reducing topsoil loss and overall labor involved in cultivating breadfruit[7]

Breadfruit (*Artocarpus altilis*) can be found in more than 90 countries throughout the tropics, yet it is generally considered an underutilized crop. With its possibility to increase food production in a regenerative and sustainable manner, breadfruit could become a vital crop for addressing food insecurity issues in tropical areas[11] .

African breadfruit is an essential natural resource for the less fortunate, contributing significantly to their income and dietary intake. Hence, African breadfruit helps ensure food security by meeting the people's protein needs and provides income to underprivileged rural households responsible for crop production, processing, and/or preservation. The plant produces large, usually round compound fruit covered with roughly pointed outgrowths [9]. This fruit is green from the outside and yellow from the inside. This soft vegetable makes a delectable dish when appropriately cooked. As a result of its high value for nutrition, one can have breadfruit regularly without the chance of any side effects. Breadfruit has many health benefits, and these benefits are evident in the

skin of the hair[12*]*. *Artocarpus altilis* has been a principal crop on the Pacific islands for more than 3,000 years. British and French voyagers brought a few seedless varieties westward to the Caribbean in the late 1700s. Breadfruit is currently being cultivated in the word's tropical regions. Though it is a fruit, breadfruit is characteristically less like fruit and more like a potato. Breadfruit is a starchy, carbohydrate fruit similar to staple field crops such as rice, maize, sweet potatoes, and potatoes. Despite all the starch, breadfruit is rich in nutrients. A single cup of breadfruit has much more potassium than three bananas. Other cultivars have additional health claims, like having high levels of fiber and beta-carotene, which prevents Vitamin A deficiency and thus night blindness (14).

Breadfruit's shorter shelf life has created a challenge in the past to keep fresh fruit stocked in stores not located in the tropical regions where breadfruit grows in their production section. Even so, making breadfruit into value-added products can diminish this dilemma. Processing and preserving the crop becomes inevitable to increase its consumption among rural households, especially during the off-season. The main goal of processing, however, is to preserve the nutrients to make them available to the consumers and to minimize or decrease the levels of phytochemicals that interfere with nutrient digestion and absorption [14]. Processing and preservation help supply wholesome, nutritious, and safe food throughout the year to maintain health and income for the producers [9] .

Reduced processing and preservation lead to high post-harvest losses. A specific example is boiling and drying, which significantly reduced the selenium and iodine content of breadfruit seeds[14]. These variations and unacceptable qualities influence the crop's economic and nutritional value and prohibit its storage and preservation. [9].

The main problem with breadfruit utilization is its high perishability, resulting in high post-harvest losses. In some extreme cases, up to 50% of losses have been reported. Consequently, only fruits for immediate needs are harvested, reducing the opportunities to develop a large-scale international trade in breadfruit. In the past decade, gluten-free products interest has fast-tracked efforts to use breadfruit in value-added products and had driven interest in processing breadfruit into flour. Breadfruit flour will expand and complement existing and potential markets for fresh or processed fruit [11].

Trinidad's first Breadfruit Exhibition and Festival. Innovations in breadfruit food technology such as shredding and French frying machines and flour were presented. Festival goers sampled breadfruit ice cream, punch, sparkling wine, chocolate-dipped chips, breadfruit cheesecake, liqueur, and fruit cake.

Its fruit can be cooked and eaten at all stages of its growth, making it extremely versatile. Breadfruit can also be frozen, sliced, dried, or even ground into flour, processing it into value-added products like crackers, chips, and bread. The fruit can also be boiled, roasted, or steamed, making it a nutritious substitute for starchy root crops like potatoes[7] . Drying and grinding the mature, starchy fruit into flour has opened up a whole new market for items like bread, cakes, chips, and cookies. Delicious dough's, hummus, tortillas, pies, and other desserts from the fruit can be marketed to consumers worldwide [15].

Entrepreneurs, researchers, chefs, marketing executives, and farmers are quickly noticing the vast potential of breadfruit for value-added products. Value-added products are produced in a way that improves a product's value and changes its physical state or form. The explosive popularity of natural, organic, and gluten-free markets has consumers clamoring for delicious, nutritious, and gluten-free foods. Breadfruit is all these things, naturally [15]

With more resources and improvements in food technology, the possibilities for new, natural, value-added breadfruit products are endless. Today, through innovative preservation and preparation methods and the demand for gluten-free products, breadfruit becomes a valuable food crop increasing its local and worldwide markets. Making breadfruit into value-added products can diminish the shorter life span of breadfruit. Grinding and drying mature, starchy fruit into flour has introduced a whole new market for products like bread, cakes, chips, cookies and, many more. Hummus, doughs, tortillas, pies, and other desserts can be made and sold to consumers worldwide [15].

