



## BICARA (Carica Seed Powder): Developing Innovation from Carica Seed Waste into Economically Valuable Products

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### ABSTRACT

The utilization of agro-industrial waste that has not been optimized poses a challenge in the development of food innovations based on local resources. One of the wastes that has the potential for development is the seeds of *Carica papaya*, typical of the Dieng Plateau, which have not been maximally utilized. This study aims to analyze the potential of carica seeds as raw materials for value-added food powder through a post-harvest processing approach. The research method uses an experimental approach with stages of seed cleaning, fermentation, drying, and grinding, accompanied by qualitative descriptive analysis of the organoleptic characteristics of the products. The results show that carica seeds do not produce a spicy flavor as assumed to be an alternative to black pepper, but instead produce a distinctive aromatic character resembling butterscotch and hazelnut. These findings indicate a shift in the utilization orientation of carica seeds from a substitute spice for black pepper to an aromatic powder with differentiating characteristics. The BICARA innovation contributes to increasing the added value of agro-industrial waste and opens up opportunities for the development of food products based on local wisdom. Conceptually, this research shows that the processing of carica seed waste has the potential to support the application of circular economy principles, reduce environmental burdens, and strengthen the competitiveness of local food products through a sustainable entrepreneurship approach.

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## INTRODUCTION

Indonesia is often referred to as an agrarian country with abundant biodiversity, especially in spices and diverse culinary offerings. However, there are still many potential local food sources, with significant challenges arising from the management of agro-industrial waste that has not been optimally utilized, particularly waste from processed fruits. The processing of *Carica papaya*, typical of the Dieng Plateau, is often cited as one of the regions producing unique horticultural products, including the fruit *Carica papaya* or carica dieng, which morphologically resembles papaya but has a distinctive flavor ([Sasongko, 2016](#)). The carica processing industry in Wonosobo

and its surroundings has rapidly developed in the form of candied products, syrups, and chips, making carica a local culinary icon and a tourist attraction ([Amelia, 2019](#)).

According to data from the Trade Office, there are 64,710 carica trees recorded in Wonosobo Regency, capable of producing around 3,997 tons of fruit. Additionally, there are about 300 entrepreneurs involved in processing carica fruit ([BPS Wonosobo, 2022](#)). This production activity generates significant side waste in the form of carica seeds, amounting to approximately 9 tons each month. This means that the higher the production of processed carica, the greater the volume of waste generated.



Figure 1. Waste from Carica Processing in the Form of Seeds and Pulp

Several studies have shown the processing of carica seed waste. Among them, [Lestari \(2021\)](#) demonstrated that carica seeds can be processed into antioxidant drink powder. Additionally, [Tania \(2021\)](#) developed a product called Parca Natural Scent that uses carica seeds as the main ingredient, aiming to utilize the fruit waste that is often discarded. However, the utilization of carica seed waste through processing is still very limited. Most of it is not managed optimally and tends to be discarded or used as fish feed. For example, in the production of Carica Laatsania in Kejiwan Village, Wonosobo, carica seed waste is only utilized as fish feed without any further processing.

Other research also indicates that carica seeds have scientific potential, as stated by Ochse (1931) (in [Wijayanti, 2016](#)), who noted that carica seeds have a spicy or sharp taste with a distinctive aroma. [Putri \(2021\)](#) also mentioned that carica seed waste has the potential to be processed as an alternative to black pepper, although it has a lower spiciness quality compared to pepper. However, there has been no realization of products or further development regarding this.

Based on the above issues, two main problems arise. First, from an environmental perspective, unprocessed organic waste can accumulate and pollute the environment. Second, from an economic perspective, discarding seeds means neglecting the potential added value that can be processed into commercially valuable products. Therefore, the researchers want to find out whether carica seeds can truly serve as an alternative to black pepper and turn them into a product that can enhance the economic value of carica seed waste.

The processing of food waste to have more benefits in this research also serves as a form of applying the principles of circular economy, which is now a global strategy to reduce environmental impact ([Garcia-Garcia et al., 2019](#); [Geissdoerfer et al., 2017](#)). This innovation aligns with the Sustainable Development Goals (SDGs), particularly SDG 12 on responsible consumption and production. By transforming carica seed waste into economically valuable

products, this research not only addresses environmental issues but also creates new entrepreneurial opportunities based on local wisdom.

The contributions of this research encompass theoretical, practical, and socio-economic domains. Theoretically, this research enriches the literature on food innovation based on agro-industrial waste, emphasizing that waste can serve as the basis for product differentiation. Practically, this research presents a new product that has the potential to be marketed as a typical souvenir from Wonosobo or as an exotic powder for modern cuisine. Socio-economically, by integrating environmentally friendly and community-based principles, this research supports the achievement of the Sustainable Development Goals (SDGs), particularly SDG 8 (inclusive economic growth) and SDG 12 (sustainable consumption and production). The research approach taken in this study is supportive, corrective, and developmental.

