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RESEARCH ARTICLE

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## UTILIZATION OF BANANA (*MUSA PARADISIACA* LINN) FLOUR IN CHURROS: PRODUCT DEVELOPMENT AND CONSUMER ACCEPTABILITY

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### ABSTRACT

Cardava bananas (*Musa paradisiaca* Linn.) can be grown in locations where there is a risk of food scarcity and can be used to make other products because of their year-round growth. Due to their abundance but highly underutilized, and low shelf life, increasing their utilization by processing using appropriate methods and technology, they can be used for sustainable products like shelf-stable banana flour. Hence, the researchers developed an alternative pastry—churros utilizing banana flour. Then, researchers invited 60 respondents provided with scoresheets to evaluate six treatments assessing the level of acceptability of churros utilizing banana flour in terms of its texture, aroma, color, flavor, and overall acceptability. On the general acceptability scale, it was scored and interpreted as like moderately. The best formulation revealed that 85% all-purpose flour and 15% banana flour must be used to measure the variable to develop banana churros. A study on the nutritional value of churros utilizing banana flour and its shelf life is recommended. Further research is needed to confirm these results and to compare Churros Utilizing Banana Flour to other banana-based flour pastries since this is a small study with only six treatments.

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## INTRODUCTION

Botanically speaking, cardava belongs to the *Musaceae* family and is a part of *Musa acuminatexbalbisiana* (ABB Group). Along with the saba, the cardava is the most popular cooking banana cultivar in the Philippines. It is categorized as a *balbisiana* cultivar or cooking banana. The Cardava banana is widely utilized in the manufacturing of food products that contain bananas, in addition to serving as a source of fresh food. The primary Cardava-based product, banana chips, is also a major export from the country, making Cardava one of the most significant crops farmed. Like most other banana cultivars, it is high in potassium and carbs and also offers an excellent amount of B vitamins and fiber. Churro originated from Spain, is a bakery product with dough based on wheat flour, water, and sugar, it has a cylindrical shape, and it is fried in oil, being externally covered with a very thin layer of sugar, which may or may not contain cinnamon (Silva et al., 2021). The popularity of churros has been steadily rising in the Philippines for several years. A growing number of cafés and companies are opening with churros as their major menu item, and many people are thinking about switching to the crispy pastry for lunch, supper, or even breakfast.

Cardava (*Musa acuminatexbalbisiana*) has been traditionally grown for the local market. In fact, according to a report from the Bureau of Agricultural Research in 2009, Cardava is the world's fourth most important staple next to rice, corn, and wheat (Calica et al., 2018). For a very long time, the Cardava (*Musa acuminatexbalbisiana*) has been a crucial food crop in the Philippines, offering both a valuable supply of food and a source of revenue as an export. Due to their year-round growth, cardava bananas contribute to food security and can be grown in areas where there is a risk of food scarcity and to supplement other crops. Though it is grown on a very modest scale in a few tropical and sub-tropical places worldwide, cardava is only produced commercially in the Philippines. Cardava trees can grow in most types of soil except in very sandy or rocky soils and they also like consistently warm, humid conditions. The raw material for making these churros is wheat flour. Wheat plants cannot develop well in tropical countries like the Philippines, at this time various kinds of raw materials can be used as flour in an effort to extend the shelf life of which comes from local food ingredients; namely fruits such as banana flour, breadfruit flour and so on (Faridah., et al 2022). The previous studies of (H.N. Ayo-Omogie et al., 2021) showed that green Cardava banana flour is a rich source of important micro and macronutrients, an indigestible fraction with higher resistant starch

than plantain. Its low glycemic index, coupled with high phenolic and flavonoid contents, makes it a potential functional food. In addition, the banana is available all year round, hence it is a cheaper alternative to seasonal conventional plantain. Based on its functional properties, Cardaba banana flour exhibited characteristics that make for a good binder, emulsifier, thickener, and aerating agent in food products. This is important for proposing Cardaba banana flour as an ingredient in new product development, incorporating it into the existing product churros. The nutritional value and wide range of applications of the Philippine Cardaba have recently captured the attention of the global market. According to the Philippine Statistics Authority (PSA), Davao Region was the top banana producer with 868.19 thousand metric tons output or 38.3 percent share to the total production in this quarter. This was followed by Northern Mindanao with 431.86 thousand metric tons (19.0%) and SOCCSKSARGEN with 279.20 thousand metric tons (12.3%). The April to June 2023 banana production was estimated at 2.269 million metric tons. This indicates an annual increase of 0.1 percent from the 2.267 million metric tons output in the same period of 2022.

