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Cendol Product Innovation Using Potato Flour Substitution to Develop Traditional Dawet Drinks in the Modern Era

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ABSTRACT

This innovation was carried out to increase the nutritional value of traditional dawet drinks so that they are richer in carbohydrates, as well as an effort to preserve local culinary in the modern era. This study aims to: (1) find the right formulation of the cendol dawet recipe for potato flour substitution, (2) determine the presentation technique and packaging of Datang products, (3) find out the level of liking of the general public for Datang products. The method used is *Research and Development* (R&D) with a 4D development model. The results of the study showed: (1) the best formulation is 100% potato flour substitution, (2) the presentation of Datang products using a 300 ml transparent bottle with a product label containing nutritional information and product composition, (3) Datang products are acceptable to the general public, have an average level of likability in the overall aspect of 4.6.

Keywords:
Cendol dawet,
Potato Flour,
Tradisional drinks,
carbohydrate

Inovasi ini dilakukan untuk meningkatkan nilai gizi minuman tradisional dawet agar lebih kaya akan karbohidrat, sekaligus sebagai upaya pelestarian kuliner lokal di era modern. Penelitian ini bertujuan untuk: (1) menemukan formulasi resep cendol dawet substitusi tepung kentang yang tepat, (2) menentukan teknik penyajian, pengemasan produk Datang, (3) mengetahui tingkat kesukaan masyarakat umum terhadap produk Datang. Metode yang digunakan adalah Research and Development (R&D) dengan model pengembangan 4D. Penelitian dilaksanakan di Laboratorium Tata Boga Fakultas Vokasi Universitas Negeri Yogyakarta yang dimulai sejak bulan September 2025 hingga April 2026.

Hasil penelitian menunjukkan: (1) formulasi terbaik adalah substitusi tepung kentang sebesar 100%, (2) penyajian produk Datang menggunakan botol transparan ukuran 300 ml dengan label produk yang berisi informasi gizi dan komposisi produk, (3) produk Datang dapat diterima oleh Masyarakat umum, memiliki rata-rata tingkat kesukaan pada aspek keseluruhan sebesar 4.6.

1. Introduction

Indonesia has a variety of traditional drinks that are very diverse, one of which is dawet which has been known for a long time by the community. However, nowadays traditional drinks are starting to be eliminated by the many more interesting modern drinks. In addition, the main raw material for making traditional dawet, namely palm sago flour, is now difficult to find in markets. This condition is a big challenge so that traditional drinks such as dawet can still survive and be liked by people today [1].

So far, there have been efforts to develop cendol dawet products to make them more attractive, such as in previous research trying to mix ingredients such as moringa leaves into cendol dough to add its nutrients. Although there have been many studies on cendol dawet, not many have tried to use local food ingredients in the form of potato tubers to overcome existing problems [2].

Potatoes are a food ingredient that is rich in nutrients such as vitamins and minerals, but it often rots quickly if not processed immediately. One way is to process potatoes into flour to make them more durable. Through this study, potato flour was chosen as a substitute for palm sago flour in the manufacture of cendol dawet. The use of potato flour is expected to provide a soft and chewy texture, as well as make dawet more nutritious. In this way, it is hoped that dawet can still be produced with materials that are easy to find and still liked by the public in the modern era [3].

This research aims to create dawet product innovations by utilizing potato flour as a substitute for palm sago flour and has nutritional value. In addition, this study also aims to find out the level of people's preference for the texture and taste of dawet resulting from this innovation. To achieve this goal, this research uses the Research and Development (R&D) method with a 4D development model, which includes the definition stage, product design (Design), development and testing (Develop), to the stage of product dissemination to the public (Disseminate) [4].

2. Methods

The research method used in the development of the "Datang" product (Dawet Kentang) is Research and Development (R&D) with a 4D development model which includes the Define, Design, Develop, and Disseminate stages [4] . The stage begins with determining the standard reference recipe, which is followed by designing the formulation of potato flour substitution of 50%, 75%, and 100% [5], as well as determining the packaging design. This research was carried out at the Culinary Laboratory, Vocational Faculty of Yogyakarta State University, Wates Campus, in the period of September 2025 to April 2026. At the development and deployment stage, the quality of the product is validated by three experts and tested sensorially through 30 semi-trained panelists. Furthermore, a preference test was conducted on 80 panelists from the general public to determine the acceptability of the product and the effectiveness of its packaging. The data analysis in this study includes descriptive data analysis [6] and paired simple t-test data analysis [7].

3. Results and Discussion

3.1. Results

a. The define stage in cendol products uses potato flour in dawet.

In the early stages of developing the Datang product, three dawet recipes were collected and analyzed as a basis for determining the standard formulation. The selection of this reference recipe is very important because it will be a measure of comparison in assessing the success of the texture, shape, aroma, color and taste of the product after being substituted with potato flour. The following can be seen in table 1.

Table 1. Recipe for cendol dawet

Ingredients	References Recipe 1	References Recipe 2	References Recipe 3
Palm sago flour (g)	125 gr	150 gr	-
Rice flour (g)	25 gr	50 gr	100 gr
Tapioca flour (g)	-	-	25 gr
Agar	-	-	1 pack
Suji Leaf Water (ml)	500 ml	650 ml	600 ml
Pandan	3 sheets	11 sheets	2 sheets
Confectioners' Sugar (g)	250 gr	250 gr	250 gr
Coconut milk (ml)	750 ml	750 ml	760 ml
Salt (g)	1/2 tsp	1/2 tsp	1/2 tsp

Based on the data in Table 1, it can be seen that there are variations in the composition of the ingredients in the three cendol dawet reference recipes to be tested, especially in the type and amount of flour used. Recipes (1) and (2) tend to use a combination of palm sago flour and rice flour in different ratios, while Recipe (3) uses tapioca flour and powdered gelatinous ingredients.

In addition, a striking difference can also be seen in the amount of water used in suji leaves and pandan leaves as a source of natural aroma and color. Despite the differences in texture and aroma ingredients, these three recipes still use relatively consistent amounts of tamarind sugar and coconut milk as the standard for sweet and savory taste in dawet dishes.

Then organoleptic properties were identified to compare the physical qualities of each recipe tested. Characteristics regarding the differences in color, aroma, texture, taste, and shape of the three recipes. The following table 2 shows the results of the characteristics of the three reference recipes.

Table 2. Characteristics of the results of the three reference recipes

Characteristics	**Recipe 1**	**Recipe 2**	**Recipe 3**
Color	Dark green	Dark green	Dark green
Aroma	Fresh pandan	Fresh pandan	Fresh pandan
Text	Very thick	Chewy	Soft
Taste	Taste of suji leaves	Taste of suji leaves	Taste of suji leaves
Shape	Oval	Oval	Oval

Based on the results of the organoleptic test in Table 2, it can be seen that the three reference recipes produce visual and taste characteristics that tend to be uniform, but have significant differences in texture aspects. In terms of color, aroma, taste, and shape, all three provide consistent results, namely dark green color with a fresh pandan aroma, the distinctive taste of sugi leaves, and an oval shape that is ideal for dawet granules.

The main difference is found in the texture aspect, where Recipe 1 produces a very thick texture, while Recipe 2 has a chewy texture, and Recipe 3 provides a softer result. This variation in texture is closely related to the composition of the type of flour used in each reference recipe, which will later become an important consideration in determining the basic formula for the development of the next product.

The following is documentation of the three reference recipes at this defining stage.

Table 3. Documentation of the reference product at the define stage

Recipe 1	Recipe 2	Recipe 3
		

All three recipes tested consistently produce products with a dark green color, a fresh pandan aroma, and a uniform oval shape. Despite having strong visual similarities, the main significant difference lies in the final texture of each product. Recipe 1 has a very chewy texture, which has the strongest physical resistance compared to other recipes, recipe 2 produces a chewy texture in a medium degree, while recipe 3 has a soft texture compared to recipes 1 and 2. Overall, the use of suji leaves provides a stable flavor consistency in all samples, so the selection of the best recipe can be focused on the desired texture preference.

Table 4 shows, overall is the R2 recipe, the most preferred product in general with the highest overall score of 4.4 and an average score of 3.8. This recipe has very strong quality in terms of color (4.2) and size (4). So the reference recipe was selected using the R2 recipe. Here can be seen the average results in table 4.

Table 4. Average results of the define stage

Sensory properties	Recipe 1	Recipe 2	Recipe 3
Shape	3,2	3,2	4,4
Size	3,2	4	4
Color	4	4,2	3,8
Aroma	3,2	3,6	3,6
Taste	3,6	3,4	3
Texture	3,6	3,6	2,4
Overall	3,4	4,4	3,8
Average	3,5	3,8	3,6

b. The design stage of cendol products uses potato flour in dawet.

At this stage, a series of trials were carried out to find the most optimal dawet recipe formulation through the substitution of potato flour ingredients. The main focus of this experiment was to partially replace the use of palm sago flour with potato flour at three different concentration levels, namely 50%, 75%, and 100%. This step aims to observe the effect of differences in texture and characteristics of the final product compared to the initial reference recipe. The following table 5 shows the formula recipe at the design stage.

Table 5. Recipe for the formulation of cendol dawet

Ingredients	Reference Recipe	Formulation 50%	Formulation 75%	Formulation 100%
Palm sago flour (g)	150 gr	75 gr	37.5 gr	-
Potato flour	-	75 gr	112,5 gr	150 gr
Rice flour (g)	50 gr	50 gr	50 gr	50 gr
Suji Leaf Water (ml)	650 ml	650 ml	650 ml	650 ml
Pandan (lmbr)	11 sheets	11 sheets	11 sheets	11 sheets
Confectioners' Sugar (g)	250 gr	250 gr	250 gr	250 gr
Coconut milk (ml)	750 ml	750 ml	750 ml	750 ml
Salt (g)	1/2 tsp	1/2 tsp	1/2 tsp	1/2 tsp

The formulation of dawet in this study uses the main ingredients in the form of palm sago flour, potato flour, and rice flour as texture forms. In the reference recipe (R2), 150 gr of palm sago flour is used, but in the development formula (F1, F2, and F3), this amount is gradually reduced and replaced with potato flour until it reaches a full substitution of 150 gr in F3. The following are the results of the characteristics of the three formulas at the design stage.

Table 6. Characteristics of the results of the design stage

Characteristics	Reference recipe	Formulation 50%	Formulation 75%	Formulation 100%
Color	Dark green	Dark green	Dark green	Dark green
Aroma	Fresh pandan	Fresh pandan	Fresh pandan	Fresh pandan
Text	Chewy	Chewy	Chewy	Slightly chewy
Taste	Taste of suji leaves	Taste of suji leaves	Taste of suji leaves	Taste of suji leaves
Shape	Oval	Oval	Oval	Oval

The identification of organoleptic tests in table 5 was carried out to compare the physical quality of reference recipes and developer recipes that have different percentages of substitutions. Characteristics regarding the differences in color, aroma, texture, taste, and shape of the three formulas

Furthermore, documentation was taken including reference recipes and three variations of the development formula, namely F1 (50%), F2 (75%), and F3 (100%), in order to objectively compare the physical characteristics of each sample. Documentation is done from a top-down viewing point to ensure texture details, and the product display is clearly visible and can be seen in table 7.

Table 7. Documentation at the design stage

Reference recipe	Formulation 50%	Formulation 75%	Formulation 100%
			

Overall, F3 can be considered the most optimal formulation because it has the highest overall score (4.4) and the highest average score (4.1). Although F2 is superior in terms of taste, it provides a better sensory balance, especially due to its success in improving textures which is often a major challenge in the development of this cendol dawet product. The following results of the sensory test at the design stage can be seen in table 8.

Table 8. Design Sensory Test Results

Sensory properties	Reference Recipe	Formulation 50%	Formulation 75%	Formulation 100%
Shape	3,2	3,2	3,6	3,6
Size	4	3,6	3,2	3,4
Color	4,2	4	4,4	4,4
Aroma	3,6	4	3,8	4,2
Taste	3,4	3,6	4,4	4
Texture	3,6	3,8	4	4,6
Overall	4,4	3,6	4	4,4
Average	3.8	3,7	3,9	4,1

c. The development stage in cendol products uses potato flour in dawet.

This development stage is an important stage where validation is carried out to compare the reference product with the development product with the percentage of substitution that has been selected. In this process, the main focus is to ensure that the new formulation still meets the desired quality standards while highlighting the unique characteristics of the development. In addition to recipe refinement, this stage also includes aesthetic planning and product logistics, starting from determining the type of packaging that is able to maintain shelf life, attractive presentation techniques to strengthen the visual identity of the product before moving on to the next stage.

In this stage of research, two main prescriptions were determined as the basis for comparison, namely the Reference Recipe (R) and the selected Development Recipe (F3 100%). The reference recipe uses a standard formula with the use of 150 gr of palm sago flour as the main ingredient. Meanwhile, in the F3 development recipe, a substitution of 100% was made by replacing all the use of palm sago flour with 150 grams of potato flour. The following development stage recipe can be seen in table 9.

Table 9. Recipe stage of developing cendol dawet

Ingredients	Recipe Mold	Formulation 100%
Palm sago flour (g)	150 gr	-
Potato flour	-	150 gr
Rice flour (g)	50 gr	50 gr
Suji Leaf Water (ml)	650 ml	650 ml
Pandan (lmbr)	11 sheets	11 sheets
Confectioners' Sugar (g)	250 gr	250 gr
Coconut milk (ml)	750 ml	750 ml
Salt (g)	1/2 tsp	1/2 tsp

The results of the sensory test in the development stage, the following is an explanation of the comparison of sensory characteristics in terms of color, aroma, texture, taste, and size between the reference product and the selected development product, namely F3 (100%) can be seen in table 10.

Table 10. Characteristics of the results of the development stage

Characteristics	Reference recipe	Formulation 100%
Color	Dark green	Dark green
Aroma	Fresh pandan	Fresh pandan
Text	Chewy	Slightly chewy
Taste	Taste of suji leaves	Taste of suji leaves
Size	Friendly	Friendly

The following documentation is taken in table 11 including a reference recipe and a selected development formula, namely F3 (100%), in order to objectively compare the physical characteristics of each sample. Documentation is done from a top-down viewing point of view to ensure the details of the product's texture and appearance are clearly visible.

Table 11. Reference and development product documentation

Reference recipe	**Formulation 100%**
	

From the results that have been obtained at this development stage, in terms of overall this data shows that the development product is superior with a score of 4.7, compared to the reference product which has a score of 4.0. On an overall average, the selected development recipe recorded a score of 4.3, higher than the reference recipe which had an average of 4.0. The following sensory test results can be seen in table 12.

Table 12. Developmental Stage Sensory Test Results

Sensory properties	Reference recipe	Formulation 100%
Shape	3,2	3,6
Size	4	3,4
Color	4,2	4,4
Aroma	3,6	4,2
Taste	3,4	4
Texture	3,6	4,6
Overall	4,4	4,4
Average	3,8	4,1

Then then determine packaging that functions not only to maintain the quality and safety of the product, but also to increase its attractiveness in the eyes of consumers. In addition, packaging plays a very important role in simplifying the distribution process until the product arrives safely in the hands of consumers. On the other hand, packaging is also an important communication medium that contains complete information, ranging from the composition of the ingredients, to the expiration date limit.

Figure 1. Packaging comes

Figure 2. Packaging Labels Come

This Datang product is packaged using a transparent 300 ml clear bottle as seen in figure 1 with a dose of 100 gr of cendol in each package, then closed with a black bottle cap. The selection of transparent packaging aims to allow consumers to clearly see the quality, color, and texture of dawet in it.

Figure 2 shows the design of the Datang product packaging label that provides information to consumers that serves as a visual identity that highlights the brand, claims of 100% potato flour raw materials, product illustrations, and a net weight of 300 grams.

d. The disseminate stage in cendol products uses potato flour in dawet.

The disseminate stage is the final stage in this research, the main focus is to test whether the product that has been developed is really worthy of acceptance by the wider community. At this stage, a series of comparative trials were carried out between the reference product and the product of development. The process involves the participation of 80 untrained general panelists, with the aim of obtaining an honest and objective assessment from the consumer's point of view.

Each panelist will be given two samples, namely, one sample as a reference product and the other as a product of development that is being tested. After receiving the samples, the panelists were asked to taste and compare the sensory characteristics of the two in depth. This organoleptic test covers several important aspects, such as taste, aroma, texture, color, packaging to the overall of the product. The following t-test results can be seen in table 13.

