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Analysis of Sensory, Preference, Physical and Chemical Characteristics of Cassava Pudding using Spherification Caviar Technique

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ABSTRACT - This study investigated the effect of cassava puree incorporation on the sensory, physicochemical, and nutritional characteristics of pudding. An experimental design with two formulations was applied: F0 (control) and F1 (with cassava puree addition). Sensory evaluation was conducted by three trained panelists, while consumer acceptance testing involved 80 untrained panelists. Color attributes were analyzed using digital image processing, and chemical composition was determined through proximate analysis, including moisture, ash, fat, protein, carbohydrate, and crude fiber content. The sensory evaluation revealed no significant differences between F0 and F1 in terms of aroma, texture, and taste. Similarly, consumer acceptance results indicated no significant difference in overall preference between the two formulations ($p = 0.470$). Color analysis demonstrated that cassava puree addition did not significantly alter the visual appearance of the product. However, proximate analysis showed notable changes in chemical composition: moisture decreased by 1.70%, ash by 9.21%, fat by 8.21%, protein by 12.56%, and crude fiber by 65.62%, while carbohydrate content increased by 10.54%. These compositional changes suggest nutritional implications, particularly the enhancement of carbohydrate content as an energy source, despite reductions in several other nutrients. Overall, cassava puree incorporation did not significantly affect sensory acceptance or color attributes but altered the nutritional profile of the pudding. This study contributes to the scientific development of cassava-based food products through comprehensive evaluation of sensory, physical, and chemical properties, providing a foundation for alternative formulation strategies in starch-based desserts.

Keywords: Pudding, cassava, sensory, preference, physical, chemical.

INTRODUCTION

Cassava (*Manihot esculenta*) is a major tuber crop that plays a strategic role in Indonesian agriculture. It is widely cultivated due to its adaptability to various soil types, including marginal and less fertile land, which contributes to its abundant availability and relatively affordable price. Saras (2023) stated that cassava is capable of growing across diverse soil conditions, climates, and humidity levels, making it one of the most widely cultivated agricultural commodities.

According to FAO (2024), Nigeria consistently ranks as the world's largest cassava-producing country, reaching 60 million tons in 2024. In comparison, Indonesia ranks sixth, with production of approximately 15.6 million tons. These figures indicate that cassava is a widely consumed food commodity with significant potential for further development into diversified processed food products.

Cassava contains essential nutrients, including carbohydrates, dietary fiber, vitamins, and minerals. Based on data from the Ministry of Health of the Republic of Indonesia (2017), 100 g of cassava contains approximately 154 kcal, 36.8 g of carbohydrates, 0.9 g of fiber, and 394 mg of potassium. These nutritional values demonstrate that cassava has strong potential as an alternative carbohydrate source to substitute rice or wheat. Furthermore, cassava-based food innovation contributes to economic value, nutritional improvement, food security, safety, quality assurance, and environmental sustainability through technological and creative approaches while maintaining its traditional identity.

Traditionally, cassava is processed into boiled cassava, *getuk*, *tiwul*, and chips. However, its utilization has expanded into high-value innovative products such as MOCAF (Modified Cassava Flour), which is used as a gluten-free substitute for wheat flour in various dessert applications. Cassava has also been incorporated into modern dishes such as cassava-based mousse, reflecting a fusion of contemporary culinary techniques and local ingredients (Anggareta, 2022; Gusnadi et al., 2021).

Pudding is a semi-solid dessert typically prepared from a mixture of gelling agents, milk, and starch, heated until thickened and then cooled before serving. Previous studies on pudding innovation indicate that substitution with local ingredients significantly affects sensory characteristics. For example, formulations containing 80% purple yam flour and 20% oyster mushroom flour, as well as 100% purple yam flour, achieved favorable acceptance scores (mean hedonic score 3.56 – "like") (Atajama & Meiyasa, 2023; Farida et al., 2023; Mutiara et al., 2025). Additionally, the incorporation of 30% purple yam into Etawa goat's milk pudding significantly influenced sensory attributes and pH values.

Molecular gastronomy refers to the transformation of food structure, texture, and sensory characteristics through controlled physical and chemical mechanisms during processing. Techniques within molecular gastronomy include spherification, sous-vide, emulsification, and gelification (This, 2013). Among these, spherification—particularly caviar spherification—is widely used to enhance aesthetic appeal and introduce novel textural elements. This technique consists of two main methods: basic and reverse spherification, differentiated by the source of calcium ions in the system (Silva et al., 2023).

Although caviar spherification has been extensively applied to liquid-based culinary products, its application to semi-solid local food matrices such as cassava-based pudding remains limited. Moreover, previous studies have largely focused on aesthetic and textural modifications without simultaneously evaluating their impact on sensory characteristics, consumer preference, physical properties (especially color), and chemical composition. A comprehensive evaluation is therefore required to ensure that technological innovation not only enhances visual and textural appeal but also maintains or improves sensory quality and nutritional value.

