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INNOVATION OF ADDING GREEN MUSTARD TO RICE CRACKERS

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Abstract

Crackers are a type of dry food that contains quite high starch, made from tapioca flour as a base ingredient. Different spices are added to produce different types of crackers. Crackers can also be innovated by using other ingredient substitutions that aim to add and have functional value, one of which is the addition of green mustard. This research aims to utilize green mustard into an innovative rice cracker product. This is caused by the lack of rice cracker products with vegetables as processed products. This study uses a quantitative approach. Specifically, this research was carried out using the rules of the experimental method which is laboratory research. This research uses quantitative data in the form of formula recipes and results of sensory tests and organoleptic tests. The formula or recipe comes from experimental tests carried out in the laboratory, namely the Bali International Polytechnic kitchen. Meanwhile, organoleptic test data was obtained from research respondents. Experiments in the laboratory and collecting responses from respondents are the primary data sources in this research. Apart from that, this research also uses secondary data sources in the form of literature related to the research topic. This research uses cracker processing theory and culinary product development models as a basis for carrying out research. Based on the results of experiments, rice crackers with the addition of green mustard can be developed into crackers that have a different color, aroma, taste, texture & crunch, as well as a shape from rice crackers in general. Crackers produced using the same method but with the addition of green mustard are more popular in terms of taste, texture, aroma, shape and color, better than rice crackers in general. And this research also found that crackers that have been dried for a long time must be dried again in the hot sun so that the crackers can bloom perfectly.

Keywords: Innovation, Crackers, Green Mustard

1. INTRODUCTION

Crackers are a popular snack across Southeast Asia, particularly in Indonesia, where they are consumed as both accompaniments to meals and standalone snacks. Traditionally made from starchy ingredients like tapioca flour, crackers have evolved significantly with innovations aimed at enhancing both flavor and nutritional value. Such innovations often involve incorporating additional ingredients like vegetables or proteins, which provide functional benefits beyond the conventional formula (Kawiji, 2009; Krisnawati, 2022).

In Indonesia, food waste remains a critical issue, particularly with leftover rice, a staple food central to the Indonesian diet. Studies indicate that households waste between 54.58 g and 185.55 g of rice monthly, which, if repurposed, could yield high-value food products (Nafiroh et al., 2019). One promising solution to this challenge is turning leftover rice into rice crackers, an innovative approach that minimizes waste while creating a nutritious and appealing product.

Green mustard, or *Brassica rapa* subsp. *pekinensis*, is a widely cultivated leafy vegetable in Indonesia, known for its high nutritional value, including vitamins A, C, K, and antioxidants. Its health benefits range from boosting immunity to reducing the risk of chronic diseases such as cancer and heart disease (Jatnika, 2010; Alifah, 2019). Despite its abundance and nutritional profile, green mustard is often limited to traditional culinary uses, such as fresh consumption or as an ingredient in soups and stir-fries. There is considerable untapped potential to incorporate it into processed foods, such as crackers, to broaden its applications and increase its consumption (Sari, 2021).

This study explores the integration of green mustard paste into rice crackers, aiming to enhance the product's sensory and nutritional qualities. By utilizing readily available and underutilized ingredients like green mustard and leftover rice, this research promotes sustainable culinary practices while innovating within Indonesia's vibrant culinary landscape. Purpose of the Study, this research seeks to develop an innovative rice cracker formulation by incorporating green mustard paste. The primary objectives include enhancing the organoleptic properties of the crackers such as flavor, aroma, texture, and appearance while improving their nutritional content. Additionally, the study aims to highlight the potential of reusing leftover rice to create economically and nutritionally valuable products.

The primary aim of this study is to create an innovative rice cracker by incorporating green mustard paste, emphasizing sustainability and nutritional enhancement. This goal aligns with the broader need to promote eco-friendly culinary innovations while addressing consumer demands for health-conscious and functionally enriched food products. The study's objectives are further specified to ensure a comprehensive approach to developing and evaluating the product. First, it seeks to develop and optimize the formula for rice crackers enriched with green mustard paste. This involves leveraging experimental methods to refine ingredient proportions and processing techniques, ensuring the crackers achieve the desired quality standards. By systematically experimenting with various formulations, the study aims to determine the optimal recipe that balances taste, texture, and visual appeal. Second, the research focuses on assessing the sensory properties of the crackers through organoleptic evaluations. This step involves testing attributes such as taste, texture, color, and aroma, which are critical determinants of consumer acceptance. By gathering feedback from target audiences, the study provides insights into how well the crackers meet consumer preferences and expectations.