Banana is a major fruit grown in the province. Total area covered by this crop is 3,109.54 ha. Dominantly produced banana is the Cardava variety (Department of Agriculture, 2022). The cardaba banana flour is a suitable choice for innovation by incorporating it into the traditional all-purpose flour making the most of its nutritional qualities and abundance through enhancing the flavor of churros. Moreover, it supports the possibility of improving churros, increasing their potential to be identified and fulfill the ever-changing palate of customers. To close this gap, this study evaluates the sensory characteristics, relevance and consumer acceptability of banana churros. The study generally aimed to determine the degree of acceptability of churros utilizing banana flour. Specifically, it sought to: (1) develop churros utilizing banana flour; (2) determine their level of acceptability in terms of texture, aroma, color, taste, and overall acceptability; and (3) identify the best formulation of churros utilizing banana flour.

## METHODOLOGY

**Research Design:** A total of six treatments were used in the experiment. A single factorial research design was used and arranged in Completely Randomized Design (CRD) with six levels of banana flour (132.6 grams, 117 grams, 85.8 grams, 70.2 grams, 39 grams, 23.4 grams) and all-purpose flour (23.4 grams, 39 grams, 70.2 grams, 85.8 grams, 117 grams, 132.6 grams) as independent variables. The efficiency and simplicity of using CRD is important for comparing six (6) treatments — it helps ensure that there are differences between treatments and differences are based on the formulations of each treatment. Butter, water, egg, and salt were constant in each treatment in this study. There were different measures of all-purpose flour and banana flour that were proposed in each treatment to determine the best formulation. The sensory evaluation score for texture, aroma, color, taste, and general acceptability were the dependent variables. Table 1 below features the six treatment combinations.

Table 1. Treatment Combination Levels

Treatment	Variables			
	All-Purpose Flour		Cardava Banana Flour	
	Grams	%	Grams	%
1	23.4	15%	132.6	85%
2	39	25%	117	75%
3	70.2	45%	85.8	55%
4	85.8	55%	70.2	45%
5	117	75%	39	25%
6	132.6	85%	23.4	15%

**Materials:** The tools and equipment used to accomplish the study were an electric oven, knife, mandolin slicer, sauté pan, measuring cups, measuring spoons, wooden spatula, piping bag, scissors, gas stove, and digital weighing scale.

### Preparation of Churros Utilizing Banana Flour

1. The researchers bought all the ingredients in the Naval, Biliran local market. The researchers used the cardava banana (a triploid hybrid banana cultivar from the Philippines) to make the cardava banana flour.
2. The process of making banana churros was formulating first the cardava banana flour. Green cardava bananas were sliced thinly and then placed in an electric oven at a temperature of 180 degrees Celsius for one hour and 50 minutes to dry. Then the dried bananas were placed in a food processor to grind and become a powder.
3. The next process was the making of banana churros. Ingredients were then weighed and measured. Ingredients like butter, salt, water, all-purpose flour, cardava banana flour, and egg were mixed in a sauté pan. Once cooled, it was placed in a piping bag molded into a 4-inch size, and fried. After frying, it was coated with powdered sugar immediately.

Figure 1 below illustrates the different steps in processing the cardava banana flour.

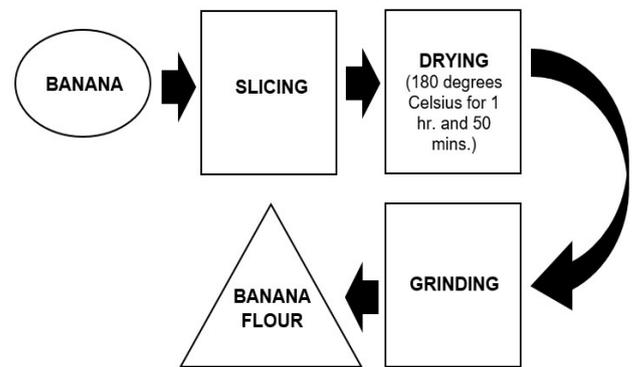


Figure 1. Process Flow in the Production of Cardava Banana Flour

Figure 2 below illustrates the different steps in processing the churros utilizing cardava banana flour.