Table 13. Product reference and development t-test results

Properties Sensory	Reference Products	Products Development	P-value	Remarks
Taste	4,2 ± 0,6	4,6 ± 0,7	0,23	no significant
Aroma	4,2 ± 0,6	4,5 ± 0,7	0,20	no significant
Texture	4,1 ± 0,6	4,5 ± 0,8	0,18	no significant
Packaging	4,2 ± 0,7	4,6 ± 0,7	0,42	no significant
Color	4,2 ± 0,6	4,5 ± 0,8	0,16	no significant
Overall	4,2 ± 0,5	4,6 ± 0,7	0,22	no significant

Based on the results of the t-test in table 13, the development products consistently obtained a higher average value compared to the reference product in all aspects tested. This test is carried out by looking at the p-value, with the basis for decision-making being the *p-value* < 0.05, then the reference and development are clearly different, while *the p-value* > 0.05, then the reference and development are not significantly different. The results of the analysis showed that for all aspects tested, namely *p-value* at taste 0.23, aroma 0.20, texture 0.18, packaging 0.42, color 0.16, and overall acceptance of 0.22, all of which had a p> value of 0.05, it can be concluded that statistically there was no real (significant) difference between the development product and the reference product in all sensory aspects assessed.

Table 14. Average results of reference and development product preference tests

Remarks	Reference	Development
Very dislike	0,0	1,0
Dislike	0,5	1,0
Quite like it	5,7	1,7
Likes	51,7	25,8
Really like	22,2	50,5

Regarding the average results of the organoleptic test of the reference product, the majority of panelists gave a good assessment, where as many as 51.7% stated "Like" and 22.2% stated "Very Like", so that in total around 73.9% of respondents had a positive response to this product. As for

the development product, the most prominent point is the high level of satisfaction of the panelists, where as many as 50.5% of respondents stated "Very Like" and 25.8% stated "Like". So in total around 76.3% of respondents have a positive response to this product.

3.2. Discussion

a. Product Recipe

The selected reference recipes are based on the acceptance rate of trained panelists in terms of texture, aroma taste, shape, and color. After testing, the 2nd reference recipe was chosen, namely from the recipe book for mixed ice and fresh drinks by Dapur Kirana. In the next stage, the researcher substituted the reference material using potato flour with a percentage of 50%, 75%, and 100%. The results of observations show that the use of potato flour affects the shape, and taste. The formulation chosen is 100%, because it produces a texture that resembles cendol in general, but with the advantage of using potato flour as a substitute for palm sago flour.

b. Product Packaging

The packaging used in Datang products is made with the aim of making the product look attractive and safe for consumption. The packaging used is a clear bottle measuring 300 ml, because this bottle is transparent, consumers can immediately see the freshness and quality of the contents of cendol in it. This bottle is also made airtight by using a black bottle cap so that the cleanliness of the product is maintained and does not go stale easily. On the bottle, there is a label containing the name of the product, an animated image of the duphet product, the serving size, the ingredients used, the way it is served, and the expiration date. With neat packaging and honest information, consumers will feel more confident and comfortable when buying this local innovation product.

c. Discussion of the level of liking of the product Datang

This study conducted an organoleptic test to compare development products with reference products, this test involved 80 untrained panelists. The parameters assessed included taste, aroma, texture, color, packaging, and overall rating. The results of the research show that the Datang product received a very positive response from the panelists where as many as 50.5% of the panelists stated that they liked it very much and 25.8% said they liked it, although there were still 1.0% of the panelists who said they did not like it and did not like it very much.

The results of *the paired t-test* showed no significant difference, p-value > 0.05 for all aspects (taste, aroma, texture, packaging, color, and overall acceptance). The innovation of using potato flour in Datang products has been successfully accepted by the public with a high level of preference. Because there is no significant difference in quality with the reference product, Datang products are considered a viable alternative and have acceptability equivalent to standard dawet products that are already on the market, but with the advantage of better nutritional value.

4. Conclusions

Based on the results of research, data analysis, and discussions that have been carried out related to the development of Datang products, it can be concluded as follows:

a. Based on the results of the research, the most appropriate formulation of the cendol dawet recipe is to use a reference recipe from the book Kirana, 2019 with a percentage of potato flour substitution of 100% as a substitute for palm sago flour.

b. Datang products have a very high level of likability test in the community with an average likability score of 4.6 on the overall aspect of the scale of 5. The results of organoleptic tests on 80 panelists showed that 76.3% of respondents stated that they liked the quality of the taste, shape, color, aroma, and texture of the product, and were statistically proven to have quality equivalent to dawet products in general.
c. Product packaging Datang uses 300 ml transparent plastic bottles as primary packaging and 150 ml bottles as secondary packaging equipped with black bottle caps and informative label stickers to ensure food safety while enhancing visual appeal in the modern era.

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Substitution Of Garut Tumber Flour (*Maranta arundinacea* L.) In The Production of Savory Pao To Increase Local Food Potential

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ABSTRACT

The use of arrowroot tubers as local food is still not optimal even though they have potential as a substitute for wheat flour in various processed products. This research aims to: (1) Find the right recipe for Savory Pao; (2) Determine the form of packaging and labels for Savory Pao; (3) Knowing the level of people's liking for Savory Pao (4) Knowing the composition and nutritional content of Savory Pao; (5) Determine the selling price and BEP on Savory Pao. The research uses the Research and Development (R&D) method with the 4D development model (Define, Design, Develop, Disseminate). The research period starts from January 2025 to July 2026 at the Catering Laboratory, Campus II, Faculty of Vocational Studies, Yogyakarta State University and the Agricultural Product Analysis Laboratory, Faculty of Agriculture, Riau University. The results showed that: (1) The best formula was obtained with 20% arrowroot tuber flour substitution; (2) The packaging used is plastic mica measuring 16×10×6 cm with a capacity of 60 grams (2 pieces) and is labeled; (3) The average sensory test result is 4.6 (like very much) and it is concluded that the product can be accepted by the public; (4) Information on the nutritional value of every 30 grams containing total energy of 82,935 kcal, fat energy of 25 kcal, fat 3 grams, protein 3 grams, carbohydrates 11 grams, and fiber 0.2 grams; (5) Selling price IDR 13,000 with a mark up of 50% and unit BEP of 7 boxes and currency BEP IDR 86,826.

Keywords:
bakpao, savory pao, arrowroot tubers, arrowroot tuber flour, mackerel

Pemanfaatan umbi garut sebagai pangan lokal masih belum optimal meskipun memiliki potensi sebagai bahan substitusi tepung terigu pada berbagai produk olahan. Penelitian ini bertujuan untuk: (1) Menemukan resep yang tepat untuk Savory Pao; (2) Menentukan bentuk kemasan dan label pada Savory Pao; (3) Mengetahui tingkat kesukaan masyarakat terhadap Savory Pao (4) Mengetahui komposisi dan kandungan gizi pada Savory Pao; (5) Menentukan harga jual dan BEP pada Savory Pao. Penelitian menggunakan metode Research and Development (R&D) dengan model pengembangan 4D (Define, Design, Develop, Disseminate). Waktu penelitian dimulai pada Januari 2025 sampai Juli 2026 di Laboratorium Boga Kampus II, Fakultas Vokasi, Universitas Negeri Yogyakarta dan Laboratorium Analisis Hasil Pertanian, Fakultas Pertanian, Universitas Riau. Hasil menunjukkan bahwa: (1) Formula terbaik diperoleh dengan substitusi tepung umbi garut 20%; (2) Kemasan yang digunakan berupa mika plastik ukuran 16×10×6 cm kapasitas 60 gram (2 pieces) dan diberi label; (3) Rata-rata hasil uji sensoris sebesar 4,6 (sangat suka) dan disimpulkan produk dapat diterima oleh masyarakat; (4) Informasi Nilai Gizi setiap 30 gram mengandung energi total 82,935 kkal, energi lemak sebesar 25 kkal, lemak 3 gram, protein 3 gram, karbohidrat 11 gram , dan serat 0,2 gram; (5) Harga jual Rp13.000 dengan mark up 50% dan BEP unit sebanyak 7 box serta BEP mata uang Rp86.826.

1. Introduction

The local food developed in Indonesia is quite diverse and has not been utilized optimally to fulfill nutritional needs. Indonesia is known for its abundant natural resource potential, one of which is tuber plants. However, the use of minor tubers as food has not been developed optimally. People still consider minor tubers as traditional food which can only be prepared simply, such as boiling [1].

One local food that has high nutritional value and can be processed into food is arrowroot tubers. Arrowroot tubers are a food commodity that is currently being developed and processed into various kinds of food [2]. Arrowroot tubers contain quite a lot of dietary fiber which can help the health of the digestive system. Its high starch content and gluten-free nature means it can be used as an alternative for people with gluten intolerance[3]. Arrowroot tubers will be processed into flour to facilitate their use in innovation. The process of processing arrowroot tubers into flour can extend the shelf life, increase economic value, and make processing easier. The use of arrowroot flour in making buns has the potential to increase product value and people's interest in consuming food based on local ingredients [4].

Bakpao is divided into two flavors: sweet and savory. Bakpao is a food that is quite easy to find on the market, but the bakpao sold only prioritizes macronutrients. Micronutrients such as fiber can be added in making bakpao. To improve nutritional quality, bakpao is filled with sauteed mackerel due to its good nutritional content, relatively affordable price, easy availability, and savory taste. Fresh mackerel contains 17 types of amino acids, consisting of 79 essential amino acids and 8 non-essential amino acids [5]. Mackerel is a source of high animal protein, omega-3, omega-6 fatty acids, vitamins and minerals so it has the potential to be used as a highly nutritious food ingredient [6].

This is because fiber is one of the nutritional components needed by the body. Along with the increasing need for food that is not only filling but also healthy, innovation in making buns has emerged in terms of ingredients and contents. One of them is by substituting wheat flour using local food ingredients, such as arrowroot tuber flour. Bakpao was chosen as a development product because it is quite widely known and has the potential to be accepted by the public.

Generally, the basic ingredient for making buns is wheat flour. As time goes by and changes in people's consumption patterns, the use of minor tubers is decreasing and being replaced by various modern wheat flour-based food products that do not originate from Indonesia [1]. This will have an impact on national food security. As an effort to diversify food, arrowroot tubers were chosen as a local food ingredient which is used as a substitute for wheat flour in processed products, including buns.

Based on these problems, this research aims to: 1) Find the right recipe for Savory Pao; (2) Determine the form of packaging and labels for Savory Pao; (3) Knowing the level of people's liking for Savory Pao (4) Knowing the composition and nutritional content of Savory Pao; (5) Determine the selling price and BEP on Savory Pao

2. Method

The method used in this research is the Research and Development (R&D) method with a 4D development model (define, design, develop and disseminate). The research location is the Catering Laboratory, Campus II, Faculty of Vocational Studies, Yogyakarta State University. The place for the proximate test is the Agricultural Product Analysis Laboratory, Faculty of Agriculture, Riau University. The define stage aims to analyze one best reference recipe from three selected recipes used as a control in product development. The design stage was the development of three arrowroot starch substitution formulations (20%, 40% and 60%). The develop stage is a validation process for selected reference and development recipes to evaluate and determine Savory Pao

packaging. The disseminate stage aims to test wide-scale liking of Savory Pao using 60 untrained panelists.

Analysis of sensory and preference test data using quantitative descriptive methods using a five-point hedonic scale, consisting of strongly dislike, dislike, somewhat like, like and very like. Statistical analysis uses a paired sample t-test with a significance level of 5%.

3. Results & Discussion

3.1 Results

a. Define Stage

The first stage of this research is the define stage. This stage focuses on identifying the product concept and determining the reference recipe for product development. All three recipes will be produced and evaluated with sensory assessments based on color, aroma, taste, texture and overall properties. The best recipe will be selected as a reference recipe for further development. The selected recipes for this stage are presented in table 1.

Table 1. Bakpao Recipe

Ingredients	**R1**	**R2**	**R3**
Medium protein wheat flour	250 g	500 g	600 g
Low protein wheat flour			
Granulated Sugar	10 g	100 g	200 g
White Butter	6 g	50 g	50 g
Yeast	10 g	11 g	11 g
Baking Powder	1 g	2 g	2 g
Ice water	120 ml	250 ml	500 ml
Salt	1 g	3 g	2 g
Tuna fish		200 g	
Chicken meat			250 g
Beef	300 gr		
Onion	10 g	-	-
Garlic	-	8 g	
Shallots	10 g	10 g	5 g
Red chili	-	8 g	
Ginger	-	2 g	-
Chives	5 g	-	-
Oyster sauce	16 g	-	9 g
Soy sauce	2 g	-	-
Pepper	1 g	2 g	1 g
Salt		5 g	
Granulated sugar	5 g	8 g	-
Sweet soy sauce	3 g	-	3 g
Kaffir lime leaves	-	1 g	-
Lemongrass	-	10 g	-
Basil leaves	-	30 gr	-

Source: (R1) Job sheet UNY (2022) [7], (R2) Buku Resep Pastry & Bakery Bakpao [8], (R3) Buku Resep Character Pao Charpao [9].

Table 1 presents three different recipe formulations. These differences affect the characteristics of the final product, particularly its color, aroma, taste, and texture. Sensory testing of these recipes was conducted. The sensory evaluation results are presented in Table 2.

Table 2. Characteristics of Reference Products

Characteristic	**R1**	**R2**	**R3**
Shape	Round	Round	Round
Size	5 cm diameter	5 cm diameter	5 cm diameter
Color	Creamy white	Creamy white	Creamy white
Aroma	Flour and yeast aroma	Flour and yeast aroma	Flour and yeast aroma
Taste	Savory, slightly fish	Savory	Savory
Texture	Soft	Soft, fluffy	A bit hard

Based on the sensory test results, recipe 2 showed better results compared to recipes 1 and 3. Recipe 2 produced bakpao with the desired taste, namely savory, and a good texture, namely soft and tender. The sensory test results table is presented in Table 3.

Table 3. Sensory Test Results of the Define Stage

Sensory Parameters	**Average Value**		
	R 1	**R 2**	**R 3**
Shape	3.6	4	3.3
Size	3.6	4	4.3
Color	3.6	4.3	4
Aroma	3.6	4	4
Taste	3.6	3.6	3.6
Texture	3	4.5	3.6
Overall Properties	3.1	4.5	3.6
Average	3.5	4.1	3.8

Based on the assessment, recipe 2 received the highest score for shape (4), size (4), color (4.3), aroma (4), texture (4.5), and overall properties (4.5). By considering the evaluation results, recipe 2 was chosen as the reference recipe for the next stage.

b. Design Stage

At this stage, the percentage of wheat flour substitution with arrowroot flour was determined. The variations in substitution percentages used in making bakpao were formula I at 20%, formula II at 40%, and formula III at 60%. This percentage comparison was intended to determine the best addition of arrowroot flour. The determination of the arrowroot flour substitution percentage interval in this study was based on several previous research journals. One of them was by the journal by Ira Handayani & Izzul Azmi Shofura (2022), which stated that a percentage of 20% produced a good shape, taste, and texture of bakpao, namely soft, tender, and hollow. At this stage, the tuna filling was also substituted with mackerel. The formulations developed at the design stage are presented in Table 4.

Table 4. Savory Pao Formula Design

Ingredients	Recipe Reference	Development		
		FI (20 %)	FII (40 %)	FIII (60 %)
Wheat flour (g)	500	400	300	200
Arrowroot flour (g)	0	100	200	300
Granulated sugar (g)	100	100	100	100
White butter (g)	50	50	6	6
Yeast (g)	11	11	10	10
Baking powder (g)	2	2	2	2
Salt	3	3	3	3
Ice water (ml)	250	250	250	250
Mackerel (g)	200	200	200	200
Garlic (g)	8	8	8	8
Shallots (g)	10	10	10	10
Red chilies (g)	8	8	8	8
Ginger (g)	2	2	2	2
Pepper (g)	2	2	2	2
Salt (g)	5	5	5	5
Granulated sugar (g)	8	8	8	8
Kaffir lime leaves (g)	1	1	1	1
Lemongrass (g)	10	10	10	10
Basil leaves (g)	30	30	30	30

Table 5. Characteristics of Reference and Development Products

Characteristic	Recipe Reference	Development		
		F I (20%)	F II (40%)	F III (60%)
Shape	Round	Round	Round	Round
Size	Diameter 5 cm	Diameter 5 cm	Diameter 5 cm	Diameter 5 cm
Color	Creamy white	Creamy white	Creamy white, slightly yellow	Creamy white yellow
Aroma	Flour and yeast	Flour, yeast, special fish	Flour, yeast, special fish	Musty arrowroot flour
Taste	Savory	Tasty	Savory	Savory
Texture	Soft and tender	Soft, soft with a slightly rough texture	Dense, somewhat rough	Dense, coarse

Based on the results of sensory evaluation with the substitution of arrowroot tuber flour, each formulation produces differences in shape, size, color, aroma, taste and texture.

(a) (b) (c) (d)

Figure 1. Design Stage Documentation, (a) reference, (b) Substitution 20%, (c) Substitution 40%, (d) Substitution 60%.

Sensory testing was conducted on the reference product and three development formulas. The average results of the sensory testing assessments at the design stage are presented in Table 8.