Finally, the study evaluates the product's potential for commercialization and its market acceptance. This involves analyzing the crackers' feasibility as a commercial product, including considerations of production scalability, economic viability, and consumer demand. The results of this evaluation will serve as a foundation for future innovations and provide actionable recommendations for culinary entrepreneurs looking to introduce similar products to the market. By addressing these objectives, the study not only contributes to the advancement of sustainable culinary practices but also highlights

the value of integrating locally sourced and underutilized ingredients, such as green mustard and leftover rice, into innovative food products.

This research carries both theoretical and practical significance, contributing meaningfully to the culinary arts and addressing contemporary challenges in food sustainability. Theoretically, it enriches the existing knowledge base by exploring the integration of vegetables, such as green mustard, into processed food products. This advancement expands the scope of culinary innovation, offering a framework for incorporating nutrient-dense, plant-based ingredients into popular snacks like crackers.

On the practical side, the study provides a sustainable solution to food waste management by repurposing leftover rice into high-value culinary products. This approach not only reduces waste but also promotes circular food practices. Moreover, the research offers economic benefits, particularly for regions like Riang Gede Village, where green mustard cultivation is abundant. By introducing a new product concept, it supports local economies and encourages the utilization of underexplored agricultural outputs. Additionally, the findings serve as a resource for future research and a catalyst for culinary entrepreneurs to venture into innovative food product development.

To achieve its objectives, the study leverages two foundational theoretical frameworks. The Cracker Processing Theory sheds light on the critical role of starch in determining the texture and expansion properties of crackers during frying (Herman, 2005). This framework ensures that the product meets the desired sensory and structural standards. Additionally, the Culinary Product Development Model by Harrington (2004) provides a systematic approach to food innovation. This model outlines four essential stages: formulation of the recipe, implementation of the innovation, evaluation and control through sensory analysis, and public introduction (Harrington & Ottenbacher, 2013).

To ensure the scientific rigor of the study, experimental methods were employed for the development and assessment of the green mustard-enriched rice cracker formula. Organoleptic tests, focusing on attributes such as taste, texture, aroma, and color, were conducted to evaluate consumer preferences. Quantitative data from these tests were analyzed using descriptive statistical methods, enabling a precise understanding of the crackers' sensory appeal. This robust methodology ensures that the findings are both reliable and actionable, paving the way for future culinary innovations.

2. LITERATURE REVIEW

In recent years, there has been increasing interest in enhancing traditional snack products by incorporating vegetables. This approach not only improves the nutritional profile of food but also aligns with growing consumer demand for healthier, more sustainable options. Several previous studies have laid the groundwork for this research, which focuses on the innovative addition of green mustard (sawi hijau) to rice crackers (kerupuk nasi), a combination that has not been widely explored in literature.

Kawiji (2009) was one of the first researchers to explore the economic and sensory characteristics of vegetable-based crackers. His study, which focused on the addition of sweet corn to crackers, found that vegetables could significantly enhance the vitamin and protein content of the product, providing a dual benefit: improved nutritional value and greater market appeal. This foundational work established the potential for using vegetables to create more functional snack products, setting the stage for future research in this area.

Similarly, Krisnawati (2022) examined the sensory properties of crackers made with green mustard, demonstrating that the incorporation of green mustard flour resulted in improvements in taste, aroma, texture, and color. Her research supports the idea that vegetables like green mustard can not only improve the flavor and appeal of traditional snacks but also provide additional health benefits. The study highlights the importance of sensory characteristics in the success of innovative food products, an aspect that is central to the current research on rice crackers.

Further supporting this trend, Sari (2021) explored the use of moringa leaves in rice-based crackers, demonstrating that the inclusion of moringa enhanced both the flavor and nutritional value of the product. Moringa, like green mustard, is rich in vitamins, minerals, and antioxidants, making it an ideal candidate for fortifying snack foods. Sari's findings underline the potential of leafy vegetables in the development of healthier, nutrient-dense snacks, providing valuable insights for the current study on green mustard-infused rice crackers.