The potential impact of breadfruit on health, community-based economic development, food security, environmental stability, manufacturing, training, certification, and green energy is why the researcher prompted them to conduct this study. Introducing a more practical way or preparing breadfruit products can serve healthy snacks or desserts and be appreciated by individuals in terms of the produced products' sensory qualities. Hopefully, the study's findings will encourage to formulation of new products that many will accept and like. Moreover, patronizing the available raw materials in the locality will help in income-generating activities by homemakers and small microenterprises to venture into business, and farmers to plant breadfruit in their respective areas.

2. METHODS

Research Design. This study is experimental and descriptive research involving the manipulation of conditions to study the relative effects of various treatments applied in three kinds of products made. The Randomized Completely Block Design was used since some possible interventions could not be controlled under laboratory conditions. However, the processes on the preparation and the conduct of the study were simultaneously done to eradicate possible errors that were encountered.

Research Locale. This experimental research was conducted from March 2019 to December 2019 at the Ilocos Sur Polytechnic State College Research Center, Sta. Maria, Ilocos Sur.

Population and Sample. Purposive sampling was adopted in the identification of respondents. There were 50 respondents broken down into the following: five (5) pie makers/cake makers, fifteen (15) teachers, fifteen (15) HM/TLE students, and fifteen (15) consumers. These respondents composed the sensory evaluation team.

Microbial Analysis. A sample product was sent for laboratory testing at Mariano Marcos State University-Molecular Microbiology and Biotechnology Laboratory in Batac, Ilocos Norte. All treatments were subjected to microbial analysis to detect the presence or absence of the test microbes. This was considered necessary to guarantee that the products are safe for human consumption.

Sensory Evaluation. This method was done to avoid bias in evaluating the products. The products were packed in a plastic container to keep the product safe. Ratings, comments, and suggestions were recorded, and these were considered in the analysis and discussion of the research results.

Proximate Analysis. The samples submitted approximately 300 grams were sent to the Accredited Testing Laboratory in Makati City, Metro Manila. Proximate analysis of the best product was done according to the standard AOAC method (AOAC, 2016). Moisture, crude fat, crude protein, ash, crude fiber, and carbohydrate were determined and calculated.

Shelf life analysis. The breadfruit product was sent back to MMSU-Microbial Laboratory, and alternate microbial testing was scheduled. This means that the product was subjected to microbial analysis every two days to determine the level of pathogens present. Once the microbes increased to a level higher than the tolerability limit, the product was already considered unsafe for human consumption.

Return of Investment. The direct material cost of all the products formulated was summed up as a basis in the computation of the return of investment. This was analyzed concerning the estimated sales of the products. The total cost was divided by the total sales, and the quotient was multiplied by 100 to arrive at the percentage value of the return of investment.

Data Gathering Instrument. Score sheet or rubrics using a 5-Point Likert Scale was used in identifying the sensory characteristics of breadfruit product such as breadfruit tart dough. The parameters included the outside and inside appearance of the product and were patterned from the Philippine Home Economics and Baking Basics (1981) printed and distributed by US Wheat Associates, Manila Philippines. The rubrics were slightly modified to suit the need of the study.

Statistical Treatment of Data. All the gathered data was summarized and tabulated using the weighted mean. One Way Analysis of Variance (ANOVA) and Tukey Kramer Multiple Comparison Test were employed to determine the significant difference in terms of the product's different sensory characteristics.

Experimentation Stage

Before we start we prepare the necessary needs tools and equipment in making the Tart Dough following the oven, rolling pin, measuring cup and spoon, mixing bowl, sifter, tart molder, Baking tray, spatula, pastry cutter, and scissors.

Breadfruit Tart Dough:

T0 - Control (basic dough recipe)

T1- 10% Breadfruit flour + 90% All Purpose Flour + basic Ingredients

T2 – 20%% Breadfruit flour + 80% All Purpose Flour + basic ingredients

T3- 30% Breadfruit flour + 70% All Purpose Flour + basic Ingredients

Preparatory Phase

Phase I. Preparation of Tools and Equipment

The tools and equipment used are Hallow Dryer, Chopping Board, Knife, Sifter, Mortar and Pestle, Mixing Bowl Basin were properly washed and sanitized before the actual food preparation. The working area was also sanitized by washing, wiping, and spraying with air sanitizer. These underwent air drying and were arranged properly according to uses in the preparation table to be accessible to the researcher. The researcher observed proper personal hygiene and used protective equipment to ensure that the foods prepared were free from microbes and safe for human consumption.