Table 6. Sensory Test Results of the Design Stage

Parameters Sensory	**Recipe Reference**	**Development**		
		F I (20%)	**F II (40%)**	**F III (60%)**
Shape	3.3	4.6	3.3	3.3
Size	3.6	4.3	3.6	4
Color	3.6	4	4	4.6
Aroma	3.6	3.6	3.6	4
Taste	3.3	4.3	3.3	3
Texture	2.3	3.6	3.3	3.3
Overall	3	4.6	4	3.3
Mean	3.2	4.1	3.5	3.6

Based on the Savory Pao trial results presented in the table, the three formulas show different sensory characteristics. The formula with 20% substitution of arrowroot tuber flour gave the best results in terms of color, aroma, taste and texture. The results of the liking test analysis show that formula II and formula III have a lower level of acceptance compared to formula I. This is because the characteristics of the product produced are not optimal in terms of taste, aroma and texture. Therefore, it can be concluded that formula I with 20% substitution of arrowroot tuber flour is the best and most suitable formulation to be applied to the Savory Pao product. Next, the selected formula will be used in the development stage to process product refinement and validation

c. Develop Stage

At the develop stage, the development recipe that has been selected is then continued to the validation test stage. This activity involves lecturers as experts in the culinary field who have competencies in accordance with the products being developed. Improvements are made based on input and suggestions from experts until a product is obtained that meets the expected criteria.

Table 7. Results of Validation I Sensory Test

Sensory Parameters	Reference Products	Development Products
Shape	4	4.3
Size	4.3	4.3
Color	3.6	4.3
Aroma	3.6	4.3
Taste	3.6	3
Texture	3.6	4.3
Overall nature	4	3.6
Presentation	4.6	4.6
Packaging	4.6	4
Average	4	4.1

Based on the average results of sensory tests, it shows that the development product has quite good quality. However, in terms of taste and packaging, it still has a lower value than the reference product. There are several inputs from validators, namely adding spices and seasonings to reduce the fishy aroma of the fish. Therefore, improvements were made through validation test II to perfect the product characteristics, so that they met the expected criteria. The average results of the validation test assessment II are presented in Table 8.

Table 8. Results of Validation Sensory Test II

Sensory Parameters	Reference Products	Development Products
Shape	4	4.3
Size	4.3	4.3
Color	3.6	4.3
Aroma	3.6	4.3
Taste	3.6	4.5
Texture	3.6	4.3
Overall nature	4	4.3
Presentation	4.6	4.6
Packaging	4.6	4.6
Average	**4**	**4.4**

Based on the results of the phase II validation test, it shows that the development product has improved in aspects that previously needed to be improved. Overall, the product obtained good assessment results and met the expected criteria, so it was declared suitable to proceed to the acceptance test stage or wider scale test.

Savory Pao is packaged using plastic mica with a size of 16x10,6 cm and contains two buns weighing 60 grams. The packaging also includes a product label. The label is an identity and product information medium. The label contains various information such as product name, composition, net weight, production address, and information on the product's nutritional value. Savory Pao packaging can be seen in Figure 2.

(a) (b)

Figure 2. Savory Pao Packaging Designs (a) Savory Pao Packaging, (b) Savory Pao Label

d. Disseminate Stage

At the disseminate stage, a product liking level test is carried out based on its sensory characteristics. This testing was carried out by distributing reference products and development products to 60 untrained panelists from the general public. During testing, panelists are asked to observe and taste the product, then assess the characteristics including aspects of color, aroma, taste, texture and quality. The test results are then analyzed to determine the difference in acceptance levels between the two products. The results of the liking test analysis are presented as follows.

Table 9. Paired Sample t-Test Results for Reference and Development Products

Characteristics	Reference	Development	P-Value	Information
Taste	4.45±0.69	4.68±0.53	0.009	Significant
Aroma	4.27±0.79	4.47±0.62	0.013	Significant
Texture	4.26±0.79	4.47±0.62	0.015	Significant
Packaging	4.26±0.79	4.43±0.69	0.000	Significant
Color	4.41±0.61	4.67±0.47	0.007	Significant
Overall nature	4.37±0.55	4.71±0.45	0.000	Significant

a. Nutritional Compotition and Nutritional Information

Based on the results of nutritional analysis, every 30 grams of Savory Pao contains a total of 82,935 kcal of energy, 25 kcal of fat energy, 3 grams of fat, 3 grams of protein, 11 grams of carbohydrates and 0.2 grams of fiber. The nutritional composition of the product is influenced by the substitution of arrowroot tuber flour and mackerel filling. Arrowroot tuber flour plays a role in analyzing dietary fiber, and mackerel acts as a source of protein. Nutrient content analysis was carried out at the Agricultural Products Analysis Laboratory, Faculty of Agriculture, Riau University. Proximate test results for reference and development products are presented in Table 10.

Table 10. Proximate test results of reference and development products

Sample Code	Types of Analysis	Analysis Results		Mean
		Test 1	Test 2	
Reference	Protein (%)	8.77	8.91	8.84
	Carbohydrates (%)	35.82	35.75	35.79
	Fat (%)	9.50	9.67	9.59
	Fiber (%)	0.64	0.62	0.63
	Water (%)	28.56	28.70	28.63
	Ash (%)	0.73	0.71	0.72
Development Sample Code	Protein (%)	8.30	8.45	8.38
	Carbohydrates (%)	37.25	37.19	37.22
	Fat (%)	10.51	10.38	10.45
	Fiber (%)	0.68	0.65	0.67
	Water (%)	29.35	29.42	29.39
	Ash (%)	0.86	0.85	0.86

Based on the results of proximate analysis of the Savory Pao product, it was concluded that Savory Pao, which was the result of development by substituting arrowroot tuber flour, experienced changes in nutritional composition. Protein content is 8.38%, carbohydrates 37.22%, fat 10.45%, fiber 0.67%, water 29.39%, and ash 0.86%. Compared with the reference product, Savory Pao experienced an increase in carbohydrate, fat, fiber, water and ash levels, while protein content experienced a slight decrease. The increase in carbohydrate levels is thought to be because arrowroot tuber flour contains quite high amounts of starch and dietary fiber. The increase in fiber content shows that arrowroot tuber flour is able to increase the nutritional value of the product, especially in the aspect of dietary fiber content. Meanwhile, the decrease in protein content shows that arrowroot tuber flour has a lower protein content. Nutritional Value Information stipulated by BPOM Regulation Number 26 of 2021 is presented in Table 11 [10].

Table 11. Nutritional Value Information

INFORMASI NILAI GIZI		
Serving Size 30 grams		
Number of servings per package	2	
AMOUNT PER SERVING		
Total energy		82.935 kcal
Fat energy		25 kcal
		%AKG*
Fat	3 g	5%
Protein	3 g	4%
Carbohydrates 11 g	3%	
Fiber	0.2 g	1%
*Percent AKG based on energy needs is 2150 kcal. Your energy needs may be higher or lower		

Based on the calculation of nutritional value information, it can be concluded that the Savory Pao product with a serving size of 30 grams, with a total of 2 servings contains Energy of 82,935 kcal, Protein 3 grams (RDA 4%), Fat 3 grams (RDA 5%), Carbohydrates 11 grams (RDA 3%), Fiber 0.2 grams (RDA 1%).

e. Selling Price and BEP

Based on the results of calculations that have been carried out, the total production cost of Savory Pao is IDR 85,257 with a selling price of IDR 13,000 per package with a 50% mark-up. Profits will be achieved on unit BEP of 7 boxes and currency BEP of IDR 86,826. A comparison of Savory Pao prices on the market is presented in Table 12.

Table 12. Savory Pao Price Comparison

Name	Amount	Weight (g)	Price
Papao Bakpao	2 *pieces*	40-60	IDR19.000
Bakpao Imperial *Kitchen*	2 *pieces*	30-45	IDR21.900
Bakpao Chik Yen	2 *pieces*	60	IDR25.000
Savory Pao	2 *pieces*	60	IDR13.000

Based on the price comparison that has been carried out, the price of Savory Pao is relatively lower compared to several bakpao variants. Apart from that, Savory Pao also has added value in the form of using arrowroot tuber flour and fish as filling which can increase the nutritional value of the product. Therefore, Savory Pao has the potential to be accepted by consumers in terms of price and innovation in local raw materials.

3.2 Discussions

The research and development of Savory Pao products through arrowroot flour substitution and mackerel filling substitution was carried out through four main stages: define, design, develop, and disseminate, with each stage providing important findings that support the success of product development. The define stage began with the identification of product concepts and determination of reference recipes through sensory testing of three different formulations (R1, R2, and R3), where the results showed that although all three recipes produced relatively similar physical characteristics in terms of round shape, 5 cm diameter, and creamy white color, significant differences were observed in taste and texture aspects [11]. Recipe 2 demonstrated the best performance with the highest average score of 4.1 compared to R1 (3.5) and R3 (3.8), with its superiority lying in the soft and fluffy texture and optimal savory taste, which was supported by the balanced composition of ingredients, particularly the use of 500 g of medium protein wheat flour with appropriate proportions of leavening agents [12]. Recipe 1 showed the lowest score in texture (3.0) and overall properties (3.1) due to suboptimal tuna filling ingredients and unbalanced ingredient proportions, while Recipe 3, despite having a better score than R1 (3.8), was still inferior to R2 due to its somewhat hard texture likely caused by excessive wheat flour (600 g) with disproportionate water content (500 ml) [13]. Based on these results, Recipe 2 was selected as the reference recipe for the next development stage, which is consistent with the principle of food product development that emphasizes consumer acceptance of primary sensory attributes, especially taste and texture [14].

In the design stage, substitution of wheat flour with arrowroot flour was carried out at three different levels: 20% (FI), 40% (FII), and 60% (FIII), along with substitution of tuna filling with mackerel, where the sensory test results showed that the formulation with 20% substitution (FI) provided the best results with an average score of 4.1, higher than the reference recipe (3.2), FII (3.5), and FIII (3.6) [15]. FI excelled in aspects of shape (4.6), size (4.3), taste (4.3), and overall

properties (4.6), with the resulting texture being soft with slight roughness that was still acceptable to panelists, which according to research, arrowroot flour substitution at the 20% level is capable of producing bakpao with good shape, taste, and texture, namely soft, tender, and hollow [16]. This is attributed to the characteristics of arrowroot flour which has low amylose and high amylopectin content, thereby producing more stable gels and soft textures [17]. Conversely, FII (40%) and FIII (60%) showed decreased quality in texture and aroma aspects, with textures becoming dense and coarse and the emergence of a musty arrowroot flour aroma in FIII, a phenomenon caused by the high starch content and low gluten in arrowroot flour [18]. Gluten is the protein responsible for dough elasticity and development, and substitution of arrowroot flour at high levels causes a significant decrease in gluten content, preventing the dough from developing optimally and resulting in a dense texture, while the musty aroma indicates that arrowroot flour has a less neutral flavor character when used in large quantities [19]. Based on these results, FI with 20% arrowroot tuber flour substitution was selected as the best formulation for the subsequent development stage.

The develop stage involved product validation by experts through two stages of validation testing, where Validation I results showed that the development product had quite good quality with an average score of 4.1 compared to the reference product (4.0), but two aspects still needed improvement, namely taste (score 3.0) and packaging (score 4.0) [20]. The validators provided input to add spices and seasonings to reduce the fishy aroma of the mackerel, and after improvements were made, Validation II showed significant improvement in all aspects, with the average score of the development product reaching 4.4 compared to the reference product (4.0) [21]. The taste aspect increased from 3.0 to 4.5 and packaging from 4.0 to 4.6, indicating that the addition of spices such as garlic, shallots, and herbs (lemongrass, kaffir lime leaves, basil leaves) was effective in covering the fishy aroma and taste of mackerel [22]. This is supported by research showing that the use of spices in fish processing can function as natural deodorizers that suppress fishy odors through carbonyl compound reactions with amine groups in fish [23]. The Savory Pao packaging was designed using mica plastic measuring 16 x 10.6 cm containing 2 pieces of bakpao weighing 60 grams, complete with a label containing product information such as name, composition, net weight, production address, and nutritional value information, which is in accordance with BPOM Regulation Number 31 of 2018 concerning Processed Food Labels which requires the inclusion of nutritional value information for certain processed food products [24].

In the disseminate stage, a hedonic test was conducted on 60 untrained panelists from the general public, and the paired sample t-test results showed that the development product had higher average values compared to the reference product for all tested parameters [25]. Statistical analysis showed significant differences ($p<0.05$) for all sensory characteristics, namely taste ($p=0.009$), aroma ($p=0.013$), texture ($p=0.015$), packaging ($p=0.000$), color ($p=0.007$), and overall properties ($p=0.000$), indicating that the development product was significantly more preferred by panelists compared to the reference product [26]. The highest average scores for the development product were achieved by overall properties (4.71), followed by taste (4.68), color (4.67), aroma (4.47), texture (4.47), and packaging (4.43), and the high level of panelist acceptance of the development product indicates that 20% arrowroot flour substitution and mackerel filling can improve the sensory quality of the product [27]. Proximate test results showed changes in nutritional composition in the development product compared to the reference product, with the development product containing protein 8.38%, carbohydrates 37.22%, fat 10.45%, fiber 0.67%, water 29.39%, and ash 0.86% [28]. There was an increase in carbohydrate content from 35.79% to 37.22%, fat from 9.59% to 10.45%, fiber from 0.63% to 0.67%, water from 28.63% to 29.39%, and ash from 0.72% to 0.86%, while protein content decreased from 8.84% to 8.38% [29]. The increase

in carbohydrate and fiber content is caused by the high starch and dietary fiber content in arrowroot flour, which contains amylose around 18-22% and amylopectin 78-82% with quite high dietary fiber content, and the increase in fiber content (from 0.63% to 0.67%) shows that arrowroot flour is able to increase the nutritional value of the product, especially in the aspect of dietary fiber content which is beneficial for digestive health [30]. The decrease in protein content is caused by the lower protein content of arrowroot flour (around 0.5-1.5%) compared to medium protein wheat flour (10-11.5%), but this decrease is still within acceptable limits and can be compensated by the protein content from mackerel filling [31]. Based on BPOM Regulation Number 26 of 2021 concerning Nutritional Values on Processed Food Labels, Savory Pao products with a serving size of 30 grams (2 servings per package) contain energy 82,935 kcal, protein 3 grams (4% RDA), fat 3 grams (5% RDA), carbohydrates 11 grams (3% RDA), and fiber 0.2 grams (1% RDA), and this nutritional value information is important to help consumers choose food products that suit their nutritional needs [32].

Based on the calculation, the total production cost of Savory Pao is Rp 85,257 with a selling price of Rp 13,000 per package (50% mark-up), with the break-even point (BEP) achieved at the sale of 7 boxes (unit BEP) with a sales value of Rp 86,826 (currency BEP) [33]. Price comparison with similar products on the market shows that Savory Pao has a relatively lower price, where Papao Bakpao is sold for Rp 19,000 for 2 pieces (40-60 g), Bakpao Imperial Kitchen Rp 21,900 for 2 pieces (30-45 g), and Bakpao Chik Yen Rp 25,000 for 2 pieces (60 g), while Savory Pao offers a more competitive price (Rp 13,000 for 2 pieces at 60 g) with added value in the form of using local raw materials (arrowroot flour) and fish filling that increases nutritional value [34]. The competitive advantage of Savory Pao lies not only in the more affordable price but also in the innovation of using arrowroot tuber flour as a fiber source and mackerel as a protein source, which is in line with current consumer trends that increasingly pay attention to health aspects and functional value of food products [35]. Food diversification based on local raw materials also supports food security programs and increases the added value of local agricultural products, and overall, the development of Savory Pao with arrowroot tuber flour substitution and mackerel filling has succeeded in producing a superior product from various aspects [36]. The 20% arrowroot flour substitution level has proven capable of producing products with better sensory characteristics, increased nutritional value (especially fiber), competitive prices, and high levels of consumer acceptance, thus this product has good commercial potential and can become a healthy food product alternative based on local raw materials [37].

4. Conclusions

Based on research that has been carried out by researchers in the process of making Savory Pao products, analysis and information data can provide the following conclusions.

1. The correct recipe for making Savory Pao uses a substitution of 20% arrowroot flour and 80% wheat flour.
2. The Savory Pao packaging uses mica measuring 16´10´6 cm with a clear lid containing 2 Savory Pao pieces with a total weight of 60 grams, equipped with a label containing the product name, image, composition, nutritional value information, net weight and production address.
3. Based on the results of the paired T test, the level of liking for Savory Pao in the aspects of taste, aroma, texture, packaging, color and overall characteristics shows significant differences (significantly different) between the reference product and the development product.

4. Information on the nutritional value of Savory Pao per 30 gram serving has an energy content of 82,935 kcal, fat energy of 25 kcal, fat 3 grams (RDA 5%), protein 3 grams (RDA 4%), carbohydrates 11 grams (RDA 3%), and fiber 0.2 grams (RDA 1%).
5. The selling price of Savory Pao is IDR 13,000 per package (2 pieces) with a total weight of 60 grams. BEP per unit is 7 boxes with BEP rupiah of IDR 86,826.