In the context of green mustard, Jatnika (2010) highlighted its exceptional antioxidant content, as well as its high levels of vitamins A, C, K, and essential minerals. These nutritional benefits make green mustard a powerful ingredient for enhancing the healthfulness of food products. Its use in the current research as a fortifier for rice crackers offers an innovative solution for improving the nutritional profile of this popular snack. Green mustard's known benefits such as boosting immunity, improving cardiovascular health, and offering anti-cancer properties—are particularly relevant in the context of this study, as they align with the increasing consumer preference for functional foods.

The principles of culinary innovation are deeply embedded in the work of Harrington & Ottenbacher (2013), who emphasized the integration of sustainability and creativity in food product development. Their research advocates for the creation of innovative food products that not only meet consumer expectations for taste and texture but also address broader concerns such as food sustainability. The incorporation of green mustard into rice crackers in this study adheres to these principles, offering a sustainable and nutritious alternative to conventional snack foods. It reflects the growing trend in the food industry to use ingredients that are both healthy and environmentally conscious.

Koesoemawardani et al. (2018) also contributed significantly to the understanding of crackers as a popular snack in Southeast Asia. Their study highlighted the widespread consumption of crackers, particularly in Indonesia, where they serve as both a snack and a meal accompaniment. The popularity of crackers creates an ideal platform for innovation, allowing for the integration of vegetables to address the rising consumer demand for healthy snacks. The current study builds on this foundation by introducing green mustard as a new ingredient in rice-based crackers, providing an opportunity for healthier and more sustainable snacking options.

Purwanti (2011) emphasized the importance of diversifying crackers to meet the evolving tastes and preferences of consumers. Her research highlighted the potential for innovation in cracker formulation by experimenting with different bases, flavors, and shapes. The incorporation of green mustard into rice crackers, as explored in this study, represents a novel approach to cracker diversification, offering a new and potentially marketable product that aligns with current trends toward health and sustainability.

In line with this, Maureen et al. (2016) detailed the seven stages involved in the traditional cracker-making process, which include ingredient preparation, dough mixing, steaming, cooling, cutting, drying, and frying. These stages are crucial in determining the texture, appearance, and flavor of crackers. By following this process and incorporating

green mustard into rice-based crackers, this study ensures that the desired sensory attributes are maintained while enhancing the nutritional value of the final product.

Koswara (2009) defined crackers as dry, starch-rich foods that undergo a process of expansion during frying. The use of rice, a starch-rich ingredient, as the base for crackers in this study adheres to this definition while introducing green mustard to enhance both the taste and health benefits of the product. This research explores the potential of incorporating unconventional ingredients, such as vegetables, into crackers, contributing to the diversification of snack products.

The concept of food sustainability is also addressed in this research, particularly using leftover rice, a common food waste issue in many households. Hidayati (2015) and Nafiroh et al. (2019) have both highlighted the substantial amounts of rice waste generated in Indonesia, which could be repurposed into food products like rice crackers. This research addresses this challenge by using leftover rice as the base for the crackers, contributing to both food waste reduction and nutritional enhancement.

While studies such as Taewee (2011) and Rohaendi (2009) have explored the role of tapioca flour in crackers, emphasizing its importance for achieving the characteristic puffing and crispiness, the current study takes a different approach by replacing tapioca with rice and adding green mustard. This represents a significant departure from traditional cracker-making, offering a healthier and more sustainable option without compromising on texture or taste.

Finally, Sherly et al. (2020) discussed the process of culinary innovation and the importance of creativity in developing new food products that align with consumer trends. This study contributes to this body of research by combining green mustard with rice to create a novel snack product that meets the increasing demand for healthy, functional, and sustainable foods.

In conclusion, this literature review highlights the growing body of research on the incorporation of vegetables in cracker products. Building on studies by Kawiji (2009), Krisnawati (2022), Sari (2021), and others, this research introduces green mustard into rice crackers, offering a unique contribution to the field by addressing food waste and enhancing nutritional value. This aligns with current trends in culinary innovation, sustainability, and the increasing consumer preference for healthier snacks.

3. RESEARCH METHODS

This research adopts a quantitative approach with an experimental method conducted in a laboratory setting. The experimental approach is chosen as it aligns with the research goal of developing an innovative rice cracker product with the addition of green mustard, to evaluate its sensory characteristics and consumer preferences. This method is deemed appropriate for systematically identifying the results of the innovation and assessing the product's quality through structured and controlled organoleptic testing.

