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Sensory Quality Analysis and Physical Quality of Pasta *Butterflies* Arrowroot Starch Substitution

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Abstract

This study aims to examine and analyze the effect of arrowroot starch substitution on the sensory and physical quality of farfalle pasta. The research was conducted at the Pastry and Bakery Laboratory, Culinary Arts Education Study Program, Universitas Negeri Jakarta, from July 2024 to June 2025. A quantitative approach was used through an experimental method, followed by an organoleptic test involving 45 semi-trained panelists, who were Culinary Arts Education students, Universitas Negeri Jakarta that had completed the organoleptic evaluation course. The arrowroot starch substitution levels used were 30%, 40%, and 50%. Descriptive analysis results showed the highest scores in the following aspects: dry farfalle pasta color at 30% substitution with a score of 4.5 categorized as golden yellow category and rated as first-best; dry pasta aroma at 30% substitution with a score of 4.3 categorized as free from arrowroot odor and rated as second-best; dry pasta texture at 30% substitution with a score of 4.5 categorized as firm and rated as first-best; cooked farfalle pasta color at 30% substitution with a score of 4.0 categorized as pale yellow and rated as second-best; cooked pasta aroma at 30% substitution with a score of 4.3 categorized as strongly free from arrowroot odor and rated as second-best; cooked pasta texture at 40% substitution with a score of 4.4 categorized as chewy and rated as second-best; and cooked pasta taste at 30% substitution with a score of 4.0 categorized as slightly tasting of arrowroot and rated as second-best. Physical quality tests showed no significant effect on water absorption capacity and moisture reduction. In conclusion, the best product was farfalle pasta with a 30% arrowroot starch substitution.

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1. INTRODUCTION

Pasta is a popular food product and is widely consumed in various parts of the world, including in Indonesia. The variety of shapes and types of pasta can stimulate appetite and prevent boredom in everyday consumption. Traditionally, pasta is made from wheat flour or semolina and is known as a distinctive part of Italian cuisine, which has now been adapted into various international and local menus. One type of pasta with a unique shape is pasta *butterflies*, shaped like a bow tie with serrated edges and a wrinkled center. Although not yet widely found on restaurant menus in Indonesia, pasta *butterflies* Dry is widely available in the market, both through supermarkets and e-commerce platforms.

In general, pasta is divided into two types: fresh pasta and dried pasta. Each presents its own unique challenges in the manufacturing process. Fresh pasta requires precise boiling times to avoid a mushy texture, while dried pasta requires a precise drying process

to maintain a long shelf life. Most pasta products on the market use wheat flour as the main ingredient. This flour comes from wheat, which cannot be cultivated in Indonesia due to the unsuitable tropical climate. Therefore, Indonesia relies heavily on wheat imports. According to data from the Central Statistics Agency (2024), Indonesia's wheat imports in 2023 reached 10.5 million tons, with the main sources being Australia (4.2 million tons) and Canada (2.3 million tons). This dependence has prompted the need to find alternative local ingredients to reduce dependence on imported wheat.

One local ingredient with great potential is arrowroot tuber (Maranta arundinacea L.), which is known to be rich in starch, easily digestible, gluten-free, and hypoallergenic. This tuber contains approximately 82.5% carbohydrates and 1.2% protein, making it suitable for development as a starch source to replace wheat flour. Research conducted by Sobari and Haq (2023) showed that arrowroot starch can be used as a substitute ingredient in pasta making. In the study, a substitution level of 50% produced the highest level of preference based on the hedonic test, while the highest starch content (67.80%) was obtained from pasta with 100% arrowroot starch substitution.

Arrowroot tubers can be processed into arrowroot flour and arrowroot starch, but the two have different characteristics. Arrowroot flour contains high fiber, which can make the dough brittle and difficult to shape, especially for pasta types like pasta *butterflies* which requires a strong and elastic shape. In contrast, purer arrowroot starch has the ability to absorb water well, form a stable gel, and create a chewy and elastic texture, resembling the characteristics of wheat flour. Furthermore, arrowroot starch's gelatinization ability can increase water absorption and help maintain the pasta's shape during the cooking process.