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Innovation of Canna Moringa Roll with Substitution Using Canna Flour and Moringa Leaves as a Source of Iron for Teenage Girls

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ABSTRACT

The love letter cookies in the research were made by substituting canna flour and moringa leaves. This research aimed to (1) formulate the recipe of Canna Moringa Roll; (2) select the presentation and packaging of Canna Moringa Roll; (3) identify the level of acceptance of Canna Moringa Roll products by young women; (4) identify the nutritional information of Canna Moringa Roll products; (5) identify the iron content of Canna Moringa Roll; and (6) determine the selling price and BEP of Canna Moringa Roll products. The research employed the research and development (R&D) method with the 4D model, namely the defining stage, by selecting one recipe from three reference recipes; the designing stage, by selecting the best development recipe from three development variations; the developing stage, by using the validation process for the recipe through a limited preference test of 30 panelists; and the disseminating stage, testing the level of product acceptance by 80 panelists of teenage girls. Then proximate and iron tests were carried out, and the selling price and BEP were calculated. The data were analyzed using a quantitative descriptive method with sensory tests and p-value tests. The research findings were; (1) the best formulation used a substitution of 75% ganyong flour and 5% moringa leaves; (2) a food basket container and a transparent jar were used for serving; (3) the level of acceptance increased from 4.3 in the reference product to 4.5 in the development product; (4) the product contained a total energy of 594 kcal, 18 g fat (26%), 6 g protein (10%), 102 g carbohydrates (32%); and (5) the iron content in the development product was 6 mg (35%), (6) The selling price of the product was IDR 32,000 per package, with a BEP unit of 4 and a rupiah BEP of IDR 112,500.

Keywords:
love letter cookies, canna flour, moringa leaves, iron, adolescent girls

Kue Semprong yang dibuat dalam penelitian adalah dengan melakukan substitusi tepung ganyong dan daun kelor. Penelitian ini bertujuan untuk: (1) Menentukan formulasi Canna Moringa Roll, (2) Menentukan penyajian dan kemasan Canna Moringa Roll, (3) Mengetahui tingkat penerimaan remaja putri produk Canna Moringa Roll, (4) Mengetahui informasi gizi produk Canna Moringa Roll, (5) Mengetahui kandungan zat besi Canna Moringa Roll, (6) Mengetahui harga jual dan BEP produk Canna Moringa Roll.

Penelitian menggunakan metode Research and Development (R&D) dengan model 4D yaitu Tahap define, menentukan 1 resep dari 3 resep acuan, Tahap

design , menentukan 1 resep pengembangan terbaik dari 3 variasi pengembangan, Tahap develop, proses validasi terhadap resep melalui uji kesukaan terbatas sebanyak 30 panelis, Tahap disseminate, pengujian tingkat penerimaan produk oleh 80 panelis remaja putri, selanjutnya dilakukan uji proksimat dan zat besi serta menghitung harga jual dan BEP. Data dianalisis menggunakan metode desktiptif kuantitatif dengan uji sensoris dan uji p-value. Hasil penelitian yang diperoleh adalah (1) Formulasi terbaik menggunakan substitusi 75% tepung ganyong dan 5% daun kelor, (2) Penyajian menggunakan wadah keranjang makanan dan dikemas dalam toples transparan, (3) Tingkat penerimaan meningkat dari 4,3 pada produk acuan menjadi 4,5 pada produk pengembangan, (4) Produk mengandung energi total 594 kkal, lemak 18 gr (26%), protein 6 gr (10%), karbohidrat 102 gr (32%), (5) Kandungan zat besi pada produk pengembangan sebesar 6 mg (35%), (6) Harga jual produk sebesar Rp 32.000 per kemasan dengan BEP unit 4 dan BEP rupiah Rp Rp 112.500.

1. Introduction

Iron deficiency remains an important nutritional problem among adolescent girls. Adolescence is a period of rapid physical growth and psychosocial development, which increases the need for adequate nutrient intake, including iron [1]. Iron plays an essential role in hemoglobin formation, energy metabolism, immune function, and cognitive performance. In adolescent girls, iron requirements are higher due to monthly blood loss during menstruation, making them more vulnerable to iron deficiency when daily food intake does not meet nutritional needs [2], [3]. Low iron intake may lead to fatigue, reduced concentration, decreased immunity, and lower academic performance [2].

The problem of iron deficiency among adolescent girls is closely related to dietary patterns. Many adolescents tend to choose practical, affordable, and taste-oriented foods rather than foods with high nutritional value. The consumption of iron-rich foods is still relatively low, especially when food preferences and daily eating habits limit the intake of iron-source foods [4], [5]. This condition indicates the need for food-based interventions that are not only nutritious but also practical, affordable, and acceptable to adolescent girls.

Several studies have developed local food-based products to improve nutritional value, particularly iron content. Canna flour has been used as a substitute ingredient in various food products because it contains carbohydrates, minerals, and higher iron content than rice flour [12]. Moringa leaves have also been widely studied as a nutrient-rich ingredient because they contain iron, vitamins, minerals, and bioactive compounds that may support nutritional improvement [9]. Previous studies reported that the addition of moringa leaf flour to biscuits, cookies, and other bakery products increased iron content, although excessive addition could affect color, aroma, taste, and texture [14], [15].

Product development using canna flour and moringa leaves has shown promising results, especially in improving nutritional quality while maintaining sensory acceptability. Kurniawan found that biscuits made with canna flour and moringa leaf flour had higher iron content than conventional products, but the formulation needed to be carefully adjusted to maintain consumer acceptance [13]. Santoso also reported that the use of local food ingredients and moringa leaves in cake products could improve nutritional value while preserving acceptable sensory characteristics [16]. These findings suggest that the combination of local ingredients and nutrient-dense plant materials can be applied to functional snack development.

However, previous studies have mostly focused on biscuits, cookies, and dry cakes, while the development of *semprong* as a traditional rolled snack using canna flour substitution and moringa leaves has received limited attention. *Semprong* is a traditional Indonesian snack with

a sweet taste and crispy texture that is generally accepted by many consumers, including adolescents [17]. Conventional *semprong* is commonly made from rice flour, which has relatively low iron content [8]. Therefore, replacing part of the rice flour with canna flour and adding moringa leaves may improve the nutritional value of the product while maintaining its traditional characteristics.

Canna Moringa Roll is developed as an innovative form of *semprong* using canna flour and moringa leaves as functional ingredients. This product is expected to provide an alternative iron-source snack for adolescent girls while supporting the utilization of local food resources. The product development also considers sensory quality, serving technique, packaging, nutritional information, iron content, selling price, and Break Even Point analysis so that the product can be evaluated not only from a nutritional perspective but also from consumer acceptance and business feasibility [19], [20].

Based on the limited studies that specifically combine canna flour and moringa leaves in *semprong* products, this research is significant in developing a local food-based snack that is nutritious, acceptable, and potentially useful for improving iron intake among adolescent girls. This study aims to: (1) determine the appropriate formulation of Canna Moringa Roll; (2) identify suitable serving and packaging techniques; (3) analyze the acceptability level of Canna Moringa Roll among adolescent girls; (4) determine its nutritional information and iron content; and (5) calculate the selling price and Break Even Point. This research uses a product development approach through formulation trials, organoleptic testing, proximate analysis, iron content analysis, and economic feasibility calculation [18].

2. Method

2.1 Research Design

This study used a research and development approach with the 4D model, consisting of define, design, develop, and disseminate stages. The model was applied to develop Canna Moringa Roll, a modified traditional *semprong* product made with canna flour substitution and moringa leaf addition. The study focused on product formulation, sensory acceptability, nutritional content, iron content, selling price, and Break Even Point analysis.

2.2 Research Location and Materials

The product formulation and sensory evaluation were conducted at the Culinary Laboratory and Chemistry Laboratory, Applied Bachelor Program of Culinary Arts, Faculty of Vocational Studies, Universitas Negeri Yogyakarta, Wates Campus. The large-scale acceptability test was conducted during a culinary exhibition at Universitas Negeri Yogyakarta, Wates Campus. The proximate and iron content analyses were carried out at Chem-Mix Pratama Laboratory, Bantul, Yogyakarta. The research was conducted from September 2025 to May 2026.

The main ingredients used in this study were canna flour, dried moringa leaves, rice flour, sago flour, eggs, coconut milk, margarine, powdered sugar, salt, and sesame seeds. The main equipment included a mixing bowl, whisk, sieve, *semprong* mold, gas stove, tray, ladle, and digital scale.

2.3 Product Development Procedure

The product development procedure followed the four stages of the 4D model. In the define stage, three reference recipes of *semprong* were collected, tested, and evaluated to determine the best basic formula. The formula with the highest average sensory score was selected as the reference formula.

In the design stage, the selected formula was modified through two formulation trials. The first trial substituted rice flour with canna flour at 50%, 75%, and 100%. The second trial added moringa leaves to the selected canna flour formulation at 5%, 7.5%, and 10%. Each formulation was evaluated based on sensory attributes to determine the best product formula.

In the develop stage, the selected formulation was validated by expert panelists through two validation stages. Product revision was carried out based on the suggestions obtained from the first validation. After the second validation, a limited sensory acceptability test was conducted involving 30 semi-trained panelists. This stage also determined the serving technique and packaging of the final product.

In the disseminate stage, the final product was introduced through a culinary exhibition. A large-scale acceptability test was conducted involving 80 untrained panelists, particularly adolescent girls and general consumers. The final product was then analyzed for nutritional content, iron content, selling price, and Break Even Point.

2.4 Sensory and Laboratory Analysis

Sensory evaluation was conducted using a five-point hedonic scale to determine panelists' acceptance of Canna Moringa Roll. The evaluated attributes included color, aroma, taste, texture, packaging, and overall acceptability. The scale ranged from 1 to 5, with higher scores indicating higher product acceptance.

Laboratory analysis was conducted to determine the nutritional quality of the selected product. Proximate analysis was used to determine water, ash, protein, fat, carbohydrate, and energy content. Iron content analysis was conducted to determine the Fe level of the developed product. The results were used to prepare the nutritional information of Canna Moringa Roll.

2.5 Data Analysis

The sensory evaluation data were analyzed using descriptive quantitative analysis by calculating the mean score of each attribute. The results were used to determine the best formulation and the level of product acceptability. A t-test was used to compare the sensory acceptance between the reference product and the developed product. The selling price was calculated using a cost-plus pricing approach, while Break Even Point analysis was used to determine the minimum sales volume required to cover production costs.

3. Results and Discussion

3.1 Results

a. Define Stage: Determining the Reference Recipe of Semprong

The define stage was conducted by collecting three traditional *semprong* recipes from different sources. These recipes were tested to determine the most suitable reference formulation for the development of Canna Moringa Roll. The selection of the reference recipe was based on sensory characteristics, including shape, size, color, aroma, taste, texture, and overall acceptability. The three reference recipes used in this study are presented in Table 1.

Table 1. Reference Recipes of Traditional Semprong

Ingredients	Recipe 1	Recipe 2	Recipe 3
Rice flour	250 g	225 g	300 g
Wheat flour	-	-	50 g
Sago flour	60 g	40 g	-
Eggs	3 pcs	3 pcs	1 pc
Granulated sugar	-	150 g	170 g
Powdered sugar	160 g	-	-
Coconut milk	250 ml	200 ml	330 ml
Margarine	3 tbsp	40 g	50 g
Salt	1/2 tsp	-	1/4 tsp
Sesame seeds	-	40 g	30 g
Vanilla	-	-	1/2 tsp

Source: Recipe 1 = Koleksi Resep Jajanan Pasar (2013); Recipe 2 = Wati (2013); Recipe 3 = YouTube Dapur Nana's.

Table 1 shows that the three reference recipes had different ingredient compositions, especially in the use of flour, sugar, coconut milk, margarine, and additional flavoring ingredients. Recipe 1 used rice flour and sago flour with powdered sugar, while Recipe 2 used rice flour, sago flour, granulated sugar, and sesame seeds. Recipe 3 used rice flour and wheat flour with vanilla and sesame seeds. These differences affected the final characteristics of the product, particularly texture, aroma, and color.

After the recipes were tested, sensory characteristics were observed to compare the quality of each reference product. The sensory characteristics of the three reference recipes are shown in Table 2.

Table 2. Characteristics of the Three Reference Recipes

Characteristics	Recipe 1	Recipe 2	Recipe 3
Color	Golden yellow	Golden yellow	Brownish yellow
Aroma	Coconut milk aroma	Coconut milk and sesame aroma	Vanilla aroma
Texture	Crispy	Crispy	Hard
Taste	Sweet	Sweet	Sweet
Shape	Cylindrical	Cylindrical	Cylindrical
Size	14 cm	14 cm	14 cm

Based on Table 2, Recipe 1 and Recipe 2 produced a crispy texture and golden yellow color, while Recipe 3 produced a harder texture and a darker color. Recipe 1 was considered more balanced because it produced a sweet taste, crispy texture, and coconut milk aroma that matched the expected characteristics of traditional *semprong*. The documentation of the three reference products can be presented in Fig. 1.

a) b) c)

Figure 1. Documentation of reference products at the define stage: (a) R1, (b) R2, (c) R3.

The mean sensory scores of the three reference recipes are presented in Table 3.

Table 3. Mean Sensory Scores of the Define Stage

Sensory Properties	Recipe 1	Recipe 2	Recipe 3
Shape	4.4	4.4	4.4
Size	4.4	4.8	4.2
Color	4.4	4.6	4.4
Aroma	4.4	4.0	4.0
Taste	4.8	4.0	3.6
Texture	4.8	4.0	3.4
Overall	4.6	3.8	3.46

Table 3 shows that Recipe 1 obtained the highest overall score of 4.6. Recipe 1 also obtained the highest scores in taste and texture, with both attributes reaching 4.8. Therefore, Recipe 1 was selected as the reference formulation for the next development stage.

b. Design Stage: Developing the Canna Flour and Moringa Leaf Formulation

The design stage was conducted in two formulation trials. The first trial focused on substituting rice flour with canna flour at 50%, 75%, and 100%. This trial aimed to determine the highest level of canna flour substitution that could still maintain acceptable sensory characteristics. The canna flour substitution formula is presented in Table 4.

Table 4. Canna Flour Substitution Formulation

Ingredients	Reference	F1 50%	F2 75%	F3 100%
Rice flour	250 g	125 g	62.5 g	-
Sago flour	60 g	60 g	60 g	60 g
Canna flour	-	125 g	187.5 g	250 g
Eggs	3 pcs	3 pcs	3 pcs	3 pcs
Powdered sugar	160 g	160 g	160 g	160 g
Coconut milk	250 ml	250 ml	250 ml	250 ml
Margarine	3 tbsp	3 tbsp	3 tbsp	3 tbsp
Salt	1/2 tsp	1/2 tsp	1/2 tsp	1/2 tsp

The sensory characteristics of the canna flour substitution products are shown in Table 5.

Table 5. Characteristics of Canna Flour Substitution Products

Characteristics	F1 50%	F2 75%	F3 100%
Color	Brownish yellow	Golden yellow	Brownish yellow
Aroma	Coconut milk aroma	Coconut milk aroma	Coconut milk aroma
Texture	Crispy	Crispy	Crispy
Taste	Sweet	Sweet	Sweet, slightly bitter
Size	16 cm	14 cm	14 cm

Table 5 shows that the 75% canna flour substitution produced the most balanced characteristics. The product had a golden yellow color, crispy texture, and sweet taste. Meanwhile, 100% canna flour substitution produced a slightly bitter taste, indicating that excessive substitution could reduce taste acceptability. The mean sensory scores of the design stage are presented in Table 6.

Table 6. Mean Sensory Scores of Canna Flour Substitution

Sensory Properties	Reference	F1 50%	F2 75%	F3 100%
Shape	4.0	4.0	4.6	4.0
Size	4.0	3.8	4.0	4.0
Color	3.8	4.2	4.0	3.6
Aroma	4.2	4.0	3.8	3.8
Taste	3.8	3.8	4.4	4.2
Texture	4.0	4.2	3.8	4.0
Overall	4.04	4.22	4.24	3.90

Based on Table 6, F2 with 75% canna flour substitution obtained the highest overall score of 4.24. This formulation was selected for the second design stage, namely the addition of moringa leaves. The documentation of canna flour substitution products can be presented in Fig. 2.

a) b) c)

Figure 2. Documentation of canna flour substitution products at the design stage: (a) F1 50%, (b) F2 75%, (c) F3 100%.

The second formulation trial was conducted by adding moringa leaves to the selected 75% canna flour formulation. The levels of moringa leaves used were 12.5 g, 25 g, and 37.5 g. The formulation is presented in Table 7.

Table 7. Moringa Leaf Addition Formulation

Ingredients	Reference	F1	F2	F3
Rice flour	250 g	62.5 g	62.5 g	62.5 g
Sago flour	60 g	60 g	60 g	60 g
Canna flour	-	187.5 g	187.5 g	187.5 g
Moringa leaves	-	12.5 g	25 g	37.5 g
Eggs	3 pcs	3 pcs	3 pcs	3 pcs
Powdered sugar	160 g	160 g	160 g	160 g
Coconut milk	250 ml	250 ml	250 ml	250 ml
Margarine	3 tbsp	3 tbsp	3 tbsp	3 tbsp
Salt	1/2 tsp	1/2 tsp	1/2 tsp	1/2 tsp

The sensory characteristics of products with moringa leaf addition are presented in Table 8.