## METHODS

This research employs an experimental approach combined with qualitative descriptive analysis to explore the potential utilization of carica seed waste. The experimental method is applied to test the initial hypothesis regarding the potential of carica seeds as a substitute for black pepper through the arrangement and control of certain process variables. On the other hand, qualitative descriptive analysis is utilized to identify and explain unexpected findings, such as the emergence of distinctive aroma characteristics during the processing stages.

The combination of both approaches is considered the most suitable as it meets the needs for collecting technical data while also providing a narrative description of the observed sensory phenomena. The choice of this method is based on the exploratory nature of the research object, which is oriented towards new product innovation. With this approach, researchers have the flexibility to shift the focus of the study from testing the level of spiciness to developing aroma characteristics. The entire methodological procedure is structured so that every change in the characteristics of the materials can be systematically recorded and scientifically accounted for.

This research design is structured using a case study method that focuses on the principles of circular economy and sustainability in the agro-industry in Wonosobo. The research design structure directs the workflow towards a series of measurable experiments, starting from the cleaning stage to the final processing into powder products. Detailed stages regarding the transformation of waste are visually presented in a process flow diagram that includes crucial steps such as fermentation and heating. Each stage in the design is intended to observe the material's reaction to the specified temperature and duration variables systematically. The image below provides a comprehensive overview of the sequence of experiments conducted to explore new functional potentials in carica seeds. The focus on the case study allows researchers to delve into the specific characteristics of waste that have had limited economic value. This design ensures continuity between field data collection, production processes, and comprehensive final analysis.

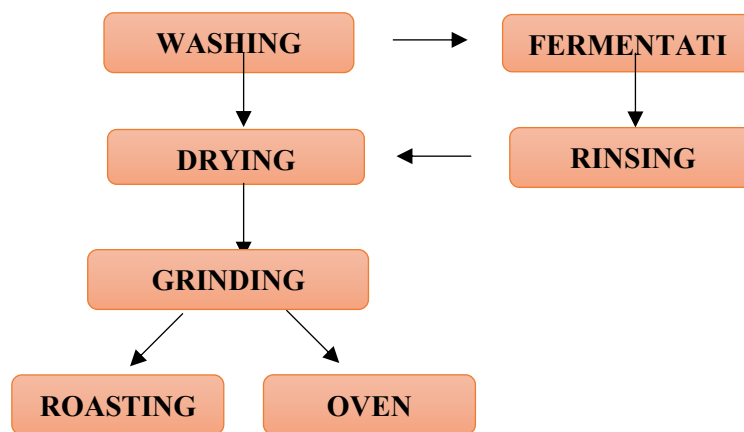


Figure 2. Flowchart of the Carica Seed Processing Experiment

The instruments used in this research include field observation devices, literature studies, and systematic experimental documentation protocols. Direct observation was employed to collect primary data regarding the quantity of waste, while the literature review served to identify research gaps related to nutritional content. In the experimental phase, the main instrument used was a process variable recording sheet that detailed temperature, dosage, and fermentation duration. This procedural documentation ensures that all stages from raw materials to final products can be accurately replicated by other researchers. Sensory testing also involved a guide for organoleptic description to record the characteristics of color, taste, and aroma profile that emerged in depth. All these instruments were calibrated to capture both technical quantitative data and sensory qualitative data from the produced products. The structured use of instruments guarantees the validity of the data collected during the research period.

The data analysis techniques in this study were conducted through several stages, starting from qualitative descriptive analysis to conceptual entrepreneurship analysis. After the experimental phase was completed, the powdered product was independently analyzed through organoleptic observation to identify the physical properties of the powder. Data from the observations and experimental documentation were then synthesized to validate the shift in research focus from spicy seasoning to aromatic materials. Additionally, an entrepreneurial framework was used to assess the potential product positioning and its competitive advantages in the dynamic creative culinary market. This analysis aims to formulate product differentiation to achieve high economic value as a highly innovative natural aromatic powder. The final analysis technique includes formulating conclusions and research implications for marketing strategies and potential waste utilization in the future. This analytical approach ensures that the research results have a strong descriptive foundation, even though they have not undergone technical laboratory testing.








## RESULTS AND DISCUSSION (12 PT)









This research began with the hypothesis that carica seeds could potentially serve as an alternative to black pepper due to the suspected spiciness contained within them. The validation of this hypothesis was conducted through experiments using various methods, including the



addition of supporting ingredients such as salt, baking powder, baking soda, and citric acid, aimed at reducing the natural bitterness of carica seeds to enhance the likelihood of the hypothesis being true. The use of these ingredients was based on previous literature, where salt is known to suppress bitterness in food ([Keast & Breslin, 2002](#)), baking soda functions to neutralize acids that cause bitterness ([McGee, 2004](#)), baking powder is often used to improve flavor and texture profiles ([Mulyani, 2021](#)), while citric acid is widely utilized to balance flavors and mask natural bitterness ([Martins et al., 2019](#)).