The research is conducted over six months, taking place at two locations: Desa Jatiluwih for sourcing the green mustard and the Kitchen Lab at Politeknik Internasional Bali (PIB) for the experiment and recipe testing.

3.1 Research Procedure

- a. Preparation for Materials and Equipment
 - Main ingredients: rice, tapioca flour, green mustard, and supporting seasonings such as garlic, salt, ground coriander, and flavoring agents.

- Equipment: blender, steaming pot (dandang), baking trays, oven, and stainless-steel knives, ensuring hygienic and high-quality standards.
- b. Experimental Stages
 - Admixture preparation, rice is soaked for 2 hours and then blended with green mustard and garlic. The mixture is combined with tapioca flour and other seasonings.
 - Shaping and steaming, the mixture is shaped into uniform trays and steamed at 100°C for 25 minutes.
 - Cooling and cutting, the steamed mixture is cooled at 10°C for 18 hours to facilitate cutting.
 - Drying, the crackers are dried in an oven at 50–60°C for 4 hours to enhance shelf life.
 - Frying, the dried crackers are deep-fried in hot oil until they expand to the desired crispness.
- c. Organoleptic Testing
 - Involves untrained panelists from the public who are familiar with cracker products.
 - The panel evaluates the crackers based on taste, aroma, texture, color, and shape using a scoring scale from 1 (dislike) to 5 (like very much).

Data are analyzed descriptively using percentage methods to illustrate consumer preference levels. This process involves calculating maximum and minimum scores, as well as the percentage range, which are then interpreted using predefined criteria for liking.

The experimental laboratory method is chosen to maintain control over variables, ensure replicability, and provide measurable results. Organoleptic testing is employed to directly assess consumer preferences, which is aligned with the research objectives. The choice of research locations, Desa Jatiluwih for local ingredient sourcing and PIB Kitchen Lab for experimentation, strengthens the connection between culinary innovation and local potential.

3.2 Limitations

- a. Subjectivity of respondents, organoleptic assessments may vary based on individual preferences.
- b. Environmental conditions, the drying process, if done using direct sunlight, can be influenced by weather conditions, affecting the consistency of the product.
- c. Scale of Experimentation: The research is limited to small-scale laboratory experiments, and further validation may be required on a larger production scale.

This systematic approach is expected to provide strong empirical data to support the innovation of rice crackers made with green mustard.

4. FINDINGS AND DISCUSSION

4.1 Development of Rice Crackers with Green Mustard

The findings of this study reveal key insights into the innovation of rice crackers (kerupuk nasi) by incorporating green mustard (sawi hijau), contributing significantly to the development of functional food products. Below is a summary of the key findings:

The research introduced an innovative approach by integrating green mustard into the rice cracker production process. Two types of crackers were produced: Kerupuk A (without mustard) and Kerupuk B (with green mustard). The green mustard was

incorporated by replacing a portion of the rice with 80g of blanched mustard leaves. The addition of green mustard changed the sensory profile of the crackers, improving their color, aroma, taste, and texture compared to the traditional rice-based cracker.

Crackers A and B have almost similar ingredients. The only difference lies in the addition of green mustard used in these crackers. Apart from that, the manufacturing process is also the same. The following is the difference in appearance of crackers A and B in the manufacturing process.

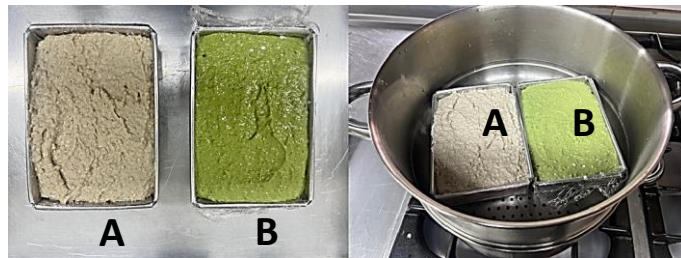


Figure 1. Difference Between Cracker Dough A and B
Source: Researcher Documentation (2024)

Figure 1 shows the difference between cracker dough A and B before steaming. The color differences are clearly visible in the three mixtures. Cracker B dough has green elements, while cracker dough A has the lightest color. The following is the appearance of cracker dough A and B after steaming for 25 minutes.

The dough has been steamed for 25 minutes and then cooled in the refrigerator for approximately 18-24 hours. Then the cracker mixture is thinly sliced. The slices are then dried in the sun and dried so they can then be fried like crackers in general. The following is the shape of crackers A and B after slicing thinly before drying.



