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Green Crunch: Utilizing Cassava Leaves (*Manihot Esculenta Crantz*) into Healthy Chips

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ABSTRACT: This study, titled "Green Crunch: Utilizing Cassava Leaves (Manihot esculenta Crantz) into Healthy Chips", explores the possibilities of using cassava leaves as an innovative raw material for producing healthy and environmentally friendly snack products. The study aimed to determine the acceptability of cassava leaf chips based on color, texture, taste, and aroma using two different treatment processes: (1) direct frying after seasoning, and (2) blending, steaming, drying, and frying. A sensory evaluation was carried out among 50 respondents using a 5-point hedonic scale. Results revealed that both treatments were acceptable; however, Treatment 2 had the highest overall weighted mean (4.92), and interpreted as "*Highly Acceptable*". The enhanced processing technique contributed to better texture, flavor uniformity, and aroma. The results show that cassava leaves, which are usually considered agricultural waste, can be transformed into a sustainable and marketable food product that promotes health, minimizes waste, and cultivates local agriculture. This study advocates for sustainable food innovation through converting underutilized resources into high-value, eco-conscious consumer products.

KEYWORDS: Cassava Leaves, Healthy Chips, Sensory Evaluation, Sustainable Food Innovation, Agricultural Waste Reduction, Eco-Friendly Packaging

I. INTRODUCTION

In many farming communities across the Philippines, cassava (Manihot esculenta Crantz) is a familiar and important crop. Its starchy roots are widely used for food and industry, yet the leaves, though highly nutritious, are often ignored or thrown away. These leaves are rich in protein, calcium, iron, and other nutrients that can help improve local diets. Fasuyi (2005) found that cassava leaves are an excellent source of essential amino acids and minerals, proving that what is often seen as waste could actually be a valuable food resource. The Green Crunch project was created to change how people see cassava leaves. Instead of treating them as leftovers, this initiative transforms them into something exciting: crunchy, tasty, and nutritious cassava leaf chips. The project's goals are simple but meaningful—to reduce agricultural waste, develop a variety of cassava leaf chip flavors, and find out how acceptable these chips are to consumers in terms of color, texture, taste, and aroma.

Scientific studies have long shown the nutritional potential of cassava leaves. They can contain up to 39.9% protein, along with minerals like iron and calcium and vitamins such as carotenoids and vitamin C (Charles et al., 2005; Montagnac et al., 2009). However, cassava leaves also contain natural compounds called cyanogenic glycosides, which can be harmful if not processed correctly. Proper preparation methods—like blanching, drying, and fermentation—can safely remove these toxins (Ravindran, 1993). Green Crunch follows these safe food-handling techniques to make sure the chips are both healthy and safe to eat.

Aside from being nutritious, cassava leaves have also shown promise in food innovation. Neves et al. (2022) discovered that adding cassava leaf flour to biscuits made them more nutritious without affecting their taste or texture. Likewise, Ketipearachchi et al. (2023) successfully created cassava-based snacks that people enjoyed in sensory evaluations. These findings inspired Green Crunch to explore similar product development, creating flavored cassava leaf chips that could appeal to both kids and adults who want healthier snack options.

Sustainability is another key value of the Green Crunch project. By making use of cassava leaves—an agricultural by-product—farmers can earn extra income while reducing waste. The Food and Agriculture Organization (FAO, 2004) emphasized that reusing root and tuber by-products can help strengthen local livelihoods and cut down post-harvest losses. Green Crunch also promotes environmental care by using biodegradable packaging, showing that good food can be made responsibly without harming the planet.

The project features four exciting chip flavors: Original, Cheese, Barbecue, and Sour Cream. To find out which ones consumers prefer, a sensory evaluation will be conducted focusing on color, texture, taste, and aroma. According to Meilgaard et al. (2016), sensory evaluation is essential in understanding what people like and how products can be improved before launching them in the market. Through this process, Green Crunch hopes to identify the most appealing product formulation that balances great taste with nutritional value.

In the end, Green Crunch is more than a snack—it's a statement. It proves that innovation can start with something as simple as a leaf. By reimagining cassava leaves as healthy chips, the project brings together nutrition, sustainability, and community empowerment. It supports local farmers, promotes healthier eating habits, and helps reduce waste, all while introducing a new and delicious product to the market. Most importantly, it shows that with creativity and responsible innovation, even the most overlooked agricultural materials can make a big difference in building a more sustainable and healthier food system for future generations.