Table 8. Characteristics of Moringa Leaf Addition Products

Characteristics	F1	F2	F3
Color	Brownish yellow	Brownish yellow	Brownish yellow
Aroma	Moringa aroma	Moringa aroma	Moringa aroma
Texture	Crispy	Crispy	Crispy
Taste	Sweet, slight moringa taste	Sweet with moringa taste	Dominant moringa taste
Size	14 cm	14 cm	14 cm

Table 8 shows that the addition of moringa leaves affected the color, aroma, and taste of the product. A higher amount of moringa leaves produced a stronger moringa aroma and a more dominant taste. Therefore, the formulation required further adjustment during the validation stage to reduce the strong aroma and bitter taste.

The mean sensory scores of moringa leaf addition products are shown in Table 9.

Table 9. Mean Sensory Scores of Moringa Leaf Addition

Sensory Properties	Reference	F1	F2	F3
Shape	4.0	3.8	4.0	4.0
Size	4.0	4.0	4.0	4.2
Color	4.2	4.0	4.0	4.0
Aroma	4.2	3.4	3.4	3.8
Taste	4.2	3.8	4.0	3.8
Texture	4.2	4.2	4.2	4.0
Overall	4.4	4.1	4.0	3.8
Mean	-	3.90	3.94	3.94

Table 9 shows that F2 and F3 obtained the same mean score of 3.94. However, F2 with 25 g moringa leaves was initially selected because it produced a more balanced sensory profile than F3. Since the moringa aroma and taste were still considered strong, the formulation was further improved in the development stage. The documentation of moringa leaf addition products can be presented in Fig. 3.

c. Development Stage: Validation and Final Formulation of Canna Moringa Roll

The development stage was conducted through expert validation. The selected formulation from the design stage was evaluated by two trained panelists. In the first validation, the experts suggested reducing the amount of moringa leaves because the product still had a strong moringa aroma and a slightly bitter taste. Roasted sesame seeds were then added to improve aroma, taste balance, and product acceptability.

After revision, the final formulation used 75% canna flour substitution, 12.5 g moringa leaves, and 12.5 g roasted sesame seeds. The final formulation of Canna Moringa Roll is presented in Table 10.

Table 10. Final Formulation of Canna Moringa Roll

Ingredients	Amount
Rice flour	62.5 g
Sago flour	60 g
Canna flour	187.5 g
Moringa leaves	12.5 g
Roasted sesame seeds	12.5 g
Eggs	3 pcs
Powdered sugar	160 g
Coconut milk	250 ml
Margarine	3 tbsp
Salt	1/2 tsp

The sensory validation results of the final product are presented in Table 11.

Table 11. Sensory Test Results of the Validation Stage

Sensory Properties	Reference	Category	Canna Moringa Roll	Category
Shape	4.0	Like	4.5	Like
Size	4.0	Like	4.5	Like
Color	4.0	Like	4.5	Like
Aroma	4.0	Like	4.5	Like
Taste	4.0	Like	4.0	Like
Texture	3.5	Slightly like	4.0	Like
Overall	4.0	Like	4.5	Like
Mean	3.92	Slightly like	4.30	Like

Table 11 shows that Canna Moringa Roll obtained a mean score of 4.30 and was categorized as liked. This result indicates that the reformulation successfully improved product acceptability, especially in aroma, color, texture, and overall evaluation. The final product, serving presentation, and packaging can be presented in Figure 3.

a) b) c)

Figure 3. Final product, serving presentation, and packaging of Canna Moringa Roll: (a) final product, (b) serving presentation, (c) packaging and label.

Canna Moringa Roll was served in a food basket lined with white paper to maintain cleanliness and improve visual appearance. The product was packaged in a transparent 750 ml cylindrical jar with a net weight of 140 g. The packaging was completed with a label containing product identity, composition, nutrition information, and net weight.

d. Dissemination Stage: Consumer Acceptance of Canna Moringa Roll

The dissemination stage was conducted through a large-scale preference test involving 80 untrained panelists, particularly adolescent girls and general consumers. The test was carried out during the Wonderoots 2025 culinary exhibition at Universitas Negeri Yogyakarta, Wates Campus. The panelists evaluated the reference product and the developed product using a five-point hedonic scale. The results are presented in Table 12.

Table 12. Large-Scale Preference Test Results

Sensory Properties	Reference Product	Canna Moringa Roll	p-value	Description
Taste	4.3 ± 0.62	4.4 ± 0.59	0.129	Not significantly different
Aroma	4.3 ± 0.64	4.4 ± 0.61	0.114	Not significantly different
Texture	4.3 ± 0.61	4.5 ± 0.50	0.001	Significantly different
Color	4.3 ± 0.62	4.5 ± 0.54	$p < 0.001$	Significantly different
Overall	4.3 ± 0.56	4.5 ± 0.52	0.007	Significantly different

Table 12 shows that Canna Moringa Roll obtained higher mean scores than the reference product in all sensory attributes. Taste and aroma were not significantly different, indicating that the addition of canna flour, moringa leaves, and roasted sesame seeds did not reduce the acceptability of these attributes. Significant differences were found in texture, color, and overall acceptability. The higher score of the developed product shows that the final formulation was acceptable to consumers and had better sensory quality than the reference product in several attributes.

e. Composition Analysis and Nutritional Information of Canna Moringa Roll

The reference product and Canna Moringa Roll were analyzed through proximate analysis and iron content testing at Chem-Mix Pratama Laboratory. The analysis included water, ash, protein, fat, crude fiber, carbohydrate, energy, and iron content. The results are shown in Table 13.

Table 13. Proximate Analysis and Iron Content Results

Component	Reference Product	Canna Moringa Roll	p-value	Description
Water (%)	3.44	3.34	0.185	Not significantly different
Ash (%)	2.04	1.60	0.114	Not significantly different
Protein (%)	4.17	4.43	0.073	Not significantly different
Fat (%)	10.54	12.65	0.063	Not significantly different
Crude fiber (%)	3.09	4.72	0.027	Significantly different
Carbohydrate (%)	76.68	73.21	0.065	Not significantly different
Energy(kcal/100 g)	408.49	415.36	-	-
Iron (mg/100 g)	1.41	4.48	0.029	Significantly different

Table 13 shows that Canna Moringa Roll had higher protein, fat, crude fiber, energy, and iron content than the reference product. The most important improvement was found in crude fiber and iron content. Crude fiber increased from 3.09% to 4.72%, while iron content increased from 1.41 mg/100 g to 4.48 mg/100 g. The increase in iron content indicates that the use of canna flour and moringa leaves contributed to improving the nutritional value of the product.

The nutrition information per 140 g serving is presented in Table 14.

Table 14. Nutrition Information of Canna Moringa Roll per 140 g Serving

Nutrient	Reference Product	% RDA	Canna Moringa Roll	% RDA
Total energy	585 kcal	-	594 kcal	-
Fat	15 g	22%	18 g	26%
Protein	6 g	10%	6 g	10%
Carbohydrate	107 g	33%	102 g	32%
Iron	2 mg	11%	6 mg	35%

Note: RDA percentage was calculated based on the reference values of 67 g fat, 60 g protein, 325 g carbohydrate, and 18 mg iron per day.

Table 14 shows that one 140 g serving of Canna Moringa Roll contains 594 kcal of energy, 18 g of fat, 6 g of protein, 102 g of carbohydrate, and 6 mg of iron. The iron content contributed approximately 35% of the daily iron requirement. This result supports the potential of Canna Moringa Roll as an alternative iron-source snack for adolescent girls.

Table 15. Nutritional Information of development products

NUTRITIONAL VALUE INFORMATION		
Serving size : 140 grams		
Number of servings per package : 28 grams		
AMOUNT PER SERVING		
Total Energy	594 kcal	
		% AKG
Fat	18 gr	26%
Protein	6 gr	10%
Karbohidrat	102 gr	32%
Fe	6 mg	35%
**Percent AKG based on energy needs is 2150 kcal. Your energy needs may higher or lower.*		

f. Selling Price and Break-Even Point Analysis of Canna Moringa Roll

The selling price of Canna Moringa Roll was determined based on production cost and profit margin. One production batch produced three jars of Canna Moringa Roll. The summary of selling price and Break Even Point analysis is shown in Table 15.

Table 16. Selling Price and Break Even Point Analysis of Canna Moringa Roll

Component	Value
Production yield	3 jars
Total production cost	IDR 73,535
Production cost per jar	IDR 24,511
Profit margin	30%
Calculated selling price	IDR 31,864
Final selling price	IDR 32,000 per jar
Break Even Point unit	4 jars
Break Even Point sales	IDR 112,500

Based on Table 15, the production cost of Canna Moringa Roll was IDR 24,511 per jar. By applying a 30% profit margin, the calculated selling price was IDR 31,864 and was rounded to IDR 32,000 per jar. The Break Even Point analysis showed that the product needs to be sold at a minimum of four jars, equal to IDR 112,500 in sales, to cover production costs. These results indicate that Canna Moringa Roll has economic potential as a marketable snack product because the selling price can cover production costs while still providing profit.

3.7 Discussion

The development of Canna Moringa Roll showed that canna flour and moringa leaves can be applied in traditional semprong products, although the formulation must be adjusted to maintain sensory quality. The 75% canna flour substitution produced the best characteristics because it maintained the crispy texture and sweet taste, while 100% substitution reduced acceptability due to a slightly bitter taste and less balanced sensory properties [11], [12].

The addition of moringa leaves improved the nutritional value, especially iron content, but excessive amounts caused darker color, stronger aroma, and bitter taste [14], [15], [16]. Therefore, the final formulation was adjusted by reducing moringa leaves to 12.5 g and adding 12.5 g roasted sesame seeds to improve aroma and taste balance.

Sensory evaluation showed that the product was generally accepted by consumers. After formula adjustment, the large-scale test showed better acceptance in taste, aroma, texture, color, and overall acceptability. The results indicate that proper formulation can reduce the negative sensory effects of moringa leaves while maintaining desirable product characteristics [16].

Nutritional analysis confirmed that Canna Moringa Roll contained higher crude fiber and iron than the reference product. The iron content increased from 1.41 mg/100 g to 4.48 mg/100 g, contributing approximately 6 mg of iron per 140 g serving, or about 35% of the daily iron requirement [7]. The higher fiber and mineral content were associated with the use of canna flour and moringa leaves [8], [9], [13].

Packaging and labeling also supported product acceptance. The transparent 750 ml jar and nutrition label improved product presentation and consumer information [19]. Economically, the selling price of IDR 32,000 per jar was considered feasible and supported by BEP analysis, indicating the product has potential for small-scale business development [20].

Overall, Canna Moringa Roll can be developed as an innovative traditional snack with improved iron content and acceptable sensory quality. The study highlights the importance of balancing nutritional improvement with taste, aroma, texture, color, packaging, and price to increase consumer acceptance.

4. Conclusions

This study shows that Canna Moringa Roll can be developed as an innovative traditional *semprong* product using canna flour substitution and moringa leaf addition. The final formulation consisted of 75% canna flour substitution, 12.5 g moringa leaves, and 12.5 g roasted sesame seeds. This formulation was selected because it produced acceptable sensory characteristics, especially in terms of taste, aroma, texture, color, and overall acceptability. The addition of roasted sesame seeds helped balance the distinctive aroma and slightly bitter taste of moringa leaves, making the product more acceptable to consumers.

The developed product obtained higher mean sensory scores than the reference product in the large-scale acceptability test. Taste and aroma were not significantly different from the reference product, while texture, color, and overall acceptability showed significant differences. These findings indicate that the substitution of canna flour and the addition of moringa leaves did not reduce consumer acceptance and even improved several sensory attributes of the product.

Nutritional analysis showed that Canna Moringa Roll had higher crude fiber and iron content than the reference product. The iron content increased from 1.41 mg/100 g in the reference product to 4.48 mg/100 g in the developed product. In one 140 g serving, Canna Moringa Roll provided approximately 6 mg of iron, contributing about 35% of the daily iron requirement. This result supports the potential of Canna Moringa Roll as an alternative iron-source snack for adolescent girls.

The selling price and Break Even Point analysis also indicated that Canna Moringa Roll has potential to be developed as a small-scale marketable food product. The product was priced at IDR 32,000 per jar, with a Break Even Point of four jars or IDR 112,500 in sales. Overall, this research contributes to local food diversification by developing a traditional snack with improved nutritional value and acceptable sensory quality. Further studies are recommended to evaluate product shelf life, iron bioavailability, consumer acceptance among a larger adolescent population, and the effectiveness of regular consumption in supporting iron intake.

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Preliminary Study Of Rejected Coffee Bean Waste In Kopi Meneer Hargobinangun Yogyakarta

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ABSTRACT

Kopi Meneer, located in Hargobinangun Village on the slopes of Mount Merapi, Yogyakarta, is a coffee business with significant potential, but faces challenges in managing rejected coffee bean waste. This preliminary study aims to identify the characteristics and potential utilization of coffee bean waste that does not meet quality standards at Kopi Meneer. This research used a case study method with observation, interviews, and literature analysis to examine the types, causes of rejection, physical-chemical characteristics, and potential waste processing. The study results indicate that rejected coffee bean waste results from the quality sorting process, with a percentage reaching 5-10% of the total beans received, caused by physical defects, pest infestation, abnormal color, and inadequate moisture content. This waste still contains organic compounds that have the potential to be used as raw material for biomass briquettes, compost, and functional cascara drinks. The study also identified management constraints such as limited knowledge, equipment, land, and market access. Similar activities in the Hargobinangun area showed that training interventions were able to reduce waste volume by 20% and increase community understanding of environmentally friendly coffee waste processing by 80%. This study recommends the need for waste processing trials and partnership development to support sustainable and economically valuable coffee bean waste management.

Keywords:
Coffee beans, waste, sorting, utilization, Meener Coffee

Kopi Meneer, yang terletak di Desa Hargobinangun di lereng Gunung Merapi, Yogyakarta, adalah bisnis kopi dengan potensi besar, namun menghadapi tantangan dalam mengelola limbah biji kopi yang ditolak. Studi awal ini bertujuan untuk mengidentifikasi karakteristik dan potensi pemanfaatan limbah biji kopi yang tidak memenuhi standar kualitas di Kopi Meneer. Penelitian ini menggunakan metode studi kasus dengan observasi, wawancara, dan analisis literatur untuk memeriksa jenis, penyebab penolakan, karakteristik fisik-kimia, dan potensi pengolahan limbah. Hasil studi menunjukkan bahwa limbah biji kopi yang ditolak berasal dari proses penyortiran berkualitas, dengan persentase mencapai 5-10% dari total biji kopi yang diterima, disebabkan oleh cacat fisik, infestasi hama, warna abnormal, dan kadar air yang tidak memadai. Limbah ini masih mengandung senyawa organik yang berpotensi digunakan sebagai bahan baku untuk briket biomassa, kompos, dan minuman cascara fungsional. Studi ini juga mengidentifikasi kendala manajemen seperti keterbatasan pengetahuan, peralatan, lahan, dan akses pasar. Kegiatan serupa di wilayah Hargobinangun menunjukkan bahwa intervensi pelatihan mampu mengurangi volume limbah sebesar 20% dan meningkatkan pemahaman masyarakat tentang pengolahan limbah kopi yang ramah lingkungan sebesar 80%. Studi ini merekomendasikan perlunya uji coba pengolahan limbah dan pengembangan kemitraan untuk mendukung pengelolaan limbah biji kopi yang berkelanjutan dan bernilai ekonomi.

1. Introduction

Indonesia is the world's fourth-largest coffee producer, with production reaching over 700,000 tons per year [1]. In the ground coffee production process, the bean sorting stage plays a crucial role in ensuring the quality of the final product. Coffee beans with physical defects (broken, hollow, moldy), uneven size, or abnormal color are separated and categorized as rejects, or damaged coffee beans. This waste is not sold as a primary product and is often used as animal feed, compost, or even simply discarded, thus not being optimally utilized [2]. However, in terms of chemical composition, reject coffee beans have potential that is not significantly different from primary coffee beans. Coffee beans generally contain bioactive compounds such as chlorogenic acid, caffeine, tannins, and other natural antioxidants [3].

Furthermore, coffee beans are also rich in lignin, cellulose, and hemicellulose, which have potential as biomass raw materials. However, the specific characteristics of rejected coffee bean waste have not been comprehensively studied. For example, whether these defect processes (e.g., pest infestation or excessive fermentation) significantly alter the bioactive compound profile, antioxidant levels, or physicochemical properties remains an open question.

Previous studies have focused primarily on the utilization of post-brewing solid waste (spent coffee grounds) or coffee cherry skins (cascara). Meanwhile, in-depth studies on the characterization and utilization opportunities of rejected coffee bean waste from the primary processing industry are still very limited. This waste volume is significant and continuous throughout

the year, following the production cycle. If not managed properly, this waste can cause environmental problems due to the accumulation of organic material.