The development of cassava-based pudding incorporating caviar spherification represents a food diversification strategy aimed at increasing product added value, nutritional quality, and sensory innovation. Accordingly, this study aims to:

a. analyze the sensory characteristics (aroma, taste, and texture) of cassava-based pudding with caviar spherification using trained panelists;
b. evaluate consumer preference for color, aroma, taste, texture, and overall acceptability using untrained panelists;
c. examine the physical characteristics of the product through color analysis; and
d. analyze the chemical composition of cassava-based pudding incorporating caviar spherification.

METHOD

This study employed an experimental design to evaluate the effect of cassava puree incorporation on pudding characteristics. The experiment was conducted at the Culinary Laboratory, Faculty of Engineering, Universitas Negeri Semarang, Indonesia, from December 2025 to January 2026.

Two formulations were prepared:

F0: control pudding without cassava puree, served with vanilla custard (vla).

F1: pudding with the addition of cassava puree, served with lemon custard and tamarind caviar.

Both formulations used the same basic pudding composition. The primary difference was the inclusion of cassava puree in F1 and the variation in accompanying components, representing a cassava-based culinary innovation approach.

The ingredient composition of both formulations is presented in **TABLE 1**.

TABLE 1. Cassava pudding ingredient formulation.

No.	Ingredients	Quantity	
		F0	F1
1.	*Cassava puree* (g)	-	50
2.	Milk (mL)	250	250
3.	Granulated sugar (g)	25	25
4.	Egg yolk (g)	17	17
5.	Agar agar powder (g)	2	2
6.	Jelly powder (g)	2	2
7.	Vanilla paste (g)	1	1

The preparation process began by mixing milk, sugar, egg yolk, agar powder, jelly powder, and vanilla paste under continuous stirring. For formulation F1, cassava puree (50 g) was incorporated into the mixture prior to heating. The mixture was heated at controlled temperature until homogeneous and slightly thickened, then poured into molds and allowed to cool at room temperature before refrigeration to achieve a semi-solid consistency.

The control formulation (F0) was served with vanilla custard, while F1 was accompanied by lemon custard and tamarind caviar prepared using a spherification technique. The overall production workflow is illustrated in **FIGURE 1**.

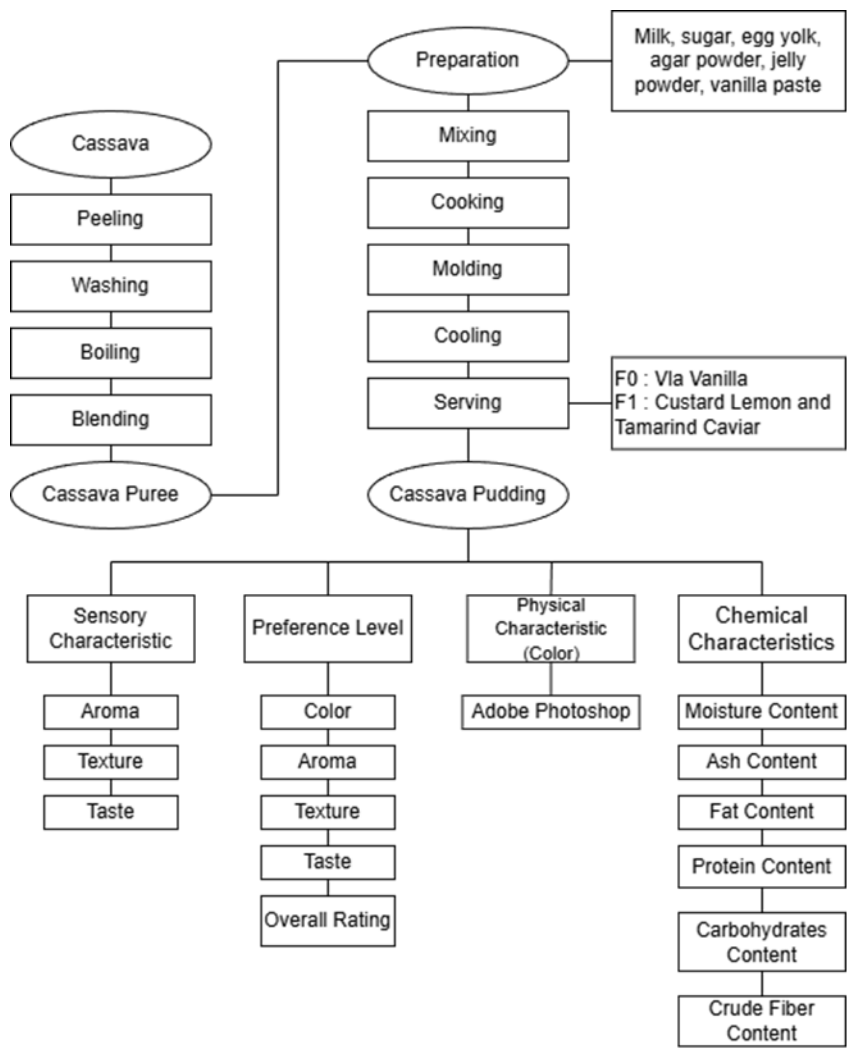

FIGURE 1. Cassava pudding product preparation flowchart.