This study aims to examine the effect of arrowroot starch substitution on the sensory quality and physical quality of pasta *butterflies.* The study focused on sensory parameters such as color, texture, and flavor, as well as physical qualities such as moisture content and water absorption. This research is expected to contribute to the development of gluten-free pasta products based on local ingredients and support food diversification through the utilization of potential local resources.

2. MATERIALS AND METHOD

This study uses an experimental method to examine the effect of arrowroot starch substitution on the sensory quality and physical quality of pasta *butterflies*. Products are made in the Laboratory *pastry* and *bakery*, as well as physical property tests at the Food Engineering and Organoleptic Laboratory, Jakarta State University. There were three treatments for the pasta *butterflies* with arrowroot starch substitution at percentages of 30%, 40%, and 50%. The sensory test panelists were 45 students of the Culinary Arts Education Study Program. Sensory quality assessments, including color, aroma, and texture in dry pasta, as well as color, aroma, texture, and taste in cooked pasta, were assessed hedonically using a scale of 1-5 by semi-trained panelists. The data obtained were tabulated and then analyzed using the Kruskal-Wallis test. If the results showed a significant difference, then the Tuckey test was continued. Physical quality testing was carried out through water absorption and water content reduction. Data obtained in physical quality were calculated using the formula for the percentage of water absorption and water content reduction, then analyzed using the ANOVA test. If the results obtained were significantly different, then to determine the differences between treatments, a multiple range test or Duncan Multiple Range Test (DMRT) was carried out. Pasta making procedure of *butterflies'* arrowroot starch substitution can be seen in **Figure 1** as follows

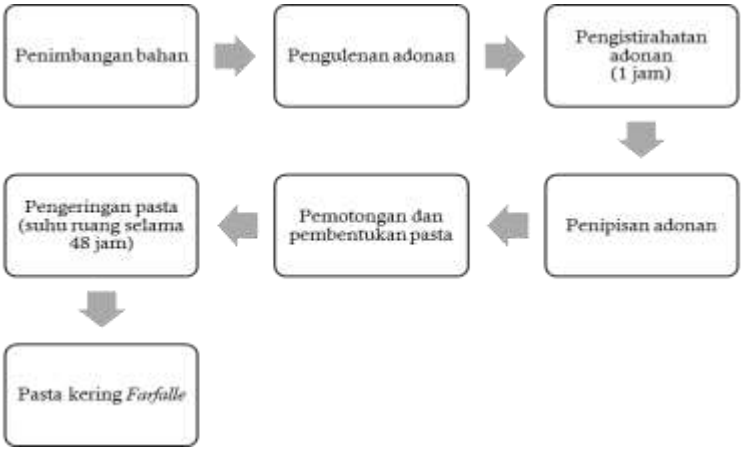

Figure 1. Pasta Making Flowchart *Butterflies* Arrowroot Starch Substitution

3. RESULTS

3.1 Sensory Quality

The average value of the results of the sensory quality research on the color aspect of pasta butterflies' substitution of arrowroot starch with treatment percentages of 30%, 40%, and 50% can be seen in **Figure 2**.