This study aims to:

1. Reduce agricultural waste by repurposing cassava leaves;
2. Develop a variety of cassava leaf chips; and
3. Determine the acceptability of cassava leaf chips in terms of color, texture, taste, and aroma.

II. METHODOLOGY

This chapter contains the materials/ingredients, equipment, procedures, experimental design, collection of the data, statistical tools and analysis used in the study.

Research Design

This study will utilize an experimental research design to develop and evaluate cassava leaf chips. The design is appropriate because it involves formulating, processing, and testing a new food product while controlling key variables such as ingredient proportions, processing methods, and sensory attributes. The experiment aims to determine the most acceptable formulation of cassava leaf chips in terms of color, taste, texture, and aroma. The study also incorporates descriptive and sensory evaluation methods to measure consumer perceptions and preferences.

Data Analysis

The data were analyzed using one-way analysis of variance (ANOVA) to determine which is more acceptable between the two treatments in terms of color, texture, taste, and aroma. The independent variable consisted of the two treatments of cassava leaf chips, while the dependent variables were the sensory evaluations, which included color, texture, taste, and aroma.

Data Gathering

Sensory evaluation was conducted at the Isabela State University-City of Ilagan Campus to determine the cceptability of the cassava leaf chips in terms of color, texture, taste, and aroma. The instrument used in data gathering was a score sheet using the 5-point hedonic scale.

The range of scale is interpreted as follows:

Scale	Mean	Descriptive Interpretation
5	4.50 - 5.00	Highly Acceptable
4	3.50 - 4.49	Acceptable
3	2.50 - 3.39	Moderately Acceptable
2	1.50 - 2.49	Slightly Acceptable
1	1.00 - 1.49	Not Acceptable

A sensory panel for this project was composed of 50 individuals who were twenty (20) Master of Arts in Industrial Education students, five (5) faculty, and twenty-five (25) random students.

Ingredients/Materials and Equipment Needed in Making Cassava Leaf Chips

These materials and equipment are essential for making cassava leaf chips, ensuring a smooth preparation process and delicious final product.

Table 1: Ingredients/Materials and Equipment Preparation

Category	
Ingredients and Flavoring	- Fresh Cassava Leaves - All-purpose flour - Salt - Water - Pepper - Garlic Powder - Paprika - Eggs - Chicken Cube - Ice (for cooling and soaking process) - Cooking Oil

	- Barbeque Powder - Sour and Cream Powder - Cheese Powder
Materials	- Biodegradable packaging - Label (for packaging) - Clean containers (for washing and soaking cassava leaves) - Mixing bowls (for combining ingredients) - Trays (for sun-drying the cassava chips) - Measuring spoons (for seasonings and mixture portions) - Puto molds (used for steaming in Treatment 2) - Strainer (for draining excess oil)
Equipment	- Cooking pot (for boiling cassava leaves) - Frying pan or deep fryer - Blender (used in Treatment 2 for blending cassava leaves and spices) - Steamer (for the steaming process in Treatment 2)

Processes applied in making cassava leaf chips along the two treatments.

The researcher executed the process of making chips out of cassava leaves using the following steps:

Procedure: (*First treatment of cassava leaf chips*)

1.) Harvest and wash the leaves.

Pick fresh cassava leaves and wash thoroughly with clean water to remove dirt and impurities.

2.) Boil the leaves.

Boil the cassava leaves for about 15-30 minutes on low heat to remove the natural toxins (cyanide).

3.) Drain and let the boiled leaves cool with the use of ice.

Dry the leaves and soak them in a bowl with ice for 15 minutes to cool them down.

4.) Season the leaves.

Once cooled down, lightly coat with all-purpose flour, egg, garlic powder, paprika, pepper, and salt mixture.

5.) Cook the chips.

Heat oil and fry until crispy for about 1-5 minutes.

6.) Drain the excess oil and put in flavoring.

Drain the excess oil using a strainer and add flavoring after draining (barbecue, sour cream, and cheese).

7.) Pack and add a label.

Pack the chips after adding the flavoring in a desired weight; the packaging is biodegradable.

Procedure: (*Second treatment of cassava leaf chips*)

1.) Harvest and wash the leaves.

Pick fresh cassava leaves and wash thoroughly with clean water to remove dirt and impurities.

2.) Boil the leaves.

Boil the cassava leaves for about 15-30 minutes on low heat to remove the natural toxins (cyanide).