The organoleptic data were collected using two groups of panelists: trained and untrained panelists. The descriptive sensory evaluation was conducted by three trained panelists who had competence in food sensory assessment. This test evaluated the attributes of aroma, texture, and taste using a structured scoring system with specific criteria for each parameter according to the observed sensory characteristics. The assessment employed a 9-point scale (1–9) adjusted to the sensory profile of the pudding, as presented in **TABLE 2**.

Consumer preference testing was conducted using 80 untrained panelists consisting of students from the Culinary Education Study Program, Universitas Negeri Semarang. The preference test aimed to determine the level of acceptance of the product using a 9-point hedonic scale applied to sensory quality attributes. The scoring criteria were as follows: 1 = extremely disliked, 2 = very disliked, 3 = disliked, 4 = somewhat disliked, 5 = neutral, 6 = somewhat liked, 7 = liked, 8 = very liked, and 9 = extremely liked (Dwi et al., 2010).

TABLE 2. Scores and assessment criteria for the sensory test of trained panelists.

Score	Aroma	Texture	Taste
1	Extremely unpleasant	Extremely non-chewy	Extremely unsweet
2	Very unpleasant	Very non-chewy	Very unsweet
3	Unpleasant	Non-chewy	Unsweet
4	Slightly unpleasant	Slightly non-chewy	Slightly unsweet
5	Neutral	Moderately chewy	Moderately sweet
6	Slightly fragrant	Slightly chewy	Slightly sweet
7	Fragrant	Chewy	Sweet
8	Very fragrant	Very chewy	Very sweet
9	Extremely fragrant	Extremely chewy	Extremely sweet

Statistical analysis of sensory and consumer preference data was performed using IBM SPSS Statistics version 31. Prior to hypothesis testing, normality of the data distribution was assessed. The Shapiro–Wilk test was applied to the sensory data obtained from trained panelists, while the Kolmogorov–Smirnov test was used for preference data collected from untrained panelists. Sensory data were analyzed using a parametric One-Way ANOVA to determine differences in sensory attributes between formulations based on trained panelist evaluations. Since the preference data were ordinal and did not fully satisfy normality assumptions, non-parametric analysis was conducted using the Kruskal–Wallis test to evaluate differences in consumer acceptance between samples. When statistically significant differences were identified ($p < 0.05$), post-hoc comparisons were performed using the Mann–Whitney U test as a follow-up analysis (Handayani & Priyanti, 2021).

Physical characteristics were analyzed through objective color measurement using digital image processing with Adobe Photoshop software based on the RGB (Red, Green, Blue) color system, which represents the intensity of color components in digital images. Brightness values were determined from the distribution of the three color channels through histogram analysis under standardized imaging conditions.

Chemical characteristics were analyzed to determine the nutritional composition of the pudding products. Proximate analyses were conducted at the Saraswati Indo Genetech (SIG) Laboratory in Semarang. The parameters evaluated included moisture content, ash content, fat, protein, carbohydrate, and crude fiber. Moisture content was determined using the oven-drying method according to SNI 01-2891-1992 (Section 5.1). Approximately 5 g of the sample was weighed, dried in an oven, cooled in a desiccator, and reweighed until a constant weight was achieved (Paramita et al., 2021). The moisture content was calculated using the standard gravimetric formula based on weight loss after drying.

$$Moisture\ Content\ (\%) = \frac{((A + B) - C)}{B} \times 100\%$$

Description:
A = Weight of empty container (g)
B = Test portion weight (g)
C = Fixed weight of the container + test portion after heating (g)

The ash content was analyzed using the gravimetric method according to SNI 01-2891-1992, section 6.1. The analysis was conducted by weighing 2–6 g of the sample into a previously weighed porcelain crucible. The sample was first subjected to a preliminary ashing process until the smoke disappeared. Furthermore, the crucible was placed in a furnace at a temperature of 550 °C. After the ashing process, the sample was cooled in a desiccator and weighed until a constant weight was obtained (Widiana et al., 2025). The ash content was calculated using the following formula:

$$Ash\ Content = \frac{(C - A)}{B} \times 100\%$$

Description:
A = Weight of empty cups (g)
B = Test portion weight (g)
C = Fixed weight of the cup + test portion after feeding (g)

Fat content was determined using the gravimetric method according to SNI 01-2891-1992, point 8. This method aims to determine the percentage of fat in a sample. The fat content analysis was carried out by weighing the sample (the weight was adjusted to the shape and type of the matrix) into a 100 mL extraction cup. The next stage was the extraction process, followed by drying until fat residues were obtained. The residue was then weighed until a constant weight was achieved (Sugiantari et al., 2023). The fat content was calculated using the following formula:

$$Fat\ Content\ (\%) = \frac{(C - A)}{B} \times 100\%$$

Description:
A = Weight of empty fat pumpkin (g)
B = Test portion weight (g)
C = Fixed weight of fat pumpkin + test portion after heating (g)