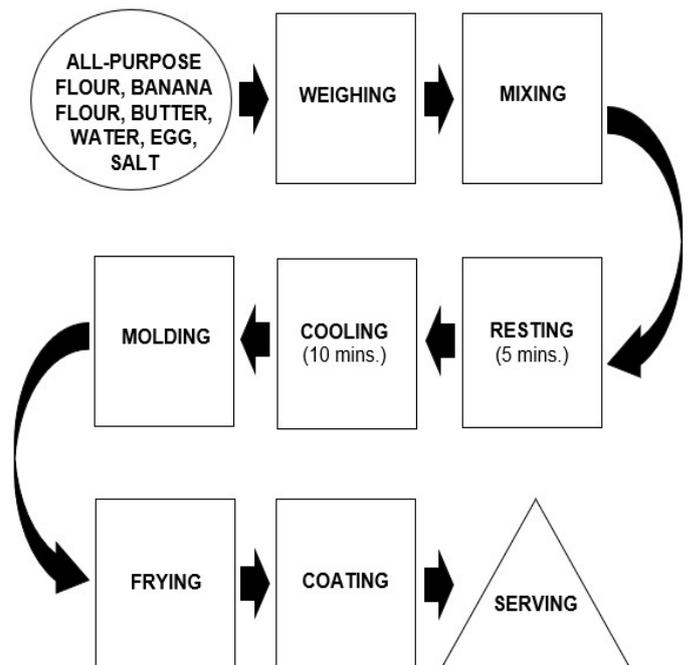


Figure 2. Process Flow in the Production of Cardava Banana Churros

**Sensory Evaluation:** Convenience sampling was used by the researchers to test the innovation. Six distinct treatments were asked to be evaluated by 60 respondents who gave their consent. A 10-gram sample was given to each respondent, who was asked to describe (4) attributes: texture, aroma, color, and taste. Based on their responses, they were also asked to rate the sample's overall acceptability on a nine-point Hedonic scale. 3-digit random codes were provided to each sample. The researchers were situated at the Biliran Province State University and used convenience sampling to obtain readily available respondents to evaluate the innovation. 30 students and 30 teachers from different departments evaluated the food using a nine-point hedonic scale. The 9-point hedonic scale is a common method for evaluating food products. The scale ranges from 1 (dislike extremely) to 9 (like extremely). The information gathered from the sensory evaluation is crucial since it tells the researchers how the respondents view the result. The data acquired can be used to modify the original recipe for churros and possibly produce new tastes for the final product.

**Statistical Analysis:** This study used different amount of all-purpose flour and banana flour to find the most suitable banana churros formulation. The optimal formulation was identified based on the findings of the sensory evaluation. The gathered data was interpreted and analyzed using Tukey's HSD. To ascertain whether there was a difference between the variables, one-way ANOVA was used.

## RESULTS

**Sensory Attributes of the Churros Utilizing Banana Flour:** This table presents the quality descriptions of the sensory attributes of churros utilizing banana flour for the six treatments as rated by the 60 panelists.

This table indicates the majority of respondents' descriptive observations about the products (texture, aroma, color, and flavor). Based on the results, the sensory attributes of churros utilizing banana flour are as follows: For Treatment 1, which consists of 15% all-purpose flour and 85% banana flour, the respondents perceived its texture as lightly soft and crunchy, well-blended banana flour and all-purpose flour for the aroma, dark brown, and more banana flour than all-purpose flour for the flavor. As for Treatment 2 which consists of 25% all-purpose flour and 75% banana flour, the respondents perceived its texture as soft, and for aroma, well-blended banana flour and all-purpose flour. The color was perceived as dark brown. Well-blended banana flour and all-purpose flour for the flavor. Moreover, for Treatment 3 which consists of 45% all-purpose flour and 55% banana flour, the respondents observed its texture as soft and has a well-blended banana flour and all-purpose flour aroma, the color was perceived as dark brown, and lastly, for flavor, it is well-blended banana flour and all-purpose flour. As to Treatment 4, it consists of 55% of all-purpose flour and 45% banana flour. It was observed as soft in texture, and aroma, well-blended banana flour and all-purpose flour. The color was observed as brown and, for the flavor, well-blended banana flour and all-purpose flour. In terms of Treatment 5, 75% of all-purpose flour and 25% banana flour. It was observed by the respondents that its soft in texture, and well-blended banana flour and all-purpose flour for the aroma. Brown in color, and well-blended banana flour and all-purpose flour in flavor. Lastly, for Treatment 6, which consists of 85% all-purpose flour and 15% banana flour. It was discerned as soft in texture. It has a well-blended banana flour and all-purpose flour aroma. Golden brown in color, and has a well-blended banana flour and all-purpose flour flavor.