3.) Drain and let the boiled leaves cool with the use of ice.

Dry the leaves and soak them in a bowl with ice for 5 minutes to cool them down.

4.) Mix the cassava leaves, garlic powder, paprika, pepper, salt, chicken cube, and water using a blender.

Mix the cassava leaves with garlic powder, paprika, pepper, salt, chicken cube, and water using a blender until it reaches the right consistency.

5.) Mix the blended cassava leaves with all-purpose flour.

Transfer the blended cassava leaves into a bowl and add all-purpose flour, and mix until it is well combined.

6.) Put it in a puto mold and steam it for 5 minutes.

Using a puto mold, put in ½ tablespoon of the combined mixture of cassava leaves, and steam it for 5 minutes.

7.) Sun-dry the steamed cassava leaves for 2 days.

After steaming it, transfer it into a tray and sun-dry it for 2 days.

8.) Fry the dried cassava leaf chips.

Fry the dried cassava leaf chips in low heat, and you can now taste the final product.

9.) Drain the excess oil.

Drain the excess oil using a strainer.

10.) Pack and add a label.

Pack the chips after draining the excess oil; the packaging is biodegradable.

III. RESULTS AND DISCUSSION

This chapter presents the results, discussion, and the personal insight that the researchers have gathered.

The study aimed to determine the acceptability of cassava leaf chips as an alternative nutritious snack, focusing on four sensory attributes—**color, texture, taste, and aroma**—along with the two treatments.

Figure 1. Sample Products developed.

Table 2: Level of Acceptability along Treatment 1

Treatment 1	Sensorial Criteria	Mean	Descriptive Interpretation
Direct frying after seasoning	Color	4.29	Acceptable
	Texture	4.16	Acceptable
	Taste	4.14	Acceptable
	Aroma	4.33	Acceptable
	Overall Weighted Mean	**4.23**	**Acceptable**

The table shows that for the first treatment, which is direct frying after seasoning, the color (4.29), texture (4.16), taste (4.14), and aroma (4.33) were rated "Acceptable". The overall weighted mean of 4.23 was described as "Acceptable". This goes to show that treatment 1 has a strong liking for the evaluators.

Table 3: Level of acceptability along treatment 2

Treatment 2	Sensorial Criteria	Mean	Descriptive Interpretation
Blending, steaming, drying, and frying	Color	4.96	Highly Acceptable
	Texture	4.90	Highly Acceptable
	Taste	4.92	Highly Acceptable
	Aroma	4.90	Highly Acceptable
	Overall Weighted Mean	**4.92**	**Highly Acceptable**

The table presents the level of acceptability of the second treatment, which is blending, steaming, drying, and frying. As seen in the table, the color (4.96), texture (4.90), taste (4.92), and aroma (4.90) were rated "Highly Acceptable". Meanwhile, the overall weighted mean is 4.92, which is interpreted as "Highly Acceptable". This shows that treatment 2 was tremendously preferred by the respondents.

Based on the sensory evaluation conducted among respondents, **Treatment 2 obtained the higher overall acceptability rating**, indicating that the additional processing steps—such as blending, steaming, and drying—resulted in a more refined texture and uniform flavor that were favored by the respondents.

IV. CONCLUSION

The study, Green Crunch: Utilizing Cassava Leaves (Manihot Esculenta Crantz) into Healthy Chips, demonstrated that cassava leaves can be effectively transformed into healthy, palatable, and eco-friendly snack products. The findings confirmed that both treatments—direct frying after seasoning and blending, steaming, drying, and frying—produced acceptable results in terms of color, texture, taste, and aroma. However, the second treatment was rated *"Highly Acceptable"* by the respondents with the highest overall mean score of 4.92. The additional steps in preparation contributed to a more refined texture, enhanced flavor, and improved aroma, making it more appealing to consumers. This result justifies the possibility of cassava leaves, which are often discarded as agricultural waste, to becoming a valuable food source. Through repurposing these leaves into healthy chips, the project not only

presents a sustainable snack alternative but also promotes waste reduction, supports local farmers, and encourages healthy eating habits. Furthermore, the utilization of biodegradable packaging reinforces the project's commitment to environmental sustainability. In summary, the Green Crunch project shows that innovation in food processing is capable of producing practical solutions for nutrition, sustainability, and community development. With proper processing and continuous improvement, cassava leaf chips can serve as a good commercial product that benefits both consumers and the environment.

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