The following table summarizes the results of the additional ingredient trials on carica seeds:

Table 1. Carica Seed Processing Experiment

No.	Sub Material	Results Product	Color	Flavor	Aroma
1	Without fermentation		14	12	1
2	Baking powder (30 grams) and water (250 ml)		9	8	15
3	baking powder (30 grams) and water (250 ml)		6	9	16
4	baking soda (30 grams) and water (250 ml)		1	10	7
5	baking soda (30 grams) and water (250 ml)		5	11	8
6	citric acid (30 grams) and water (250 ml)		18	3	10
7	citric acid (30 grams) and water (250 ml)		16	4	11

8	salt (4 grams) and citric acid (2 grams) and water (300 ml)		10	5	12
9	salt (4 grams) and citric acid (2 grams) and water (300 ml)		15	6	6
10	salt (4 grams) and baking soda (1 gram) and water (300 ml)		3	7	5
11	salt (4 grams) and baking soda (1 gram) and water (300 ml)		7	2	9
12	salt (4 grams) and baking powder (2 grams) and water (300 ml)		13	1	17
13	salt (4 grams) and baking powder (2 grams) and water (300 ml)		2	14	4
14	baking soda (1 gram) and baking powder (1 gram)		17	15	18
15	baking soda (1 gram) and baking powder (1 gram)		4	16	3

16	Without fermentation		8	13	2
17	salt 30 grams and water (300 ml)		12	17	13
18	salt 30 grams and water 300 ml)		11	18	14

Based on the data presented in the table above, the use of additives to reduce bitterness only provides limited improvement in several experimental parameters and has not been able to produce the spiciness characteristic of black pepper. The experimental results instead revealed the emergence of a distinctive aroma that serves as the main differentiating factor of the product, thus emphasizing that the main advantage of carica seed powder lies in its unique and exotic aromatic character. Organoleptically, the carica seed powder produced through various treatments shows diverse characteristics, where the powder that is dried and then directly roasted or baked produces a strong and exotic aroma with a color resembling cocoa powder, while the powder from fermented carica seeds exhibits a range of flavors from slightly sour to neutral, with some treatments capable of reducing bitterness levels, although a bitter aftertaste remains in some samples. This variation indicates that post-harvest treatments significantly influence the formation of aroma, flavor, and final color of the product.

Of the total 18 trials conducted, the 1st and 16th experimental processes showed the most optimal results as they were able to produce the strongest and most appealing aroma, although further testing proved that both treatments did not produce the spiciness characteristic of black pepper. Conversely, carica seeds processed without undergoing fermentation produced a distinctive aroma resembling butterscotch and hazelnut, which was an unexpected finding and significantly shifted the research focus from seeking spicy characteristics to exploring the potential of natural aromas. This finding prompted a shift in research focus from developing a substitute spice for black pepper to developing an aromatic powder with strong distinguishing features.

The aroma profile produced in the experimental process provides a stronger unique selling proposition (USP) compared to if the product were only positioned as an alternative to black pepper. In line with this finding, the production of aromatic powder with aromas resembling butterscotch and hazelnut was carried out using the same raw materials and process stages, with the difference in aroma character primarily influenced by variations in roasting duration ([Yuniarti, 2022](#)). The process began with washing the carica seeds to remove dirt and residual slime, followed by drying through sun exposure until the moisture content decreased, and then roasting to trigger the formation of aromatic compounds due to heat treatment. Roasting for approximately 4 minutes produced an aroma resembling butterscotch, while roasting for approximately 7 minutes produced

an aroma resembling hazelnut, where the difference in roasting duration affects the formation of volatile compounds and results in different aroma characteristics. After roasting, the seeds were cooled and ground until a fine-textured powder with a distinctive aroma resembling butterscotch and hazelnut was obtained.



Figure 3. Product Photo

Based on the experiments conducted, from the aspect of product flavor, further refinement is still needed through additional research because various processing methods that have been applied, such as baking, roasting, and fermentation, have not fully produced a stable and consistent flavor profile, and a relatively high level of bitterness is still found in some samples, thus limiting its use to certain culinary applications. This condition further reinforces the finding that the main value of the product does not lie in its spiciness, but rather in the strength and uniqueness of its aroma.

From the perspective of sustainability, the utilization of carica seeds as aromatic powder reflects the application of circular economy principles as proposed by [Apriyanto et al. \(2020\)](#) regarding the potential of fruit waste as an alternative food source. Thus, this research not only presents food innovation based on local wisdom but also opens up opportunities for sustainable business development for SMEs in the Wonosobo region and fills the research gap that has yet to explore carica seeds as aromatic powder material.

## CONCLUSION

This research concludes that carica seeds (*Carica pubescens*), which were initially positioned as an alternative to black pepper, empirically do not exhibit spicy flavor characteristics but instead transform into an aromatic powder product with a unique profile resembling butterscotch and hazelnut. Through a series of experiments, it was found that the non-fermentation processing technique using heating methods (roasting and oven) is key to extracting these exotic aromas. This finding fundamentally corrects previous hypotheses and has a significant impact on the valorization strategy of agro-industrial waste, which has had marginal economic value. The practical impact of this research is the creation of the "BICARA" product innovation, which has a high competitive advantage (USP) in the creative culinary market, while also serving as a model for implementing a circular economy that supports the achievement of SDG 12 in responsible

production. Thus, this research successfully transforms the perception of waste into functional aromatic raw materials that strengthen the identity of local commodities in Wonosobo.

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