Phase II. Preparation of Breadfruit Flour

Pre-Trial processes. The experiment was done in two phases: Breadfruit Flour Making and Breadfruit recipe.

Breadfruit flour was utilized in the preparation of the tart dough. Breadfruit flour was already made before product formulation while the fresh breadfruit was gathered and prepared for the cooking proper.

Washing and Cleaning. All the needed tools, equipment, and materials were made available on the prepared table for simultaneous preparation and cooking. Trying out a recipe for the different treatments for the tart dough was done to attain the standard recipe.The gathered breadfruit flesh was washed to make sure that dirt and other contaminants were removed. This was done by scraping the surface using a brush while washing the fruit in running water.

Peeling. The outer skin and all the green portion on the breadfruit exterior were removed using a sharp knife. This was done to ensure that the quality of the breadfruit flour is high and acceptable.

Cutting and Slicing. The breadfruit was cut into four and sliced thinly for easy drying.

Drying. The breadfruit slices were arranged in the finely-meshed tray using a hallow dryer. The trays were arranged in the dryer compartments and brought out under the sun. To hasten the evaporation and escape of moisture, the hallow dryer was provided an exhaust fan to draw the moisture out from the products. The drying starts at 10:00 AM when the sun has gone fully shining and ends at 3:00 PM before the day's temperature starts to cool. The process took four to five days to attain a crispy characteristic ready for pulverizing. It is also necessary that dried breadfruit be crispy to be easily pulverized and sifted.

Pulverizing. This was done using a food grinding machine used to pulverize cereals, grain, herbs, etc. The available commercial grinding machine owned by a private establishment in the market was utilized to assure that it is free from any contamination that might affect the products made. In the absence of the machine, mortar and

pestle were also utilized for small quantities.

Packing. After shifting, the breadfruit flour was packed in a tight plastic container to prevent the entrance of moisture, which will promote the growth of microorganisms. These packed breadfruit flours were stored at room temperature until the snack development phase of the research was conducted.

Phase III. Preparation of the ingredients and the cooking procedures

Breadfruit Tart/Dough

Ingredients:

1 cup (240 grams) All-Purpose Flour/Breadfruit flour
3 tbsp. (50 grams) butter
1 tsp. (5 grams) salt
1 tbsp. (16 grams) sugar
1 piece egg yolk
Drop of water

Procedure:

1. Sift flour, salt, and sugar into a bowl.
2. Add the margarine or butter and cut with a pastry blender until the margarine is broken into fine particles.
3. Add egg yolk and sprinkle water, and continue cutting using the pastry blender. Gather the mixture to form a dough.
4. Knead the dough until smooth, roll it with your bare hands, and cut it into pieces using the pastry cutter.
5. Flatten the dough and roll on a clean flat surface, leaving 1/8 inch thick.
6. Fit into the boat, tart molder, and cut the excess dough using a scissor.
7. Bake at 3500F for 10 minutes or until golden brown.

3. RESULTS AND DISCUSSION

Microbial Analysis of the Products

Microbial load analysis and detection of pathogens are the first moves before the products undergo further evaluation, most especially the sensory evaluation, which may cause the ingestion of harmful bacteria by the panelists. Different tests for bacterial presence, including Escherichia coli, Salmonella sp., Listeria monocytogenes, Staphylococcus aureus, and molds, were conducted.

Table 1. Microbial Analysis of Breadfruit Tart Dough Table

Food Product Sample Code	Aerobic Plate Count (CFU/g) 10^4	Detections of Pathogens				
		Escherichia coli	*Salmonella sp.*	*Listeria monocytogenes*	*Staphylococcus aureus*	Molds
T0- Control (100% APF)	8.0	Negative	Negative	Negative	Negative	Negative
T1-10% BFF & 90% B	10.0	Negative	Negative	Negative	Negative	Negative
T2-20% BFF and 80% APF	16.0	Negative	Negative	Negative	Negative	Negative
T3-30% BFF & 70% APF	17.0	Negative	Negative	Negative	Negative	Negative

Outside and Inside Sensory Qualities of Breadfruit Tart Dough

The outside characteristics of tart dough (see Table 2) include shape, size, color, and crust.