T1-a, T2-b, T3-c, T4-d, T5-e, T6-f

**Texture.** The texture analysis table shows that the results of the texture differ among treatments.

**Table 2. Quality Descriptions of the Sensory Attributes of Churros Utilizing Banana Flour**

Treatment	All-Purpose Flour (%w/w)	Cardava Banana Flour (%w/w)	Texture*	Aroma*	Color*	Flavor*
1	15%	85%	Lightly Soft and Crunchy	Well Blended Banana Flour and All-Purpose Flour Aroma	Dark Brown	More Banana Flour Than All-Purpose Flour
2	25%	75%	Soft	Well Blended Banana Flour and All-Purpose Flour Aroma	Dark Brown	Well Blended Banana Flour and All-Purpose Flour
3	45%	55%	Soft	Well Blended Banana Flour and All-Purpose Flour Aroma	Dark Brown	Well Blended Banana Flour and All-Purpose Flour
4	55%	45%	Soft	Well Blended Banana Flour and All-Purpose Flour Aroma	Brown	Well Blended Banana Flour and All-Purpose Flour
5	75%	25%	Soft	Well Blended Banana Flour and All-Purpose Flour Aroma	Brown	Well Blended Banana Flour and All-Purpose Flour
6	85%	15%	Soft	Well Blended Banana Flour and All-Purpose Flour Aroma	Golden Brown	Well Blended Banana Flour and All-Purpose Flour

6TRT=treatment, n=60

**Table 3. General Acceptability of Churros Utilizing Banana Flour**

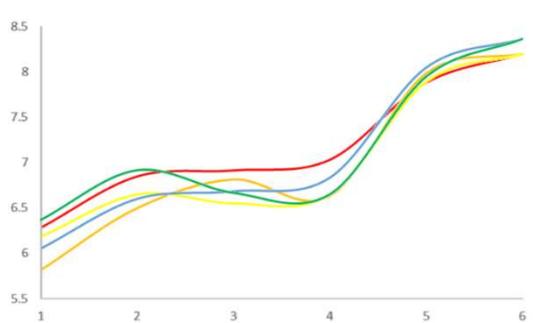
Treatment	All-Purpose Flour (%w/w)	Banana Flour (%w/w)	Texture*	Aroma*	Color*	Flavor*	General Acceptability*
1	15%	85%	6.05 <sup>a</sup>	6.37 <sup>a</sup>	6.18 <sup>a</sup>	5.82 <sup>a</sup>	6.28 <sup>a</sup>
2	25%	75%	6.60 <sup>b</sup>	6.92 <sup>b</sup>	6.65 <sup>b</sup>	6.50 <sup>b</sup>	6.85 <sup>b</sup>
3	45%	55%	6.68 <sup>c</sup>	6.67 <sup>c</sup>	6.55 <sup>c</sup>	6.82 <sup>c</sup>	6.92 <sup>c</sup>
4	55%	45%	6.83 <sup>d</sup>	6.65 <sup>d</sup>	6.65 <sup>d</sup>	6.63	7.03 <sup>d</sup>
5	75%	25%	8.05 <sup>abcd</sup>	7.95 <sup>abcd</sup>	7.90 <sup>abcd</sup>	7.98 <sup>abc</sup>	7.88 <sup>abcd</sup>
6	85%	15%	8.37 <sup>abcd</sup>	8.37 <sup>abcd</sup>	8.20 <sup>abcd</sup>	8.20 <sup>abc</sup>	8.20 <sup>abcd</sup>
<b>Mean</b>			7.10	7.15	7.02	6.99	7.19

Means with common letters within a column are significantly different at 5% level of significance based on Tukey's HSD. 9-point Hedonic Rating Scale: 1=dislike extremely, 2=dislike very much, 3=dislike moderately, 4=dislike slightly, 5=neither like nor dislike, 6=like slightly, 7=like moderately 8=like very much, 9=like extremely