Therefore, this preliminary study is crucial as a foundation for promoting the utilization of rejected coffee bean waste with greater added value, in accordance with circular economy principles. This research aims to conduct initial characterization of rejected coffee bean waste, including proximate analysis (moisture, ash, protein, and fat content), identification of bioactive compounds, and antioxidant activity. The results of this preliminary study are expected to provide accurate baseline data on the chemical and functional potential of this waste, which can then serve as a reference for further research. Potential uses that can be explored include as a source of natural antioxidants, a raw material for food supplements, a substrate for fermentation, or a raw material for biocomposites.

2. Method

This research uses a qualitative approach with an exploratory case study. This approach was chosen to deeply understand the phenomenon of reject coffee bean waste utilization from an emic (actor) perspective, exploring meanings, processes, and constraints that cannot be measured quantitatively [4]. This research focuses on exploring the knowledge, perceptions, management practices, and potential innovations in the utilization of reject coffee bean waste as experienced and interpreted by key actors in coffee production centers.

This research was conducted from November to December 2025. The research subjects were at Kopi Meneer Hargobinnangun, Sleman, Yogyakarta. The location was selected using purposive sampling based on the following criteria: (1) it is an area with intensive post-harvest coffee processing activities (drying, hulling, sorting), and (2) it produces an identifiable volume of reject coffee bean waste.

The research subjects (informants) were selected using a purposive sampling technique [5]. Key informants included: a) one coffee plantation owner in the Hargobinangun area, b) two coffee bean collectors, and c) one farmer group leader.

Data collection was conducted using in-depth semi-structured interviews. Questions developed through the interviews included: a) the identification process and volume of damaged coffee bean waste, b) waste management practices and utilization, c) constraints and challenges in waste management. Interviews lasted between 40 and 60 minutes.

In addition to interviews, direct observations were conducted to observe the sorting process and the physical form of damaged coffee bean waste in the field. Observations focused on the socio-cultural and technical context of waste management [6]. Observations were documented in the form of field notes and photographs (with permission).

The data analysis in this study used thematic analysis techniques to process the interview and observation data. According to [7], which consists of six stages: a) reading transcripts and field notes, b) marking interesting pieces of data, c) grouping related codes, d) reviewing and checking the relevance of themes, e) articulating the essence of each theme formed, f) presenting the analysis in a narrative. To ensure the credibility of the findings, triangulation of sources and methods was carried out [8]: a) Comparing information obtained from farmers, middlemen, b) Comparing data from interviews with data from direct observations in the field.

3. Results and Discussion

3.1. **Results**

Based on observations and initial interviews with the management, the rejected coffee bean waste originates from the quality sorting process before the beans are further processed. Kopi Meneer, located in the Hargobinangun area of Pakem, Sleman, is situated on the slopes of Mount Merapi, a coffee-producing region known for its fertile volcanic soil.

1. Characteristics of Rejected Bean Waste

Coffee beans are rejected at Kopi Meneer based on physical quality criteria that do not meet standards. Rejection criteria include:

a. Physically defective coffee beans: Beans that are broken, have holes, or are misshapen (double beans or underdeveloped beans).
b. Pest-infested coffee beans: Beans showing signs of coffee smut (Hypothenemus hampei) infestation.
c. Abnormally colored coffee beans: Beans that are blackened or have an uneven color due to excessive fermentation or improper drying.
d. Coffee beans with inappropriate moisture content: Beans that are still wet or whose moisture content exceeds the standard (12-13%).

Based on preliminary data, rejected coffee bean waste is estimated to reach 5-10% of the total coffee beans received, depending on the harvest season and weather conditions. This waste has not been optimally utilized and is simply discarded or piled up in areas around business locations.

2. Physical and Chemical Characteristics of Waste

Based on the characteristics of Robusta coffee beans generally processed in the Yogyakarta region, rejected coffee beans have distinctive physical characteristics. In general, Robusta coffee beans have a higher yield than Arabica coffee, with a slightly rounder bean shape and thicker curves.

Initial analysis of rejected coffee bean waste indicates that, although physically not meeting quality standards for consumption, this waste still contains organic compounds with potential for utilization. Coffee beans contain carbohydrates, proteins, fats, minerals, and bioactive compounds such as caffeine and chlorogenic acid.

3. Potential Environmental Impact

Improperly managed coffee bean waste can cause environmental problems. Coffee beans have a relatively high moisture content and are easily damaged, and they contain organic compounds that can pollute the environment if left to rot. Furthermore, the accumulation of solid waste in areas around business locations can produce unpleasant odors and become a breeding ground for pests.

In general, coffee processing waste from coffee cherries can account for up to 48.10% of fresh fruit production, consisting of the pulp (42.20%) and the seed coat (5.90%). Rejected coffee bean waste at Kopi Meneer falls into the solid waste category, requiring special handling to prevent negative environmental impacts.

Figure 1. Reject Coffee Waste

Figure 2. With the resource person for Meneer Coffee products

3.2. **Discussion**

Damaged coffee beans can be utilized in various new products. Previous research indicates that coffee beans have a relatively high carbon content and have potential as a raw material for alternative energy. Coffee grounds contain 47.8%–58.9% total carbon, 1.9%–2.3% total nitrogen, 0.4%–1.6% ash, and 8.6% cellulose. Rejected coffee bean waste also has a calorific value that makes it potential for use as a raw material for biomass briquettes.

Research on the use of coffee waste as briquettes shows that a composition of 70% coffee grounds and 30% adhesive can produce briquettes with the following characteristics: density 0.49 g/cm^3, moisture content 5.11%, volatile matter content 78.33%, bound carbon content 17.31%, ash content 0.62%, and a calorific value of 4656 cal/g. This potential demonstrates the potential for processing rejected coffee bean waste into an environmentally friendly alternative fuel.

Besides being used as a raw material for biomass briquettes, damaged coffee beans can be used as compost. Coffee bean waste is rich in nutrients that can be used as raw material for organic fertilizer. Indonesia produces significant amounts of coffee hull waste, accounting for 50-60% of the total coffee bean harvest. Processing coffee hull waste into compost can improve soil fertility and support sustainable agriculture.

Besides damaged beans, coffee hulls are also produced as waste, which can be made into tea. Besides being used as fertilizer, coffee hull waste can also be processed into cascara, a tea drink made from dried coffee bean hulls [9]. The process for making cascara is relatively simple: the harvested coffee beans are washed, the hulls are removed, and dried.

Based on a preliminary study, there are several obstacles in managing rejected coffee bean waste at Kopi Meneer:

a. Limited knowledge: Management does not yet have adequate knowledge about the potential utilization of coffee bean waste.
b. Limited equipment: Equipment is not available to process waste into value-added products.
c. Limited land: Limited land available for processing or storing waste.
d. Limited market access: There is no market access for processed coffee waste products.

4. Conclusions

Based on the results of a preliminary study on rejected coffee bean waste at Kopi Meneer Hargobinangun Yogyakarta, the following conclusions can be drawn:

a. Waste Characteristics: Rejected coffee bean waste at Kopi Meneer originates from the quality sorting process, accounting for 5-10% of the total coffee beans received. Causes of rejection include physical defects (broken, hollow, or misshapen beans), coffee bean pest infestation (Hypothenemus hampei), abnormal color due to excessive fermentation or improper drying, and substandard moisture content (above 12-13%).
b. Potential Utilization: Rejected coffee bean waste still contains organic compounds that have the potential to be utilized as value-added products, including: (a) raw material for biomass briquettes with a calorific value of 4,656 cal/g, (b) nutrient-rich compost to support sustainable agriculture, and (c) raw material for the economically valuable functional cascara beverage.
c. Management Constraints: Currently, coffee bean waste management at Kopi Meneer faces various constraints, including limited management knowledge about the potential for waste utilization, limited processing equipment, limited land for storage and processing, and the lack of market access for processed waste products.
d. Development Opportunities: Based on the results of similar activities in the Hargobinangun area, coffee waste management has shown positive results, with a 20% reduction in waste volume, an 80% increase in community understanding of environmentally friendly waste management, and 60% of participants being able to practice waste processing independently. This opens up opportunities for Kopi Meneer to develop sustainable waste management.
e. Follow-up Recommendations: Strategic steps are needed, such as detailed identification of the chemical composition of waste, trials of waste processing into various products, training for managers, developing partnerships with research institutions or universities, and evaluating the economic feasibility of various waste utilization alternatives.

Overall, rejected coffee bean waste at Kopi Meneer has significant potential to be processed into value-added products. With proper management, this waste can not only reduce its negative impact on the environment but can also become a source of additional income, supporting the future sustainability of Kopi Meneer's business.

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The Role of Competency Certification in Improving the Hard Skills and Soft Skills of Diploma Three Culinary Arts Students

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ABSTRACT

This study aims to analyze the role of competency certification in improving hard skills and soft skills of Diploma Three Culinary Arts students. The study used a quantitative method with a survey with a sequential explanatory design. The sample consisted of 30 Diploma III Culinary Arts students who had participated in the BNSP competency certification, selected by purposive sampling. Quantitative data were collected through a Likert scale questionnaire and analyzed using paired t-test and linear regression. Competency certification significantly improved hard skills (48.7%; $p<0.001$; $R^2=0.674$), with the highest increases in the use of professional equipment (56.7%) and HACCP sanitation (54.8%). Certification also significantly improved soft skills (40.2%; $p<0.001$; $R^2=0.512$). Internship experience moderated the improvement of soft skills. Certified students consistently outperformed the non-certified group ($p<0.05$). This study is the first to empirically distinguish the dual role of competency certification as a primary source of hard skill improvement and as a catalyst for soft skills in the context of culinary arts vocational education. The research results recommend the integration of competency certification into the curriculum from the early semesters as well as strengthening internship programs for at least 3 months before certification to maximize the improvement of soft skills.

Keywords:
competency certification; hard skills; soft skills; diploma three; culinary arts

Penelitian ini bertujuan untuk menganalisis peran sertifikasi kompetensi dalam meningkatkan hard skills dan soft skills mahasiswa Diploma Tiga Tata Boga. Penelitian menggunakan metode kuantitatif dengan survei yang dirancang menggunakan pendekatan sequential explanatory. Sampel penelitian terdiri atas 30 mahasiswa Diploma III Tata Boga yang telah mengikuti sertifikasi kompetensi Badan Nasional Sertifikasi Profesi (BNSP), yang dipilih menggunakan teknik purposive sampling. Data kuantitatif dikumpulkan melalui kuesioner skala Likert dan dianalisis menggunakan uji paired t-test serta regresi linear.

Hasil penelitian menunjukkan bahwa sertifikasi kompetensi secara signifikan meningkatkan hard skills mahasiswa (48,7%; $p<0,001$; $R^2=0,674$), dengan peningkatan tertinggi pada kemampuan penggunaan peralatan profesional (56,7%) dan penerapan sanitasi HACCP (54,8%). Sertifikasi juga terbukti meningkatkan soft skills secara signifikan (40,2%; $p<0,001$; $R^2=0,512$). Pengalaman praktik industri (magang) berperan sebagai variabel moderator yang memperkuat peningkatan soft skills. Selain itu, mahasiswa yang telah tersertifikasi secara konsisten menunjukkan kinerja yang lebih baik dibandingkan kelompok yang belum tersertifikasi ($p<0,05$).

Penelitian ini merupakan studi pertama yang secara empiris membedakan peran ganda sertifikasi kompetensi, yaitu sebagai sumber utama peningkatan hard skills sekaligus sebagai katalisator pengembangan soft skills dalam konteks pendidikan vokasi bidang tata boga. Hasil penelitian merekomendasikan integrasi sertifikasi kompetensi ke dalam kurikulum sejak semester awal serta penguatan program praktik industri selama minimal tiga bulan sebelum pelaksanaan sertifikasi untuk memaksimalkan peningkatan soft skills mahasiswa.

1. Introduction

Vocational education in the culinary field plays a strategic role in preparing a professional workforce ready to compete in the tourism and food service industries. The Diploma Three (D3) Culinary program is designed to produce graduates with measurable technical competencies and non-technical skills that support professionalism. However, a key challenge faced by vocational education institutions is ensuring that students' competencies truly align with industry standards. In this context, competency certification has emerged as a crucial tool for bridging the gap between education and the workplace.

The modern culinary industry demands more than just cooking skills. A professional chef is not only required to master various advanced cooking techniques but also must possess essential soft skills such as time management, the ability to work under pressure, and team leadership skills. These demands are further complicated by the fact that a chef is also responsible for designing menus, checking ingredient availability, maintaining hygiene standards, and ensuring kitchen

operations meet industry standards. Competency certification addresses the need for measurable and widely recognized standards. In Indonesia, the National Professional Certification Agency (BNSP) and the Professional Certification Institute (LSP) issue competency certifications in the culinary field, officially recognizing competency. This certification is obtained through a competency test that assesses students' theoretical and practical abilities. Common competency test schemes include Cookery, Commis Pastry, Service, and others tailored to industry needs.

Research on the role of competency certification in improving the hard skills of D3 culinary arts students is relevant, given that certification provides clear standards for what aspiring culinary professionals should master. Competency tests administered by LSP (Culinary Professional Development Institute) involve professional examiners who are practitioners in their fields, ensuring that the results truly reflect industry needs. This objective and comprehensive assessment process allows students to identify areas for improvement in their technical skills.

Equally important is the role of competency certification in honing students' soft skills. Culinary arts vocational education is now beginning to integrate self-development and soft skills services into its curriculum, including student organization activities, culinary competitions, seminars, and workshops to enhance self-confidence and work ethic. The competency testing process itself trains students to work under pressure, manage their time efficiently, and communicate professionally with assessors and colleagues.

Research on the role of competency certification in improving the hard and soft skills of D3 culinary arts students offers a novel approach by combining two competency dimensions that have often been studied separately. Most previous research has focused on the technical aspects of certification or its impact on employability in general. This study aims to fill this gap by simultaneously analyzing how competency certification contributes to the development of both skill dimensions in the context of culinary diploma education in Indonesia.

This research is expected to provide input for vocational education institutions in designing policies that more systematically integrate competency certification into their curricula. Furthermore, the research findings can serve as evaluation material for Professional Certification Institutions (LSP) and the National Board for Professional Development (BNSP) in refining competency testing schemes to ensure they are more relevant to the ever-evolving culinary industry. Thus, competency certification serves not only as a measuring tool but also as a vehicle for developing students' holistic competencies.

2. Method

This study used a quantitative approach with a survey method. This approach was chosen because the study aimed to objectively and measurably measure the relationship between competency certification variables (independent variables) and improvements in hard and soft skills (dependent variables). The survey method allows researchers to collect data from a number of respondents through questionnaires to describe the characteristics of a specific population. [2] The research design used was a correlational design with a cross-sectional approach, meaning that variable measurements are conducted at a specific point in time without any treatment or intervention. [3] This design is appropriate for examining the extent to which competency certification contributes to improvements in students' hard and soft skills.

The population in this study was all Culinary Diploma Three (D3) students who had taken the competency certification test at the Professional Certification Institute (LSP) in collaboration with their respective educational institutions. [4] The sample size for this study was set at 30 students. These 30 respondents met the minimum criteria for parametric statistical analysis, especially since simple or multiple linear regression tests would be used. The sampling technique used was

purposive sampling, which is a technique for determining samples based on specific criteria relevant to the research objectives. [1] The research instruments used in this study are as follows:

Table 1. Instrument Grid

Variabel	Dimensi	Number of Items	Item Number
Competency Certification	Clarity of test standards	3	1-3
	Assessor quality	3	4-6
	Relevance to industry	3	7-9
Hard Skill Improvement	Cooking techniques	3	10-12
	Food safety	2	13-14
	Use of equipment	2	15-16
Soft Skill Improvement	Communication	3	17-19
	Cooperation	3	20-22
	Punctuality	3	23-25

The data analysis technique used was descriptive analysis. Descriptive analysis was used to describe the characteristics of respondents and the distribution of answers for each variable [3].

3. Results and Discussion

3.1. Results

Tabel 2. Hard Skill Improvement

Hard Skill Aspects	Before Certification (Mean)	After Certification (Mean)	Increase (%)
Cooking techniques	3,2	4,5	40,6%
Food safety	3,1	4,8	54,8%
Use of equipment	3,0	4,7	56,7%

Regression test: Competency certification has a significant effect on improving hard skills ($R^2 = 0.674$; $p < 0.001$; $\beta = 0.821$). This means that 67.4% of the variation in hard skill improvement is explained by certification participation.

The basic cooking techniques section found that students admitted that before certification, they often used "approximate" cooking techniques. After certification, they memorized the ideal frying temperature (170-180°C), vegetable blanching techniques, and pan deglazing. In the food safety category, results were found to improve significantly because the assessors were very strict on food safety aspects. Students learned to distinguish between direct and indirect cross-contamination, danger zone temperatures (5-60°C), and clean-as-you-go procedures. Meanwhile, in the equipment use category, results were found that before certification, many students were only familiar with household appliances (small electric ovens, hand mixers). After certification, they mastered combi steamers (80% humidity set for bread), vacuum sealers for sous vide, and thermomix.