Protein content was determined using the titrimetric method according to AOAC (2001). In this method, the sample is digested to convert organic nitrogen into ammonium, which is then distilled after the addition of NaOH. The ammonia formed is absorbed in boric acid and subsequently titrated with standard HCl until the endpoint is reached. The nitrogen content obtained from the titration is then used to calculate the protein content (Anisa et al., 2021). The protein content was calculated using the following formula:

$$Protein\ Content\ (\%) = \frac{\left(V_p - V_b\right) \times N \times 1.4007 \times Fk}{Wspl\ or\ Vspl}$$

Description:
V_p = Volume of HCl required for sample titration (mL)
V_b = Volume of HCl required for blank titration (mL)
N = Normality of HCl solution (N)
FK = Protein conversion factors
Wspl = Test portion weighing weight (g)
Vspl = Test portion pipetting volume (mL)

Carbohydrate content was calculated using the by-difference method. The carbohydrate content was determined by subtracting the sum of moisture, ash, protein, and fat contents from the total sample composition (Kusumastuti & Wismanto, 2023). The total carbohydrate content was calculated using the following formula:

$$Carbohydrates\ (\%) = 100\% - (\%\ Protein + \%\ Fat + \%\ Water + \%\ Ash)$$

Crude fiber content was analyzed using the gravimetric method with sequential treatment using dilute acid and dilute alkali solutions. The sample was then filtered using ash-free filter paper (Whatman) and washed successively with hot acid solution, hot water, and ethanol. The residue was dried until a constant weight was obtained and subsequently ashed. The difference in weight before and after the ashing process was used to determine the crude fiber content (Tumangger et al., 2021). The crude fiber content was calculated using the following formula:

Crude Fiber < 1 %

$$Crude\ Fiber\ (\%) = \frac{(B - A)}{w} \times 100\%$$

Crude Fiber > 1 %

$$Crude\ Fiber\ (\%) = \frac{(B - A) - (D - C)}{w} \times 100\%$$

Description:
A = Weight of empty filter paper
B = Weight of filter paper + coarse fiber residue
C = Weight of empty cups
D = Weight of crucible + ash residue
w = Test portion weighing weight (g)

RESULTS AND DISCUSSION

Sensory Characteristic

Sensory evaluation was conducted to objectively describe the sensory characteristics of cassava pudding based on the perceptions of trained panelists. The assessment focused on three main attributes—aroma, texture, and taste—which are important parameters in determining the sensory profile of a food product. This evaluation aimed to identify differences in sensory characteristics between the control pudding and pudding with the addition of cassava puree produced using the caviar spherification technique. Through this evaluation, a more specific description of the product's sensory profile could be obtained.

TABLE 3. Average scores of trained panelists' assessment of sensory characteristics.

Parameter	Mean Value	
	F0	F1
Aroma	7.33 ± 1.528[a]	7.67 ± 0.577[a]
Texture	6.00 ± 2.646[a]	9.00 ± 0.000[a]
Taste	8.33 ± 1.155[a]	7.33 ± 1.155[a]

Description:
F0 = control formulation
F1 = treatment formulation with the addition of cassava puree
a,b = identical superscript letters indicate no significant difference based on the ANOVA test at a significance level of 5%

The results of the aroma sensory test conducted by trained panelists showed that the average aroma score for the control pudding (F0) was 7.33 ± 1.528, while the treatment pudding (F1) obtained a slightly higher score of 7.67 ± 0.577. Based on the evaluation criteria, these scores fall within the category ranging from less fragrant to moderately fragrant, indicating that both products possess a recognizable aroma according to trained panelists. Statistical analysis using ANOVA revealed that there was no significant difference between the aroma of F0 and F1 ($p = 0.742$; $p > 0.05$). This result indicates that the addition of cassava puree in the formulation did not significantly influence the aroma intensity of the pudding. However, the lower standard deviation observed in F1 compared to F0 suggests that panelists' evaluations of the treatment pudding were more consistent, indicating a more uniform aroma perception. These findings are consistent with the study reported by Zulhira et al. (2025), which found that the P0 formulation (100 g purple sweet potato and 0 g dates) and P3 formulation (100 g purple sweet potato and 75 g dates) were the most preferred by panelists, with approximately 60% of panelists categorizing the pudding aroma as fragrant.