Treatments 1, 2, 3, and 4 with a mean texture score ranging from 6.05 to 6.83 interpreted as “like slightly” can affect the texture acceptability of Treatments 5 and 6 with a mean texture score ranging from 8.05 to 8.37 interpreted as “like very much”. This implies that decreasing banana flour may yield a relatively preferable texture. A broader study may be needed to confirm these findings determine the best texture.

impact on the overall acceptance of the finished product. Treatments that contained a lower percentage of banana flour had a greater tendency to be well-liked, showing a preference for the sensory qualities that are associated with all-purpose flour. As shown in Table 4, the following sensory attributes (from the regression) which is the texture, aroma, color, flavor and overall acceptability were pertinent to the changes in the levels of banana flour.

**Table 4. Optimum formulation of Churros Utilizing Banana Flour**



Texture Acceptability    Aroma Acceptability    Color Acceptability    Flavor Acceptability    General Acceptability

**Aroma.** Treatment 6 (85% all-purpose flour and 15% banana flour) has the highest sensory score of 8.37 interpreted as “like very much”. On the other hand, Treatment 1 (15% all-purpose flour and 85% banana flour) received the lowest score of 6.37 interpreted as “like slightly”. Treatments 1, 2, 3, and 4 with an average mean texture score ranging from 6.37 to 6.65 interpreted as “like slightly” can significantly affect the aroma acceptability of Treatments 5 and 6 with a mean texture score ranging from 7.95 to 8.37. This means that lesser amount of banana flour has a more aroma acceptability than Treatments with higher amount of banana flour.

**Color.** The color acceptability result shows the Statith higher sensory scores. Treatments 1, 2, and 3 with higher banana flour content resulted in darker color product which greatly affected its color acceptability. Treatment 6 with 85% all-purpose flour and 15% banana flour received the highest score suggesting that it has the most acceptable color among all treatment

**Flavor.** Treatment 1 (15% all-purpose flour and 85% banana flour) received the lowest mean score of 5.82 interpreted as “neither like nor dislike” while Treatment 6 has the highest mean score of 8.20 with a standard interpretation of “like very much” suggesting that Treatment 6 which was made of 85% all-purpose flour and 15% banana flour achieved the right optimum formulation in production of banana churros.

**General Acceptability.** Treatment 1 obtained a general acceptability score of 6.28 interpreted as “like slightly”. For Treatment 2, the general acceptability score of 6.85 was interpreted as “like slightly”. While, for Treatment 3, the general acceptability score is 6.92 interpreted as “like slightly”. Moreover, Treatment 4 garnered a total of 7.03 for the general acceptability which is interpreted as “like moderately”. As for Treatment 5, the general acceptability score of 7.88 is interpreted as “like moderately”. Lastly, Treatment 6 obtained a general acceptability score of 8.20 interpreted as “like very much”. These results suggest that all 6 treatments are generally accepted by the respondents. However, Treatment 6 has the highest general acceptability score with a weighted mean of 8.2 interpreted as “like very much”, indicating that it is the most preferred treatment. The overall result of the study base on the general acceptability obtained a total weighted mean of 7.19 interpreted as is “like moderately”. According to the findings of this research, the proportion of all-purpose flour to banana flour that is blended has a considerable

The majority of the parameters such as texture, aroma, color, flavor and overall acceptability increased at Treatment 6. Therefore, at this ascertain point it is considered as the best formulation of churros utilizing banana flour.

## CONCLUSIONS

The result of the study found that the general acceptability of formulated churros utilizing banana flour obtained an average descriptive score indicating that the best formulation is Treatment 6 with 85% all-purpose flour and 15% banana flour. This formulation received the highest overall acceptability score and the highest level of acceptability in terms of its texture, aroma, color, and flavor. The banana churros has the potential to become an innovative product with nutritional value.

## RECOMMENDATIONS

Based on the findings and conclusion of the study, the following recommendations are put forward: (1) use 132.6 grams of all-purpose flour and 23.4 grams of banana flour in the preparation of churros utilizing banana flour; (2) conduct further research to validate the results and to compare churros made with banana flour to other banana-based flour pastries, given the limited scope of only six treatments; (3) compute the production cost per piece of banana churros; (4) undertake a study on the nutritional value and shelf life of churros utilizing banana flour; and (5) encourage food vendors and business sectors to introduce and market this innovative pastry.

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