Figure 2. Crackers A & B After Slicing
Source: Researcher Documentation (2024)

Crackers A and B that have been dried in the sun are then fried like frying crackers in general. The frying results showed that crackers that had just been dried in the sun would produce greater swelling power compared to crackers that had been stored for a long time. The following is what the crackers look like after frying.

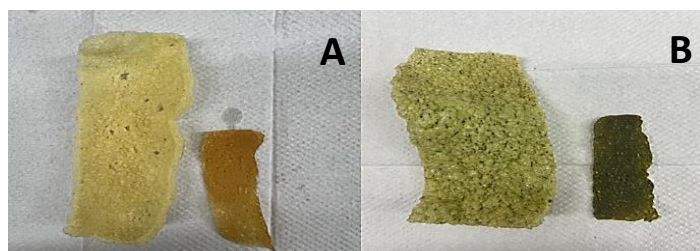


Figure 3. Fried Crackers
Source: Researcher Documentation (2024)

From Figure 3, rice crackers with the addition of vegetable ingredients have a higher swelling power compared to rice crackers. This is almost the same as research in Tanius (2023) which states that cracker dough using tapioca flour will make the dough 2-3 times bigger than the size of a cracker.

4.2 Sensory Analysis and Preference

A sensory evaluation was conducted to assess the preferences of respondents towards Kerupuk A and Kerupuk B. The results indicated that Kerupuk B, with the addition of green mustard, was preferred by 75% of the respondents. This preference was based on better scores in texture, aroma, taste, and color. Kerupuk B was favored for its enhanced sensory characteristics, likely due to the nutritional and aromatic qualities imparted by the mustard leaves.

The addition of green mustard significantly enriched the crackers with vitamins and minerals, particularly vitamin K, vitamin C, and various essential minerals such as calcium and iron. These nutrients contribute to the functional value of the product, positioning it as a healthier alternative to traditional rice crackers. Green mustard is known for its health benefits, including its role in boosting immunity, improving bone health, and reducing cholesterol levels.

4.3 Favorite Ranking Test Results for Crackers A and B

The results of the analysis of 30 respondents' level of preference for crackers A and B can be depicted in the following picture:

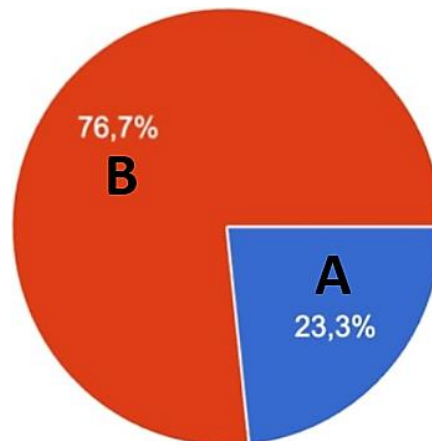


Figure 4. Results of Liking Test for Crackers A and B
Source: Research Results (2024)

Based on Figure 4 regarding the comparison of people's preferences for crackers A and B. From the round diagram, respondents chose Crackers B compared to Crackers A. Of which 23 respondents chose Crackers B, which reached more than 75% percent of respondents chose Crackers B.

5 CONCLUSION

The study also highlighted an important finding regarding the drying process of the crackers. It was discovered that crackers that had been left to dry for an extended period before frying required re-drying under the sun to ensure optimal expansion during frying. This step was crucial for achieving the desired texture and crispness, which might otherwise be compromised if not properly re-dried.

The results suggest a promising market acceptance for Kerupuk B as a product that combines the popularity of traditional rice crackers with the added value of functional ingredients like green mustard. Based on sensory preferences and the enhanced nutritional profile, it is recommended that this innovation be explored further for commercial production, especially in regions with a strong cultural affinity for snack foods.

Recommendations for Further research is encouraged to explore the use of other green vegetables in the production of rice crackers. This could diversify the range of flavors and functional benefits while providing a sustainable way to utilize surplus vegetables. Additionally, experiments with different drying techniques or alternative flour combinations could further improve the product's quality.

This study contributes to the field of food, particularly in enhancing the nutritional value of traditional snack foods through the incorporation of vegetables like green mustard. It also demonstrates the potential for creating products that are not only popular in terms of taste but also offer significant health benefits, thus expanding the functional food market.

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