The results of the texture sensory evaluation showed that the average texture score of the control pudding (F0) was 6.00 ± 2.646, while the treatment pudding (F1) obtained a higher score of 9.00 ± 0.000. Based on the scoring criteria, the texture of F0 was categorized as very chewy, while F1 was categorized as chewy. Statistical analysis using ANOVA indicated that there was no significant difference between the texture of F0 and F1 ($p = 0.121$; $p > 0.05$). This suggests that although the average texture score of F1 was higher, the difference in perceived texture intensity among panelists was not statistically significant. The results of this texture evaluation are consistent with the findings reported by Zulhira et al. (2025), who stated that the P0 formulation (100 g purple sweet potato and 0 g dates) produced a pudding texture that tended to be soft according to the majority of panelists. However, the texture characteristics observed in the present study may be influenced by differences in raw materials and processing techniques. In this study, the use of cassava combined with the caviar spherification technique likely contributed to the formation of a pudding texture that tends to be chewy.

The results of the taste evaluation conducted by trained panelists showed that the average taste score for the control pudding (F0) was 8.33 ± 1.155, while the treatment pudding (F1) obtained an average score of 7.33 ± 1.155. Based on the scoring criteria, the taste of F0 was categorized as very sweet and balanced, whereas F1 was categorized as sweet with a slightly sour note. Statistical analysis using ANOVA showed that there was no significant difference between the taste attributes of F0 and F1 ($p = 0.349$; $p > 0.05$), indicating that the addition of cassava puree did not significantly influence the taste perception among trained panelists. These findings are in line with the results reported by Zulhira et al. (2025), who found that the P1 formulation (100 g purple sweet potato and 50 g dates) and P3 formulation (100 g purple sweet potato and 100 g dates) exhibited a sweet taste profile, with 68% of panelists evaluating the products within the sweet taste category.

Preference Level

The hedonic (preference) test was conducted to determine the level of panelists' acceptance of the cassava pudding produced. The evaluation was carried out by untrained panelists based on several attributes, including color, aroma, taste, texture, and overall acceptance.

The results of this test illustrate the panelists' preference for the product and indicate the extent to which the addition of cassava puree using the caviar spherification technique is acceptable without reducing consumer preference for the pudding.

TABLE 4. Mean hedonic scores of cassava pudding.

Parameter	Mean Hedonic Score	
	F0	F1
Color	7.54 ± 0.913^{a}	7.46 ± 1.078^{a}
Aroma	7.63 ± 0.905^{a}	7.44 ± 1.029^{a}
Texture	7.76 ± 1.009^{a}	7.65 ± 1.008^{a}
Taste	7.64 ± 1.161^{a}	7.90 ± 1.154^{a}
Overall acceptance	7.66 ± 0.954^{a}	7.74 ± 1.052^{a}

Color

Color evaluation was conducted to determine the level of panelists' preference for the color of cassava pudding. As shown in Table 4, the mean hedonic score for the control pudding (F0) was 7.54 ± 0.913, while the treatment pudding (F1) obtained a slightly lower score of 7.46 ± 1.078. This indicates that the control pudding was slightly more preferred in terms of color compared to the pudding with the addition of cassava puree.

The results of the Kruskal–Wallis test showed a value of $p = 0.990$ ($p > 0.05$), indicating that there was no significant difference in color preference between the two formulations (F0 and F1). This suggests that the addition of cassava puree did not significantly influence the visual appearance of the pudding. These findings differ from those reported by Farida et al. (2023), who found significant differences in color preference in purple sweet potato–based products.

Aroma

Aroma evaluation was conducted to determine the level of panelists' preference for the aroma of cassava pudding. The results showed that the control pudding (F0) obtained a slightly higher average hedonic score (7.63 ± 0.905) compared to the treatment pudding (F1), which obtained a score of 7.44 ± 1.029.

The results of the Kruskal–Wallis test indicated that the addition of cassava puree to the pudding formulation did not significantly affect aroma acceptance ($p = 0.240$; $p > 0.05$). This suggests that the aroma characteristics of the pudding remained acceptable to panelists despite the addition of cassava puree. These results are consistent with the findings of Farida et al. (2023), who reported that variations in ingredient formulation in pudding products still produced an aroma that was generally acceptable to consumers. The presence of tuber-based ingredients may contribute to a distinctive aroma profile that is still well received by panelists.

Texture

Texture evaluation was conducted to assess panelists' acceptance of the texture of cassava pudding. The mean hedonic score for the control pudding (F0) was 7.76 ± 1.009, which was slightly higher than that of the treatment pudding (F1), with a score of 7.65 ± 1.008.

The results of the Kruskal–Wallis test showed $p = 0.422$ ($p > 0.05$), indicating that there was no significant difference in texture preference between the control and treatment formulations. These findings are consistent with the study conducted by Farida et al. (2023), which reported that the addition of oyster mushrooms to purple sweet potato pudding did not significantly influence the texture of the product. Similarly, Zulhira et al. (2025) reported that pudding formulated with 100 g of purple sweet potato without the addition of dates produced a soft texture that was well accepted by panelists.

Taste

Taste evaluation was conducted to determine panelists' acceptance of the flavor of the cassava pudding. The results showed that the treatment pudding (F1) obtained a slightly higher average score (7.90 ± 1.154) compared to the control pudding (F0), which had an average score of 7.64 ± 1.161. This indicates that the formulation with the addition of cassava puree tended to be more preferred in terms of taste.