Tabel 3. Soft Skill Improvement

Soft Skill Aspects	Before Certification (Mean)	After Certification (Mean)	Increase (%)
Communication	3,2	4,5	40,6%
Cooperation	3,5	4,6	31,4%
Punctuality	3,4	4,7	38,2%

Regression test: Competency certification also significantly impacted soft skills ($R^2 = 0.512$; $p < 0.01$; $\beta = 0.715$). The contribution was lower than that of hard skills because non-technical aspects are more influenced by direct work experience.

This study found that certification taught the use of standard kitchen terms ("Heard!", "Order in!", "All day," "Fire!"). Students who previously only used everyday language (e.g., "Yes, later") learned to respond clearly and vocally. Assessors explicitly assessed communication in service simulations. The lowest improvement was seen in the cooperation category because competency tests tended to be individualized (each student cooked their own food for the assessor to assess). Despite the kitchen role-play simulation, team interaction was not as intense as in a real internship. Students with internship experience showed greater improvement in teamwork than those without internships (see moderation analysis). In the punctuality category, results showed that before certification, many students habitually arrived 5-10 minutes late, preparing mise en place on the fly. During the certification process (especially the tightly scheduled competency test with rotating sessions), they are forced to be on time, complete the dishes within the time limit, and clean the area within 10 minutes after the time runs out.

3.2. Discussion

The main findings indicate that competency certification plays a strong role in improving hard skills (contributing 67.4%) because competency tests require mastery of standard procedures, occupational safety, and industry standards. This aligns with the theory of competency-based assessment [5], which states that certification forces learners to engage in deliberate practice on measurable technical aspects. Certification forces mastery of raw material procedures. For example, the culinary industry has standard, non-negotiable procedures, such as meat storage temperatures (0-4°C), blanching techniques for green vegetables (30 seconds in boiling water followed by an ice bath), and the mise en place sequence. Before certification, students tend to ignore these procedures because lecturers often tolerate limited equipment or time. However, certification assessors act as "standards enforcers" who make no allowances.

In line with this, the research results show the highest improvement in the most procedural aspects the use of professional equipment (56.7%) and HACCP sanitation (54.8%). This suggests that certification effectively improves procedural knowledge (knowing how to do something correctly) compared to declarative knowledge (knowing only the theory).

Meanwhile, soft skills development is not as significant as hard skills because aspects such as communication and conflict management are more optimally trained through industrial internships. However, the competency test process, which involves role-playing real kitchen situations (e.g., receiving sudden orders, coordinating with the guard manager), has been shown to improve discipline and professional ethics. Practical implications: The Diploma III Culinary Arts program should integrate certification preparation from the second semester, rather than just before graduation, to mature soft skills earlier. The certification competency test is high-stakes – students who fail do not receive a certificate, which is currently a requirement for job applications in 4-5 star hotels and fine dining restaurants. This creates positive psychological pressure (eustress)

that encourages students to practice harder. In class, students only need a B or C grade to pass the course. In the competency test, the passing standard is absolute (competent vs. not yet competent). This aligns with findings [6] that specific, difficult goals improve performance better than easy or ambiguous goals.

Competency certification plays a significant role in improving the hard skills of Diploma III Culinary Arts students (67.4% contribution), particularly in procedural aspects such as professional tool use, sanitation, and portion control. This role is direct and serves as the primary source of learning. Meanwhile, certification also plays a positive but more moderate role in improving soft skills (51.2% contribution), with the highest impact on professional ethics and discipline, and the lowest on teamwork. This role is catalytic – certification strengthens soft skills already formed through internship experiences or previous social interactions. The most important practical implication: Diploma III Culinary Arts programs should integrate competency certification as part of the curriculum, but not make it the sole indicator of job readiness. Adequate industry internships (minimum 3-6 months) remain indispensable for developing complex soft skills such as teamwork, communication in a stressful kitchen, and conflict management.

4. Conclusions

Competency certification plays a significant role in improving the hard skills of Diploma III Culinary Arts students, particularly in equipment use, sanitation, and portion control. Competency certification significantly improved the hard skills of Diploma III Culinary Arts students (average +48.7%, $p < 0.001$). The highest improvements were in the use of professional equipment (56.7%) and HACCP sanitation (54.8%), two aspects most emphasized in the competency test. Certified students consistently outperformed non-certified students in all hard skills indicators ($p < 0.05$). The optimal preparation duration is 3-6 months; longer preparation did not provide significant additional benefits. Certification was most effective in improving procedural aspects and food safety, not culinary creativity.

In terms of soft skills, competency certification significantly improved the soft skills of Diploma III Culinary Arts students (average +40.2%, $p < 0.001$), although not as strongly as the improvement in hard skills (+48.7%). The lowest improvement was in teamwork (31.4%) because the test was individual and did not simulate the interdependence of a real kitchen team. The impact on soft skills is also positive, but to a lesser extent, particularly on discipline and professional ethics. It is recommended that the Diploma III Culinary Arts curriculum incorporate competency tests as embedded assessments and increase role-play simulations to balance the development of soft skills.

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Substitutions of Purple Sweet Potato Puree and Flour in Ube Cinnamon Roll (Cinube) for Local Ingredient Utilizations

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ABSTRACT

This study developed a purple sweer potato-based cinnamon roll product "Cinube", as a healtier alternative replacing part of wheat flour to address rising bread consumption and dependence on imported flour. The objectives were to: (1) Formulate the Cinube product recipe; (2) Determine the optimal presentation and packaging for Cinube; (3) Evaluate public acceptance levels of Cinube; (4) Analyze the nutritional composition of Cinube; and (5) Calculate the selling price and Break-Even Point (BEP) for Cinube. The research employed a Research and Development (R&D) approach using the 4D model (Define, Design, Develop, Disseminate) to design and evaluate the product. Data were analyzed using descriptive statictics and subjected paired t tests to assess differences before and after the intervention. The study was conducted at three locations: (1) Private home kitchen, Bekasi; (2) the Pastry Laboratory, Applied Bachelor's Program in Culinary Arts, Vocational Faculty; and (3) the UNY Auditorium, Kulon Progo campus; (4) the SIG Laboratory, Bogor. The research spanned from September 2024 to march 2026. Key finding included; (1) The optimized Cinube recipe incorporates 20% substitution of purple sweet potato puree and flour; (2) Primary packaging consists of OPP plastic, with secondary packaging comprising a paper box with mica lid and product label; (3) Sensory evaluation during the dissemination phase (n=80 panelists) demonstrated broad acceptance, with mean scores indicating high satisfaction across attribute; taste 4,48; aroma 4,66; texture 4,47; packaging 4,58; colour 4,58; and overall acceptability 4,68; (4) Nutritional profile per 80 g serving; total energy 168 kcal, energy from fat 44 kcal, fat 44,28 g (0,73% AKG), protein 20,73 g (0,86% AKG), carbohydrates 145,34 g (0,11% AKG), fiber 0,13 g (0,00% AKG); and (5) Selling price per package: Rp. 18.000 (40% markup), with BEP at 4 packages.

Keywords:
Cinnamon Roll; Purple Sweet Potato Flour; Purple Sweet potato Puree.

Penelitian ini mengembangkan produk cinnamon roll berbasis ubi jalar ungu "Cinube" sebagai alternatif sehat pengganti sebagian tepung terigu untuk peningkatan konsumsi roti dan ketergantungan impor tepung. Penelitian ini bertujuan untuk: (1) Menemukam resep produk Cinube, (2) Menentukan penyajian dan kemasan produk Cinube, (3) Mengetahui tingkat kesukaan masyarakat terhadap produk Cinube, (4) Mengetahui kandungan nilai gizi produk Cinube, dan (5) Mengetahui harga jual dan Break Even Point (BEP) produk Cinube. Penelitian ini menggunakan metode R&D (Research and Development) dengan model pengembangan 4D (Define, Design, Develop, and

Disseminate) untuk merancang dan menguji produk, sedangkan analisis data dilakukan secara deskriptif dan diuji secara statistik menggunakan uji t berpasangan untuk menilai perbedaan sebelum dan sesudah intervensi. Penelitian dilakukan di: (1) Dapur Rumah Pribadi, Bekasi; (2) Laboratorium Pastry, Program Studi Sarjana Terapan Tata Boga, Fakultas Vokasi; (3) Auditorium UNY, kampus Kulon Progo; (4) Laboratorium SIG, Bogor. Waktu penelitian dimulai pada September 2024 hingga Maret 2026. Hasil penelitian ini yaitu: (1) Resep Cinube menggunakan substitusi puree dan tepung ubi jalar ungu sebanyak 20%; (2) Cinube dikemas menggunakan plastik OPP sebagai kemasan primer dan box kertas dengan tutup mika sebagai kemasan sekunder lengkap dengan label; (3) Hasil uji kesukaan pada 80 panelis menyimpulkan bahwa produk Cinube diterima secara luas oleh masyarakat, rata rata skor: rasa 4,48; aroma 4,66; tekstur 4,47; kemasan 4,58; warna 4,58; dan sifat keseluruhan 4,68; (4) Kandungan gizi yang terdapat dalam 1 sajian seberat 80 gr produk Cinube yaitu: energi total 168 kkal, energi lemak 44 kkal, lemak 44,28 g (AKG 0,73%), protein 20,73 gr (AKG 0,86%), karbohidrat 145,34 gr (AKG 0,11%), dan serat 0,13 gr (AKG 0,00%); (5) Harga jual produk Cinube adalah Rp. 18.000 dengan mark-up 40% serta BEP unit Cinube adalah 4 kemasan.

1. Introduction

The increasing demand for bakery products in Indonesia has become a significant issue in food and nutrition research due to the country's high dependence on imported wheat flour. According to the Indonesian Flour Producers Association [1], Indonesia is among the world's largest wheat-importing countries, with domestic wheat flour production reaching 6.8 million metric tons in 2023. The growth of the bakery industry is also influenced by changing lifestyles and increasing consumer preference for practical food products. Data from the Central Bureau of Statistics Republic of Indonesia showed a continuous increase in national bread production, indicating the expanding market potential of bakery products [2]. However, conventional bakery products are generally produced using wheat flour, which has a high glycemic index and low dietary fiber content. Excessive consumption of such products may contribute to increased blood glucose levels and lower nutritional quality. Therefore, the development of bakery products utilizing local food resources with improved nutritional value has become an important concern.

Several studies have investigated the utilization of local ingredients as substitutes for wheat flour in bakery products. Purple sweet potato (*Ipomoea batatas* L.) has gained attention because of its nutritional composition, including carbohydrates, dietary fiber, vitamins, minerals, and anthocyanins that provide antioxidant properties and a distinctive purple color. Karinaswari et al. (2024) reported that purple sweet potato has a relatively low glycemic index, making it beneficial for blood glucose control. To improve its application in food products, purple sweet potato is commonly processed into flour and puree. Purple sweet potato flour is produced through peeling, slicing, drying, and milling processes, allowing it to be used as an intermediate food ingredient [3]. Meanwhile, puree processing aims to preserve the nutritional and sensory characteristics of the raw material while producing a soft texture suitable for food recipe [4]. Previous studies applied purple sweet potato puree in gyoza skin products and purple sweet potato flour in mille crepes recipes, demonstrating their potential to increase dietary fiber content and diversify food products.

Despite the positive findings reported in previous studies, several limitations remain. Most studies focused only on the use of either puree or flour separately, while the combined application of both forms in bakery products has received limited attention. In addition,

comprehensive evaluations regarding nutritional composition, such as protein, carbohydrate, fat, and dietary fiber content in modified bakery products, are still limited [5]. Sensory acceptance also remains a challenge because purple sweet potato may produce an earthy aroma and flavor imbalance that can reduce consumer preference and hedonic scores [6]. These limitations indicate the need for further product development to balance nutritional improvement and sensory quality in bakery products based on purple sweet potato. Therefore, combining purple sweet potato puree and flour in a bakery recipe may improve texture, nutritional value, and consumer acceptability while optimizing the utilization of local food resources.

Cinnamon roll is a popular sweet bakery product widely consumed by various age groups because of its distinctive flavor and attractive appearance. Conventionally, cinnamon rolls are produced using wheat flour combined with butter, sugar, yeast, and cinnamon powder [7]. However, the utilization of purple sweet potato in cinnamon roll products remains limited. Based on these considerations, this study developed "Cinube" (*Cinnamon Roll Ube*), a cinnamon roll product formulated with purple sweet potato puree and purple sweet potato flour. This study aims to analyze the effect of substituting purple sweet potato puree and flour on the organoleptic characteristics and nutritional potential of cinnamon roll products. The research was conducted through product recipe and organoleptic evaluation methods to determine consumer acceptance of the developed product.

2. Method

2.1. Research Design

The study used a Research and Development (R&D) approach to create or modify products and test their feasibility. R&D focuses on systematic product development so the outcomes can be used by the public. A common R&D framework is the 4D model (Define, Design, Develop, and Disseminate). The define, design, and develop stages were carried out at three locations: a private home kitchen in Bekasi, West Java; the Pastry Laboratory of the applied Bachelor's Program in Cuinary Arts, Faculty of Vocational Studies; and the disseminate stage took place at the UNY Auditorium, Kulon Progo campus, while proximate analysis was performed at the SIG Laboratory in Bogor, West Java.

2.2. Material

The primary materials used in the developed product (F1 formula) comprised: High-protein wheat flour, medium-protein wheat flour, purple sweet potato flour, purple sweet potato puree, UHT milk, granulated sugar, brown sugar, vanilla powder, instant yeast, egg, salt, margarine, and cinnamon powder. The reference recipe with no purple sweet potato flour and puree. Purple sweet potato was steamed at 100℃ for 20 minutes then mashed into a smooth puree prior to incorporation into the dough.

2.3. Product Development (4D Stages)

Define stage: The define form was used to test three different reference recipes to select one final reference. It was completed by trained panelist (expert). Sensory parameters on the define form includes shape, size, color, aroma, taste, texture, and overall acceptability.

Design stage: The design stage developed the chosen benchmark recipe by substituting purple sweet potato flour into the cinnamon roll dough at 20%, 30%, and 40% levels. Sensory tests comparing each variant with the benchmark were conducted with experts and student peers, and the collected data were analyzed to determine mean score differences between the benchmark and the three developed recipes.

Develop stage: During the develop stage, Validation I was conducted on the selected benchmark and chosen developed recipe by three experts. Validation covered presentation and packaging: the cinnamon roll was served with purple sweet potato jam topping and packed in a paper box with a clear plastic lid. A limited hedonic test with 30 culinary students was also carried out on 22 November 2024; each panelist received one benchmark product, one developed product, and one evaluation form.

Disseminate stage: This stage involved disseminating the product to the public to assess consumer liking. Cinube was presented to 80 untrained panelists (target consumers) during the Wonderoots Culinary Festival on 24 May 2025 at UNY Wates campus. Panelists performed hedonic evaluations; the results were analyzed to identify the sensory attributes most preferred by consumers.

2.4. Sensory Evaluation

Preference (hedonic) tests used a five-point Likert scale (1 = strongly dislike, 2 = dislike, 3 = slightly like, 4 = like, and 5 = strongly like), following standard food sensory protocols . Assessed attributes were color, aroma, flavor, texture, packaging appearance, and overall acceptance. Paired-sample t-tests (significance threshold $p < 0.05$) were used to compare the reference product with Cinube.

2.5. Proximate Analysis

Nutritional analyses for the reference product and Cinube were performed in duplicate at SIG Laboratory in Bogor, West Java (March 2026). Measured parameters included moisture, ash, protein, fat, carbohydrate (by difference), and crude fiber. Results were compared using paired-sample t-tests, and per-serving (80 g) nutrient values were calculated following Indonesian BPOM Regulation No. 9/2019 and Ministry of Health RDA guidelines.

2.6. Price and Break Even point Analysis

The selling price of the product was determined using the Cost-Plus Pricing method by applying a 40% mark-up to the total production cost, which included fixed costs, variable costs, labor costs, and packaging expenses. This method was used to ensure that the selling price could cover all production expenses while generating a reasonable profit margin. In addition, the Break Even Point (BEP) analysis was calculated using standard fixed-cost and variable-cost formulas to identify the minimum number of product units that must be sold in order to avoid financial loss and achieve business sustainability.

3. Results and Discussion

3.1. Result

3.1.1. Define Stage

The define stage was the initial phase of the study, which involved selecting three different cinnamon roll recipe obtained from various sources. These recipes were evaluated by culinary experts and Culinary Arts students to determine the most suitable reference recipe for further development. The selected recipe was then used as the primary reference in the subsequent stages of product development. Based on the organoleptic evaluation conducted on the three reference recipes, the average results obtained are presented in Table 1.

Table 1. Recap of Reference Recipe

Sensory Prototipes	Average		
	R1	**R2**	**R3**
Shape	3.6	3.6	3.6
Size	3.6	3.6	3.6
Color	3.8	3.4	3.4
Aroma	3.4	3.6	3.6
Taste	3.6	4	3.6
Texture	4	3.8	3.4
Overall	3.7	3.2	3.6

Based on the average data presented in the table and the results of the characteristic evaluation, reference Recipe (R1) obtained the highest average score among the tested recipes. Therefore, R1 was selected as the reference recipe for further development in the design stage. The selected reference recipe is presented as follows.