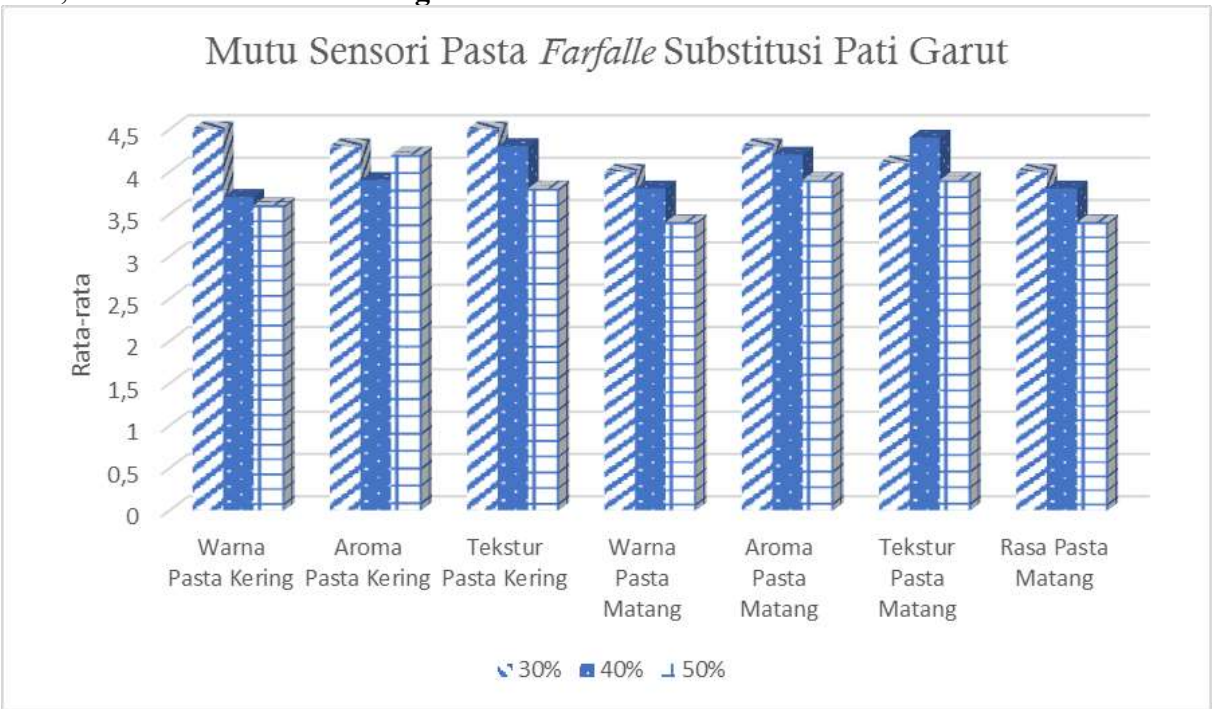

Figure 2. Average Sensory Quality Assessment of Pasta *Butterflies* Arrowroot Starch Substitution

1) Sensory Quality Paste Color Aspect *Butterflies* Dry Arrowroot Starch Substitute

Based on the results of the analysis of the color aspects of pasta *butterflies* dry matter substituted with arrowroot starch, it was found that the highest average was obtained in the 30% treatment, which was 4.5, which is included in the golden yellow category. Meanwhile, the 40% and 50% treatments each obtained an average score of 3.7 and 3.6, which are included in the golden yellow category. The results of the Kruskal-Wallis statistical analysis of pasta butterflies' starch substitution shows χ^2 count (9,521) > x ^{2}table (5.991). This shows that there is a significant influence of

arrowroot starch substitution on the color quality of pasta *butterflies* dry, because the calculated χ^2 value is greater than the table χ^2, then the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted. Thus, further testing using the Tuckey method is needed to determine which treatment provides a significant difference. The results of the Tuckey test on the color aspect of pasta butterflies with arrowroot starch substitution served on following **Table 1**

Table 1. Tuckey's Multiple Comparison Test on Pasta Color Aspects of *Butterflies* Dry Arrowroot Starch Substitute

Rest of Each Treatment	Comparison of Results	Conclusion
|A – B| = | 4,53 – 3,73 | = 0,8	0,8 > 0,055	**Real difference**
|A – C| = | 4,53 – 3,60 | = 0,93	0,93 > 0,055	**Real difference**
|B – C| = | 3,73 – 3,60 | = 0,13	0,13 > 0,055	**Real difference**
Information : **A = pasta*butterflies*30% arrowroot starch substitution** **B = folder*butterflies*40% arrowroot starch substitution** **C = folder*butterflies*50% arrowroot starch substitution**		

Based on the results of the Tuckey test on **Table 1**shows uniform results. Pasta *butterflies dry* arrowroot starch substitution percentages of 30% and 40% showed significantly different results, where the 30% percentage produced a different paste color *butterflies* significantly different dry percentage compared to the 40% percentage of pasta butterflies dry arrowroot starch substitution percentages of 30% and 50% showed significantly different results, where the percentage of 30% produced a different paste color *butterflies* significantly different dry percentage compared to 50%. Pasta *butterflies' dry* arrowroot starch substitution percentages of 40% and 50% showed significantly different results, where the percentage of 40% produced a different pasta color-butterflies significantly different dry percentage compared to the 50% percentage. So it can be concluded that the substitution of arrowroot starch in making pasta *butterflies* affects the final product result, pasta butterflies. The 30% dry product tends to produce the most distinct dry pasta color. However, analysis of other aspects did not show significant differences, so these will be discussed further in the next section.