However, the results of the Kruskal–Wallis test showed that there was no statistically significant difference between the two formulations ($p = 0.120$; $p > 0.05$). These findings are consistent with Farida et al. (2023), who reported that tuber-based pudding formulations with certain combinations of ingredients tended to produce favorable taste characteristics, although the differences were not always statistically significant. The addition of ingredients at moderate levels may contribute to a distinctive flavor profile that enhances consumer acceptance.

Overall Acceptance

The overall acceptance parameter was evaluated to determine panelists' general preference for cassava pudding. The control pudding (F0) obtained an average score of 7.66 ± 0.954, while the treatment pudding (F1) obtained a slightly higher score of 7.74 ± 1.052.

The results of the Kruskal–Wallis test indicated that the addition of cassava puree did not significantly affect overall acceptance ($p = 0.470$; $p > 0.05$). These findings are consistent with the study conducted by Wadhani et al. (2021), which reported that the incorporation of local plant-based ingredients in pudding products did not necessarily produce statistically significant differences in overall consumer acceptance. However, treatment formulations often showed slightly higher mean scores compared to control formulations, suggesting a positive trend in consumer preference.

Physical Characteristics (Color)

Color is one of the important parameters in assessing the quality of food products because it is the first attribute observed by consumers and can influence the initial perception of the product. Color analysis of cassava pudding was conducted to determine the effect of adding cassava puree using the caviar spherification technique on the visual appearance of the product. Color measurements were carried out objectively using the Adobe Photoshop application to obtain color values representing potential changes or stability in the pudding color between treatments.

TABLE 5. Objective color analysis of cassava pudding using adobe photoshop.

Color Parameter	F0	F1
Brightness (Mean ± SD)	234.16 ± 43.62	235.88 ± 45.40

Description:
F0 = control formulation
F1 = treatment formulation with the addition of cassava puree

Based on the objective color analysis using Adobe Photoshop, the average brightness value was 234.16 for the control sample (F0) and 235.88 for the treatment sample (F1). These values indicate that the brightness levels of both samples were relatively similar, suggesting that the addition of cassava puree did not cause a substantial change in the visual brightness of the pudding.

The control sample (F0) exhibited a white base color with a bright appearance, whereas the treatment sample (F1) showed a light yellow hue due to the addition of cassava puree. This change influenced the color tone (hue) but did not significantly reduce the overall brightness of the product.

The standard deviation values, ranging from 43.62 to 45.40, indicate some variation in brightness across the product surface. This variation may be associated with differences in surface structure and the distribution of light during image capture.

Chemical Characteristics

Chemical characteristics are important parameters in evaluating the nutritional quality and composition of food products. Chemical analysis of cassava pudding was conducted to determine the effect of adding cassava puree using the caviar spherification technique on changes in the chemical composition of the product. The analyzed parameters included moisture, ash, fat, protein, crude fiber, and carbohydrate contents, which provide an overview of the changes in nutritional value and chemical characteristics of the pudding between treatments.

TABLE 6. Chemical composition of cassava pudding.

No	Parameter	F0	F1
1	Moisture content (%)	73.73 ± 0.042	72.48 ± 0.113
2	Ash content (%)	0.76 ± 0.007	0.69 ± 0.007
3	Fat content (%)	4.14 ± 0.063	3.80 ± 0.021
4	Carbohydrate content (%)	17.81 ± 0.134	19.91 ± 0.070
5	Protein content (%)	3.58 ± 0.035	3.13 ± 0.056
6	Crude fiber content (%)	0.64 ± 0.021	0.22 ± 0.007

Description:
F0 = control formulation
F1 = treatment formulation with the addition of cassava puree

Moisture Content

The analysis results showed that the moisture content of cassava pudding decreased by 1.70% compared with the control product. This decrease is likely related to the heating process during cooking, which may cause partial evaporation of water from the product matrix.

Rajapaksha et al. (2017) reported that the moisture content of raw cassava (MU51 variety) decreased from 62.17% to 61.94% after boiling. These findings suggest that heat treatment in cassava processing can slightly reduce moisture content. The results of the present study are consistent with these findings, indicating that the cassava starch matrix is still able to retain water even after processing, resulting in only a small reduction in moisture content.

Ash Content

The ash content of cassava pudding decreased by 9.21%, indicating a reduction in the total mineral content of the product. Mohidin et al. (2023) reported that cassava generally contains relatively low levels of minerals and vitamins compared with other staple food crops such as cereals and legumes.

The reduction in ash content may be associated with the naturally low mineral content of cassava as well as potential mineral losses during processing stages such as heating and mixing. These results suggest that although cassava is rich in energy-producing carbohydrates, its contribution to mineral intake remains relatively limited.