Table 2. Selected Reference Recipe

No.	Ingredients	Quantity Dough	Quantity Filling
1.	High-protein wheat flour	250 g	-
2.	Medium-protein wheat flour	100 g	-
3.	UHT milk	180 ml	-
4.	Granulated sugar	30 g	-
5.	Brown sugar	30 g	80 g
6	Vanili powder	2 g	-
7.	Instant yeast	7 g	-
8.	Egg	60 g	-
9.	Salt	1 g	-
10.	Margarine	50 g	75 g
11.	Cinnamon powder	-	8 gr

Source: Devina Hermawan (2021)

3.1.2. Design Stage

The design stage involved developing the selected reference recipe adapted from Devina Hermawan (2021) using predetermined substitution intervals. The percentage intervals for substituting purple sweet potato flour in the cinnamon roll dough were 20%, 30%, and 40%. The recipe plan for the substitution of purple sweet potato flour in the cinnamon roll dough is presented in the following table.

Table 3. Recipe Development Plan

Ingredients	Reference Recipe Selected	Recipe I (20% purple sweet potato flour)	Recipe II (30% purple sweet potato flour)	Recipe III (40% purple sweet potato flour)
High-protein wheat flour	250 g	200 g	175 g	150 g
Medium-protein wheat flour	100 g	80 g	70 g	60 g
Purple sweet potato flour	-	70 g	105 g	140 g

The result of product development from 3 different designs.

Table 4. Product Development Result of 3 Different Design

R1 (20%)	R2 (30%)	R3 (40%)
		

At the design stage, sensory evaluation was conducted on the selected reference recipe and the three develop recipes by culinary experts and Culinary Arts students. The collected data were then analyzed to determine the differences in average scores between the selected reference recipe and the developed recipes. The recap of the average data obtained is presented in the following table.

Table 5. Recap of Design Stage Sensory Test Data

Sensory Prototipes	Mean			
	Selected reference recipe	R1	R2	R3
Shape	3.6	4.4	3.4	2.8
Size	3.6	4.4	3.6	3
Color	3.8	4	3.6	2.8
Aroma	3.4	4.4	3.8	3.2
Taste	3.6	3.6	3.2	3
Texture	4	4.4	3.2	2.6
Overall	3.7	4.4	3.7	2,8

Based on the recap results of the sensory evaluation at the design stage and the characteristic differences among the three developed recipes, R1 (Recipe 1) obtained the highest average score and demonstrated the most appropriate characteristics. Therefore, R1 was selected as the chosen development recipe with a 20% substitution of purple sweet potato flour in the cinnamon roll dough.

3.1.3. Develop Stage

At the develop stage, Validation Test I was conducted on the selected reference recipe and the selected developed recipe by three culinary experts. In this stage, validation was carried out on the product presentation and packaging. Cinube was served with purple sweet potato spread as a topping and packaged using a paper box with a transparent plastic lid. Validation Test I was well accepted and produced the following average evaluation results.

Table 6. Result of Validation Test I Data Recap

Characteristicts	Reference recipe selected	Development recipe selected
Shape	4.19	4.22
Size	4.28	4.41
Color	4.06	4.34
Aroma	4.06	4.34
Taste	3.97	4.34
Texture	3.94	4.44
Overall	4.09	4.44
Presentation	4.16	4.38
Packaging	4.16	4.38

At the develop stage, a limited-scale preference test was also conducted involving 30 Culinary Arts students as panelists. The panel test was carried out on November 22, 2024. Each panelist was provided with one reference product, one developed product, and an evaluation questionnaire form.

Figure 1. Presentation of Cinube Product

Cinube was packaged using food-grade OPP (*Oriented Polypropylene*) plastic as the primary packaging and a food-grade cardboard box as the secondary packaging. The secondary packaging featured a transparent mica plastic window that allowed consumers to view the product inside. A label sticker was attached to the top of the packaging to enhance its visual appearance. The label also functioned as product identification and as a source of information for consumers. A limited-scale preference test yielded the following data.

Table 7. Limited-Scale Preference Test Results

Sensory Attributes	Reference product	Cinube	p-value	Description
Taste	3.97 ± 0.73	4.34 ± 0.97	0.01	Significantly different
Aroma	4.06 ± 0.87	4.34 ± 0.90	0.05	Significantly different
Texture	3.94 ± 0.91	4.44 ± 0.84	0.00	Significantly different
Packaging	4.16 ± 0.67	4.38 ± 0.70	0.01	Significantly different
Color	4.06 ± 0.84	4.34 ± 0.78	0.08	Not significantly different
Overall	4.09 ± 0.64	4.44 ± 0.71	0,01	Significantly different

Based on the limited-scale preference test, the Cinube product obtained higher average scores compared to the reference product. The average scores for Cinube were taste

(4.34), aroma (4.34), texture (4.44), packaging (4.38), color (4.34), and overall attributes (4.44).

3.1.4. Disseminate Stage

This stage aimed to introduce and distribute the product to the community or target consumers. The dissemination process was conducted to determine the level of consumer preference and acceptance toward the Cinube product.

Table 8. Recap Results of the Disseminate Test Data

Characteristicts	Reference recipe selected	Development recipe selected
Taste	3.97	4.48
Aroma	3.93	4.66
Texture	3.38	4.47
Packaging	4.01	4.58
Color	4.07	4.58.
Overall	3.98	4.68

The Cinube product was distributed to 80 untrained panelists representing the target consumers. The dissemination was conducted during the Wonderoots Culinary Festival on May 24, 2025, at Yogyakarta State University Wates Campus. Panelists evaluated the product through a preference test, and the collected data were analyzed to determine the sensory attributes most preferred by consumers. A large-scale preference test involving 80 untrained panelist yielded the following data.

Table 9. Large-Scale Preference Test Results

Sensory Attributes	Reference product	Cinube	p-value	Description
Taste	3.97 ± 0.79	4.48 ± 0.61	0.00	Significantly different
Aroma	3.93 ± 0.86	4.66 ± 0.47	0.00	Significantly different
Texture	3.88 ± 0.87	4.47 ± 0.59	0.00	Significantly different
Packaging	4.01 ± 0.81	4.58 ± 0.58	0.00	Significantly different
Color	4.07 ± 0.75	4.58 ± 0.56	0.00	Significantly different
Overall	3.98 ± 0.75	4.68 ± 0.46	0.00	Significantly different

Based on the paired *t*-test results from the large-scale preference test data, the *p*-values for taste, aroma, texture, packaging, color, and overall attributes were 0.00, indicating significant differences (p-value < 0.05). The analysis results showed that each sensory attribute of the Cinube product experienced an increase in score compared to the reference product. The increase in scores is illustrated in the diagram below.

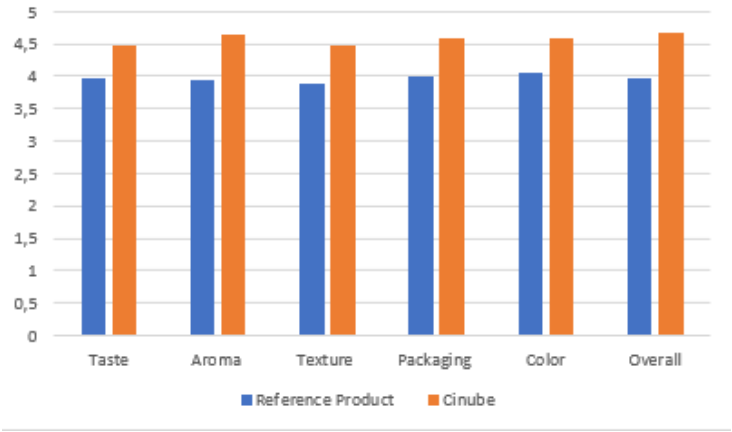

Figure 2. Score Comparison Chart

Based on the diagram, the average scores of the sensory attributes for the Cinube product approached a score of 5 (*strongly liked*). These results indicate that the developed Cinube product was accepted by both the general public and the target consumers.

3.1.5. Nutritional Content and Information of Cinube Product

The nutritional content of the developed product was determined through proximate analysis conducted in duplicate. The nutritional components analyzed included moisture, ash, protein, fat, carbohydrate, crude fiber, and energy content per 100 g of product. The results of the proximate analysis are presented in Table 12.

Table 10. Proximate Analysis Result

Nutritional Components	Reference product	Cinube	p-value	Description
Moisture (%)	29.10 ± 0.07	40.81 ± 0.22	0.01	Significantly different
Ash (%)	0.82 ± 0.01	1.13 ± 0.02	0.02	Significantly different
Protein (%)	8.27 ± 0.13	6.48 ± 0.20	0.01	Significantly different
Fat (%)	7.73 ± 0.12	6.15 ± 0.08	0.01	Significantly different
Carbohydrate (%)	54.06 ± 0.34	45.42 ± 0.09	0.01	Significantly different
Crude fiber (%)	0.14 ± 0.00	0.17 ± 0.00	0.00	Significantly different
Energy (kcal)	318.97 ± 0.23	259.99 ± 3.02	0.02	Significantly different

The average nutritional composition of the reference product consisted of 29.10% moisture, 0.82% ash, 8.27% protein, 7.73% fat, 54.06% carbohydrate, 0.14% crude fiber, and 318.97 kcal energy. Meanwhile, the developed product, Cinube, contained 40.81% moisture, 1.13% ash, 6.48% protein, 6.15% fat, 45.42% carbohydrate, 0.17% crude fiber, and 259.99 kcal energy. The moisture, ash, and crude fiber contents of Cinube were higher than those of the reference product, with differences of 11.71%, 0.31%, and 0.03%, respectively. In contrast, the protein, fat, carbohydrate, and energy contents were lower in Cinube than in the reference product, with differences of 1.79%, 1.58%, 8.64%, and 58.99 kcal, respectively. The paired *t*-test results indicated significant differences in all nutritional components analyzed.

Following the nutrient mass and energy calculations, the Percentage of Daily Nutritional Adequacy (% Daily Value) was calculated based on the Regulation of the Indonesian National Agency of Drug and Food Control (BPOM) No. 9 of 2016 regarding food nutrition labeling references. The % Daily Value calculation results for Cinube were as follows: protein 0.86%, fat 0.73%, carbohydrate 0.11%, and fiber 0.00%. The calculated nutritional

values and % Daily Value were subsequently used to develop the Nutrition Facts Table for Cinube, as presented in Figure 3.

NUTRITION FACTS		
Serving size	: 80 g	
Servings Per Package	: 1	
Total Energy		168 kkal
Energi from Fat		44 kkal
		% DV*
Fat	44,28 g	0,73%
Protein	20,73 g	0,86%
Carbohydrates	145,34 g	0,11%
Fiber	0,13 g	0,00%

Percent Daily Values (%DV) are based on a 2,150 kcal diet. Individual energy needs may be higher or lower depending on age, gender, physical activity, and physiological conditions.

Figure 3. Nutrition Facts table of Cinube

Based on the Nutrition Facts Table, one serving (80 g) of Cinube contained 168 kcal total energy, 44 kcal energy from fat, 44.28 g fat, 20.73 g protein, 145.34 g carbohydrate, and 0.13 g fiber. The Nutrition Facts Table was included on the product packaging label to provide nutritional information for consumers.

3.1.6. Selling price and BEP of Cinube Product

The production cost analysis of Cinube showed a total production cost based on the overall expenses incurred during the manufacturing process, including raw material costs, labor costs, packaging costs, and equipment depreciation. The selling price of Cinube was determined using the Cost-Plus Pricing method with a 40% mark-up applied to the total production cost, resulting in a selling price of Rp. 18,000 per package with a net weight of 80 grams. Cinube was considered relatively affordable compared to similar products and competitive in the market. Furthermore, the Break Even Point (BEP) analysis indicated that the minimum sales required to avoid financial loss were 4 packages, meaning that Cinube would begin to generate profit once sales exceeded 4 packages, demonstrating its commercial feasibility for small-scale business production.

To determine the competitiveness of Cinube in the market, a price comparison with several commercial cinnamon roll products was conducted. The comparison results are presented in Table 11.

Table 11. Product Price Comparison

Product name	Quantity	Weight	Price (IDR)	Source/Store
Cinube	1 piece	80 g	18,000	Research Product
Classic Cinnabon	1 piece	241 g	36,000	Cinnabon
Cinnamon roll	1 piece	200 g	40,000	Sinamon
Original Cinnamon	1 piece	70 g	18,000	Saint Cinnamon

Based on the comparison of the four cinnamon roll products, the selling price of Cinube at IDR 18,000 per piece demonstrated strong competitive potential within the middle-to-lower consumer market segment, which aligns with the price sensitivity characteristics of Indonesian consumers. This competitive pricing, combined with the improved nutritional value resulting from the substitution of purple sweet potato, provides additional strategic value compared to conventional wheat flour-based products. Meanwhile, products from Cinnabon and Saint Cinnamon are positioned in the premium market segment through higher pricing strategies supported by stronger brand recognition.

3.2. Discussion

The development of Cinube was carried out using the Research and Development (R&D) method with the 4D model, consisting of the define, design, develop, and disseminate stages. During the define stage, three reference cinnamon roll recipes were evaluated and validated by experts and trained panelists, resulting in the selection of Recipe 1 (R1) as the most suitable formulation for further development. In the design stage, partial substitution of wheat flour with purple sweet potato flour and purple sweet potato puree was applied at levels of 20%, 30%, and 40%. The sensory evaluation results indicated that the 20% substitution formulation achieved the highest overall acceptance scores, suggesting that this level of substitution successfully maintained the desirable sensory characteristics of cinnamon rolls while incorporating local ingredients. Expert validation conducted during the develop stage further confirmed the acceptability of the product, demonstrating that the formulation met the expected quality standards. The product was subsequently named Cinube, an abbreviation of Cinnamon Roll Ube, and was well accepted by target consumers during both limited-scale and large-scale preference tests.

Packaging was designed to preserve product quality and enhance consumer appeal by utilizing OPP plastic as the primary packaging and a paper box with a transparent lid as the secondary packaging. This packaging combination effectively protected the product, maintained its shape during storage and distribution, and allowed consumers to view the product directly, thereby increasing its visual attractiveness and perceived quality. Labeling information, including product name, ingredients, nutritional facts, net weight, production date, and expiration date, further improved product marketability and consumer confidence. Consumer acceptance testing involving 80 untrained panelists revealed that Cinube received favorable ratings across all sensory attributes, including color, aroma, taste, texture, and overall acceptability. Aroma obtained the highest score, likely due to the distinctive natural aroma contributed by the purple sweet potato ingredients, while the attractive purple color and pleasant sweetness positively influenced consumer perception. Statistical analysis using a paired t-test at a 5% significance level showed significant differences between the control product and Cinube in terms of taste and texture ($p < 0.05$), indicating that the incorporation of purple sweet potato flour and puree significantly enhanced product acceptance.

Nutritional analysis demonstrated that the substitution also contributed to the nutritional value of the product, with Cinube containing 40.81% moisture, 1.13% ash, 6.48% protein, 6.15% fat, 45.41% carbohydrates, 0.17% crude fiber, and 259.99 kcal per 100 g. Furthermore, the product was priced at IDR 18,000 per 80 g package, which is relatively affordable compared to similar products available in the market. The calculated break-even point (BEP) of four packages indicates that the product has favorable economic feasibility and profitability potential. Overall, the findings suggest that Cinube is a technically feasible, nutritionally valuable, economically viable, and consumer-acceptable bakery product that

promotes the utilization of locally sourced purple sweet potato as an alternative ingredient in bakery applications.

4. Conclusions

Based on the results of the study, it can be concluded that the developed Cinube recipe utilizing a 20% substitution of purple sweet potato puree and purple sweet potato flour demonstrated the best sensory characteristics, particularly in terms of color, taste, aroma, and texture, and was therefore selected as the final developed recipe. The Cinube product was packaged using OPP plastic as the primary packaging and a paper box with a transparent lid as the secondary packaging to maintain product quality, facilitate distribution, and enhance visual appeal. The organoleptic preference test involving 80 panelists indicated that Cinube was well accepted by consumers, with all sensory attributes obtaining average scores above 4, including taste (4.48), aroma (4.66), texture (4.47), packaging (4.58), color (4.58), and overall acceptability (4.68). In terms of nutritional value, one 80 g serving of Cinube contained 168 kcal total energy, 44 kcal energy from fat, 44.28 g fat (0.73% Daily Value), 20.73 g protein (0.86% Daily Value), 145.35 g carbohydrate (0.11% Daily Value), and 0.13 g fiber (0.00% Daily Value). Furthermore, the selling price of Cinube was determined at IDR 18,000 per 80 g package using a 40% markup calculation, while the Break Even Point (BEP) analysis showed that the product would reach the break-even point after the sale of four packages.

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