2) Sensory Quality of Pasta Aroma Aspect of *Butterflies* Dry Arrowroot Starch Substitution

Based on the results of the analysis of the aroma aspect of pasta *butterflies dry* matter substituted with arrowroot starch, it was found that the highest average score was obtained in the 30% treatment, which was 4.3, which is included in the very unaromatic category of arrowroot tubers. Meanwhile, the 50% and 40% treatments each obtained an average score of 4.2 and 3.9, respectively. All three are included in the very unaromatic category of arrowroot tubers. The results of the Kruskal-Wallis statistical analysis of pasta *butterflies'* arrowroot starch substitution shows x^2count (1.178) < x^2table (5.991). Based on these results, it can be concluded that arrowroot starch substitution does not have a significant effect on the aroma quality of pasta *butterflies* dry

3) Sensory Quality of Pasta Texture Aspects of *Butterflies* Dry Arrowroot Starch Substitution

Based on the results of the analysis of the texture aspects of pasta *butterflies dry* matter substituted with arrowroot starch, it was found that the highest average was

obtained in the 30% treatment, which was 4.5, which is included in the sturdy category. Meanwhile, the 40% and 50% treatments each obtained an average score of 4.3 and 3.8, which are included in the somewhat sturdy category. The results of the Kruskal-Wallis statistical analysis of pasta butterflies' arrowroot starch substitution shows χ^2 count (2,458) < x^2table (5.991). Based on these results, it can be concluded that arrowroot starch substitution does not have a significant effect on the quality of pasta texture of *butterflies* dry

4) Sensory Quality Paste Color Aspect of *Butterflies* Mature Arrowroot Starch Substitution

Based on the results of the analysis of the color aspects of pasta butterflies Aater the arrowroot starch substitution treatment, it was found that the highest average score was obtained in the 30% treatment, which was 4.0, which is included in the pale-yellow category. Meanwhile, the 40% and 50% treatments each obtained an average score of 3.8 and 3.4, which are included in the pale yellow and creamy yellow color categories. The results of the Kruskal-Wallis statistical analysis of pasta *butterflies'* arrowroot starch substitution shows χ^2 count (3,414) < x^2table (5.991). Based on these results, it can be concluded that arrowroot starch substitution does not have a significant effect on the color quality of pasta *butterflies'* type.

5) Sensory Quality of Pasta Aroma Aspect of *Butterflies* Mature Arrowroot Starch Substitution

Based on the results of the analysis of the aroma aspect of pasta *butterflies* After the arrowroot starch substitution treatment, it was found that the highest average score was obtained in the 30% treatment, which was 4.3, which is included in the category of very unflavored arrowroot tubers. Meanwhile, the 40% and 50% treatments each obtained an average score of 4.2 and 3.9, respectively. All three are included in the category of very unflavored arrowroot tubers. The results of the Kruskal-Wallis statistical analysis of pasta *butterflies'* arrowroot starch substitution shows χ^2 count (0.623) < x^2table (5.991). Based on these results, it can be concluded that arrowroot starch substitution does not have a significant effect on the aroma quality of pasta *butterflies'* type.

6) Sensory Quality of Pasta Texture Aspects of *Butterflies* Mature Arrowroot Starch Substitution

Based on the results of the analysis of the texture aspects of pasta *butterflies* When comparing the results of the arrowroot starch substitution test, it was found that the highest average score was obtained in the 40% treatment, which was 4.4, which is included in the chewy category. Meanwhile, the 30% and 50% treatments each obtained an average score of 4.1 and 3.9, respectively. All three are included in the chewy category. The results of the Kruskal-Wallis statistical analysis of pasta *butterflies' arrowroot* starch substitution shows χ^2 count (1.276) < x^2table (5.991). Based on these results, it can be concluded that arrowroot starch substitution does not have a significant effect on the quality of pasta texture of *butterflies'* type.