Fat Content

The results showed that the fat content decreased by 8.21% in the cassava pudding formulation. These findings are consistent with the report by Mohidin et al. (2023), which states that cassava is naturally low in fat content.

The decrease in fat content in the cassava pudding may be influenced by the low lipid fraction in cassava raw materials and the absence of additional fat sources in the formulation. Therefore, cassava-based pudding products tend to contain lower fat levels compared with food products made from cereals or ingredients with higher lipid content.

Protein Content

The protein content of cassava pudding decreased by 12.56% compared with the control formulation. This result indicates that cassava-based products generally provide relatively low protein contributions.

Mohidin et al. (2023) reported that cassava tubers typically contain low levels of protein and limited essential amino acids. The reduction in protein content in processed cassava pudding may therefore be related to the naturally low protein content of cassava as well as possible protein denaturation during the heating process. Consequently, the use of cassava as a primary ingredient may reduce the overall protein content of the product compared with the control formulation.

Carbohydrate Content

The addition of cassava puree to the pudding formulation increased the carbohydrate content by 10.54%. This finding is consistent with the systematic review by Mohidin et al. (2023), which reported that cassava root (*Manihot esculenta*) is a major energy source rich in carbohydrates, with levels reaching 94.65 g per 100 g dry weight.

This increase highlights the potential of cassava as a functional food ingredient capable of contributing to daily energy requirements through its high carbohydrate content.

Crude Fiber Content

The results showed that the crude fiber content of cassava pudding decreased by 65.65% compared with the control product. This substantial decrease may be associated with the naturally low crude fiber content of cassava raw materials. Idris et al. (2020) reported that cassava flesh contains crude fiber levels of approximately 2.11% ± 0.03%, indicating that cassava contributes only limited dietary fiber.

In addition, processing conditions may influence fiber levels in the final product. Lambebo et al. (2025) reported that the crude fiber content in cassava tuber flour ranges from 0.98–2.31%, depending on the variety and processing methods used.

In the present study, the processing treatment involving heating and gel matrix formation in pudding may have caused partial degradation and softening of fiber components, resulting in a lower measured crude fiber content.

CONCLUSION

The addition of cassava puree to the pudding formulation using the caviar spherification technique did not significantly affect the sensory characteristics or the panelists' preference levels. Based on the sensory evaluation, the control pudding (F0) was characterized by a less fragrant to moderately fragrant aroma, a very chewy texture, and a very sweet taste, whereas the treatment pudding (F1) exhibited a more fragrant aroma, chewy texture, and sweet taste.

The hedonic test results indicated that, in terms of overall evaluation, the pudding formulated with cassava puree (F1) was slightly more preferred than the control pudding (F0), although the difference was not statistically significant ($p = 0.470$). The physical color analysis also showed that the addition of cassava puree through the caviar spherification technique did not cause significant changes in the visual color characteristics of the pudding.

However, the addition of cassava puree in the F1 formulation influenced the chemical composition of the product. The results showed a decrease in moisture content (1.70%), ash content (9.21%), fat content (8.21%), protein content (12.56%), and crude fiber content (65.62%), while the carbohydrate content increased by 10.54%.

These findings indicate that the incorporation of cassava puree combined with the caviar spherification technique can be applied in pudding production as a product innovation without reducing consumer acceptance, while simultaneously modifying the sensory characteristics and chemical composition of the product.

This study contributes to the development of local food–based product innovation by providing a comprehensive evaluation of sensory characteristics, consumer preference, physical properties, and chemical composition within a single experimental framework. However, the present study was limited to two formulations and laboratory-scale testing, which may limit the generalizability of the findings. Therefore, future studies are recommended to explore different formulation levels, larger panelist populations, and product stability during storage in order to enhance the practical applicability of the results.

REFERENCES

Anggareta, P. C. (2022). Gluten free product cassava flour as an alternative for making pandan dessert boxes. *Scientific Journal of Tourism and Business*, *1*(9), 2299–2317.

Anisa, D., Amna, U., & Amri, Y. (2021). Protein content analysis in black soldier fly maggot flour (Hermetia illucens) using the titrimetric method. *QUIMICA: Journal of Scientific and Applied Chemistry*, *3*(2), 31–34.

Atajama, Y. H., & Meiyasa, F. (2023). Study of the Chemical and Organoleptic Properties of Seaweed Pilus (Kappaphycus alvarezi) Fortified Moringa Leaf Flour (Moringa oleivera). *Samakia: Journal of Fisheries Science*, *14*(1), 9–25.

Dwi, S., Anton, A., & Maya, P. S. (2010). Sensory analysis for the food and agro industries. *IPB. Press Bogor*.

FAO. (2024). *Top 10 Country Production of Cassava, fresh 2024*. Food and Agriculture Organization of the United Nations. https://www.fao.org/faostat/

Farida, S., Widyastuti, D., & Perdana, R. G. (2023). Consumer Acceptance of Functional Foods Pudding Made from Purple Sweet Potato (Ipomoea batatas L.) and Oyster Mushrooms (Pleurotus ostreatus). *Journal of Halal Agroindustry*, *9*(1), 33–40.