Shape. The panelists evaluated the shape characteristics of the breadfruit tart dough. It can be seen in the table that the highest rating obtained was in T1 (4.56) with a descriptive rating of "very much acceptable," followed by T2 (4.45), also described as "very much acceptable." In contrast, the lowest mean rating was obtained in T3 (4.00) with a descriptive rating of "very acceptable." This showed the panel of evaluators prefers 10% of breadfruit flour mixed with All-Purpose Flour. Therefore, it is an indication that the amount of breadfruit flour added to the mixture affects the shapes of the breadfruit tart dough. The shape of the product in the different treatment combinations varies according to the amount of breadfruit flour mixed in the recipe.

Size. T1 (4.53) registered the highest mean with a descriptive rating of "very much acceptable." At the same time, the lowest was obtained in T3 (3.99) with a descriptive rating of "very acceptable." This implied that the amount of breadfruit flour as a substitute to wheat flour might affect the shape of the breadfruit tart as ratings of evaluators vary in all the treatments.

Color. the sensory characteristics of the breadfruit tart dough in terms of color appeared that T1 with 10% breadfruit flour was rated as best (4.54), followed by T2 (20% breadfruit flour) with a rating of 4.30 and described as "very much acceptable." At the same time, the lowest was observed in T3 (3.75), described as "very acceptable." This implies that the panelists still prefer a lower level of breadfruit flour as they love the whiter color more than the yellowish color, which is affected by the increased quantity of breadfruit flour.

Crust. In terms of crust, T1 containing 10% breadfruit flour obtained a rating of 4.47, which was described as "very much acceptable," while T3 (30% Bread flour) has the lowest mean of 4.06 among the treatments. This means that the higher breadfruit flour added, the lesser the preference on the part of the evaluators. This indicated that the percentage of wheat flour substituted with breadfruit flour affects the crust of the baked products.

Table 2. Sensory characteristics of Breadfruit Tart Dough in terms of the outside qualities of the products

Sensory Characteristics	Experimental Lot	Mean	Descriptive Rating
Shape	T0 - Control	4.23	Very Much Acceptable
	T1 – 10% Breadfruit flour + Basic ingredients	4.56	Very Much Acceptable
	T2 – 20% Breadfruit flour + Basic ingredients	4.45	Very Much Acceptable
	T3 – 30% Breadfruit flour + Basic ingredients	4.00	Very Acceptable
Size	T0 - Control	4.17	Very Acceptable
	T1 – 10% Breadfruit flour + Basic ingredients	4.53	Very Much Acceptable
	T2 – 20% Breadfruit flour + Basic ingredients	4.48	Very Much Acceptable
	T3 – 30% Breadfruit flour + Basic ingredients	3.99	Very Acceptable
Color	T0 - Control	4.19	Very Acceptable
	T1 – 10% Breadfruit flour + Basic ingredients	4.54	Very Much Acceptable
	T2 – 20% Breadfruit flour + Basic ingredients	4.30	Very Much Acceptable
	T3 – 30% Breadfruit flour + Basic ingredients	3.75	Very Acceptable

Crust	T0 - Control	4.19	Very Acceptable
	T1 – 10% Breadfruit flour + Basic ingredients	4.47	Very Much Acceptable
	T2 – 20% Breadfruit flour + Basic ingredients	4.16	Very Acceptable
	T3 – 30% Breadfruit flour + Basic ingredients	4.06	Very Acceptable

CONCLUSIONS AND RECOMMENDATION

The breadfruit tart dough is safe for human consumption. The addition of different levels of breadfruit flour to tart dough caused significant variations in the sensory qualities of the products. Specifically, the addition of 10% breadfruit in making tart dough enhances both the outside and inside attributes to a very much acceptable degree. The nutritional quality of breadfruit tart dough was enhanced by the addition of breadfruit flour by increasing the ash and fiber contents. The shelf life of breadfruit tart dough (6 days) was shortened due to the presence of breadfruit flour. The addition of breadfruit flour in tart dough increases the Return of Investments.

It is therefore recommended to use breadfruit flour at a level not more than 10% wheat flour to enhance the nutritive quality of tart dough and to promote the consumption of breadfruit by the school children. Best formulations must be further tested and subjected to analyses for possible Intellectual Property registration and commercialization. Conduct of further studies on practices that can prevent browning reactions, on the utilization of breadfruit flour yeast-leavened pieces of bread, on the use of cooked and uncooked breadfruit in flour production, and on the assessment on how breadfruit flour affects the quality of other gluten-free product formulas is also recommended.

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