Gusnadi, D., Taufiq, R., & Baharta, E. (2021). Oranoleptic test and acceptability on cassava tapai-based mousse products as an MSME commodity in Bandung district. *Journal of Research Innovation*, *1*(12), 2883–2888.

Handayani, I., & Priyanti, E. (2021). Analysis of Wingko Acceptance and Nutritional Content with Moringa Leaf Flour Substitution (Moringa Oleifera). *TEKNOBUGA: Journal of Fashion and Fashion Technology*, *9*(2), 79–84.

Idris, S., Rosnah, S., Nor, M. Z. M., Mokhtar, M. N., & Abdul Gani, S. S. (2020). Physicochemical composition of different parts of cassava (Manihot esculenta Crantz) plant. *Food Research*, *4*(1), 78–84.

Ministry of Health of the Republic of Indonesia. (2017). *Indonesian Food Composition Table (TKPI).*

Kusumastuti, I., & Wismanto, W. (2023). Analysis of nutritional content and harmful substances (Rhodamin B and Formalin) in dorokdok crackers in Cibeureum Village, Cibeureum District, Kuningan Regency. *Edufortech*, *8*(1), 53–60.

Lambebo, T., Deme, T., & Geleta, M. (2025). Nutritional enhancement of cassava through processing: implications for sustainable food systems. *Frontiers in Sustainable Food Systems*, *9*, 1660792.

Mohidin, S. R. N. S. P., Moshawih, S., Hermansyah, A., Asmuni, M. I., Shafqat, N., & Ming, L. C. (2023). Cassava (Manihot esculenta Crantz): A systematic review for the pharmacological activities, traditional uses, nutritional values, and phytochemistry. *Journal of Evidence-Based Integrative Medicine*, *28*, 2515690X231206227.

Mutiara, Abdurrahman, Z. H., & Prasetyo, A. B. (2025). EFFECT OF THE ADDITION OF PURPLE SWEET POTATO (Ipomoea batatas l) ON SENSORY QUALITY, PH, AND SYNERESIS IN ETAWA GOAT MILK PUDDING. *Tropical Animal Science*, *7*(2), 186–193. https://doi.org/10.36596/tas.v7i2.1854

Paramita, V. D., Hr, Y., Rosalin, R., & Purnama, I. (2021). *The effect of various drying methods on the moisture content, ash and protein of moringa leaf powder*.

Rajapaksha, K. D. S. C. N., Somendrika, M. A. D., & Wickramasinghe, I. (2017). *Nutritional and Toxicological Composition Analysis of Selected Cassava Processed Prodducts*.

Saras, T. (2023). *Cassava: Culture, Benefits, and Innovation*. Media Oysters. https://books.google.co.id/books?id=YWfeEAAAQBAJ

Silva, V., Quintas, C., Ratao, I., & Nunes, P. (2023). Exploring spherification with some foods of the Mediterranean Diet. *Chemical Engineering Transactions*, *102*, 271–276.

Sugiantari, W., Wibawa, A. A. C., & Pramitha, D. A. I. (2023). Analysis of Fat and Water Content in Cocoa Bean Simplicia (Theobrama Cacao L.) Gumbrih Village, Pakutatan District, Jembrana Regency. *Ushad*, *2*(4), 14–19.
This, H. (2013). Celebrate chemistry. recent results of molecular gastronomy. *European Review*, *21*(2), 158–174. https://doi.org/10.1017/S1062798712000336
Tumangger, J., Amna, U., Fajri, R., & Amri, Y. (2021). Analysis of Crude Fiber Levels and Ash Levels in Rice Flour (Oryza Sativa L.) Using the Gravimetric Method. *CHEMISTRY: Journal of Scientific and Applied Chemistry*, *3*(2), 27–30.
Wadhani, L. P. P., Ratnaningsih, N., & Lastariwati, B. (2021). Nutritional content, antioxidant activity and organoleptic assay of cauliflower-based pudding (Brassica oleracea var. Botrytis) and Strawberry (Fragaria x ananassa). *Journal of Food Technology Applications*, *10*(1), 6–12.
Widiana, D. R., Zukryandry, Z., Puspitasari, K., & Dalimunthe, N. K. (2025). Chemical Characteristics of Pie Crust Physically Modified Banana Flour Substitution. *Journal of Food and Culinary*, 81–88.
Zulhira, P., Nurhamidah, N., & Nova, M. (2025). ORGANOLEPTIC QUALITY AND GLYCEMIC INDEX LEVELS IN THE MANUFACTURE OF PURPLE SWEET POTATO PUDDING (IPOMOEA BATATAS) WITH THE ADDITION OF DATES (PHOENIX DACTYLIFERA) AS AN ALTERNATIVE SNACK FOR PEOPLE WITH DIABETES MELLITUS. *Encyclopedia of Journal*, *7*(3), 50–58.