7) Sensory Quality of Pasta Taste Aspects of *Butterflies* Mature Arrowroot Starch Substitution

Based on the results of the analysis of the taste aspects of pasta *butterflies* after the arrowroot starch substitution treatment, it was found that the highest average score was obtained in the 30% treatment, which was 4.0, which is included in the category of slightly tasted arrowroot tubers. Meanwhile, the 40% and 50% treatments each obtained an average score of 3.8 and 3.4, which are included in the category of slightly tasted arrowroot tubers and tasted arrowroot tubers. The results of the Kruskal-Wallis statistical analysis of pasta *butterflies'* arrowroot starch

substitution shows χ^2 count (3,414) < x^2table (5.991). Based on these results, it can be concluded that arrowroot starch substitution does not have a significant effect on the taste quality of pasta *butterflies'* type.

3.2 Physical Quality

1) Physical Quality of Pasta Water Absorption Capacity Aspect*Butterflies*Arrowroot Starch Substitution

Physical test of water absorption capacity of pasta *fall* arrowroot starch substitution was carried out to determine the pasta's ability of *butterflies* with treatment percentages of 30%, 40%, and 50% in absorbing water during the cooking process. The test was carried out three times for each treatment. The results obtained from weighing the pasta using a digital scale were then calculated using the following formula:

$$\text{Water Absorption Capacity (\%)} = \frac{(IN_B - IN_A)}{IN_A} \times 100\%$$

Information:
WA = Weight of pasta before boiling (gr)
WB = Weight of pasta after boiling (gr)

The average value of the results of the physical quality research on the water absorption capacity of pasta *butterflies'* dry arrowroot starch substitution can be seen in the following **Figure 3**:

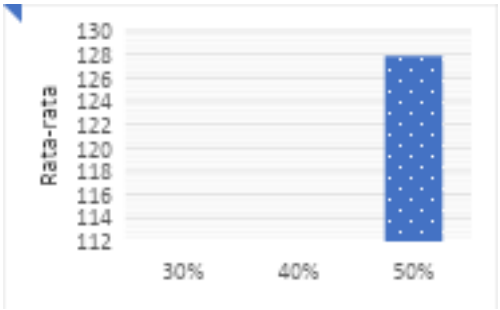

Figure 3. Average Physical Quality of Pasta Water Absorption Aspect of *Butterflies'* Arrowroot Starch Substitution

Based on the diagram above, the highest average water absorption capacity of pasta butterflies. The substitution of arrowroot starch was found in the 50% treatment at 180.56%. In the 30% and 40% treatments, the water absorption capacity was 125.45% and 118.18%, respectively. The results of the ANOVA statistical analysis of the water absorption capacity of pasta *butterflies'* arrowroot starch substitution can be observed in **Table 2**:

Table 2. Results of ANOVA Analysis of Water Absorption Capacity

SK	Db	JK	KT	F-count	F-table
Treatment	2	152,80	76,40	0,25	5,14
Error	6	1774,10	295,68		
Total	**8**	**1926,90**			

Based on the statistical test, it was obtained that F-count (0.25) < F-table (5.14). Thus, it can be concluded that arrowroot starch substitution does not have a significant effect on the water absorption capacity of pasta *butterflies*.

2) Physical Quality Aspect of Water Content Reduction of Pasta *Butterflies'* Arrowroot Starch Substitution

Physical test of water content reduction in pasta *fall* arrowroot starch substitution was carried out to determine the pasta's ability of *butterflies* with treatment percentages of 30%, 40%, and 50% reduced after the drying process. The test was carried out three times for each treatment. The results obtained from weighing the pasta using a digital scale were then calculated using the following formula:

$$\text{Decrease in Water Level (\%)} = \frac{(M_B - M_K)}{M_B} \times 100\%$$

Information:
MB = Weight of pasta before drying (gr)
MK = Weight of pasta after drying (gr)

The average value of the results of the physical quality research on the aspect of reducing the water content of pasta *butterflies'* dry arrowroot starch substitution can be seen in **Figure 4**:

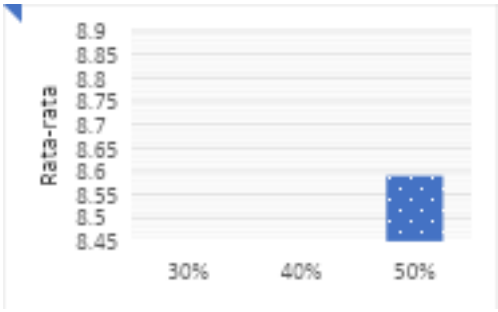

Figure 4. Average Physical Quality of Pasta Water Content Reduction Aspect of *Butterflies'* Arrowroot Starch Substitution

Based on the diagram above, the highest average decrease in water content in pasta butterflies. The substitution of arrowroot starch was found in the 30% treatment at 8.84%. In the 40% and 50% treatments, there was a decrease in water content of 8.57% and 8.58%. The results of the ANOVA statistical analysis of the decrease in water content in pasta *butterflies'* arrowroot starch substitution can be observed in **Table 3**:

Table 3. Results of ANOVA Analysis of Water Content Decrease

SK	Db	JK	KT	F-count	F-table
Treatment	2	0,13	0,06	0,34	5,14
Error	6	1,15	0,19		
Total	8	1,28			

Based on the statistical test, it was obtained that F-count (0.34) < F-table (5.14). Thus, it can be concluded that arrowroot starch substitution does not have a significant effect on reducing the water content in pasta *butterflies*.

3.3 Discussion

a) Sensory Quality Paste Color Aspect of *Butterflies'* Arrowroot Starch Substitution

Results of sensory quality tests on the color aspect of pasta *butterflies' dry* paste with arrowroot starch substitution percentages of 30%, 40%, and 50% showed significant differences. In the pasta color, the pasta butterflies the dry substitution percentage of 30% has the highest value with a value of 4.5 which is included in the golden yellow category. Referring to research conducted by Anjani (2016), this can occur because the arrowroot starch used has a white base color. The color of arrowroot starch has a higher degree of whiteness than wheat flour. Arrowroot starch

has a whiteness degree of around 80.5% - 85.6%, while wheat flour has a whiteness degree of 76.38% (Utomo, et al. 2012). The higher the use of arrowroot starch, the brighter the resulting color will be.

b) Sensory Quality of Pasta Aroma Aspect of *Butterflies'* Arrowroot Starch Substitution

Results of sensory quality tests on the aroma aspect of pasta *butterflies'* Dry food with arrowroot starch substitution percentages of 30%, 40%, and 50% showed no significant differences. This is in line with research by Anita (2024), which stated that the results of organoleptic analysis of products using arrowroot starch substitution did not cause changes in aroma and maintained the resulting product's aroma. The presence of aroma can support a person's assessment of the quality of the food. Arrowroot starch has a neutral natural characteristic, meaning it does not have a distinctive aroma. Therefore, when applying arrowroot starch to pasta *butterflies.* There is no significant difference in the aroma of arrowroot because arrowroot starch does not have a distinctive aroma.

c) Sensory Quality of Pasta Texture Aspects of *Butterflies'* Arrowroot Starch Substitution

Results of sensory quality tests on the texture aspect of pasta *butterflies'* Dry dough with arrowroot starch substitution percentages of 30%, 40%, and 50% showed no significant difference. This finding is in line with the results of research conducted by Farida (2023), which stated that the use of arrowroot starch substitution can produce products with a crispier texture and lower hardness levels. This is due to the absence of gluten content in arrowroot starch, in contrast to wheat flour which contains gluten. Gluten plays an important role in forming the structure of pasta dough because it has elastic and cohesive properties, thus providing a chewy and dense texture. In contrast, arrowroot starch is gluten-free and easily gelatinized, which also supports structure formation and increases the elasticity of pasta products.

d) Sensory Quality of Pasta Taste Aspects of *Butterflies'* Arrowroot Starch Substitution

Results of sensory quality tests on the taste aspect of pasta *butterflies* Cooked rice with arrowroot starch substitution percentages of 30%, 40%, and 50% showed no significant difference. This is in line with research by Sekarjati et al. (2022), which stated that arrowroot starch has the same taste characteristics as wheat flour, so the use of arrowroot starch in making noodles and pasta does not provide significant results on the taste of the final product.

e) Physical Quality of Pasta Water Absorption Capacity Aspect of *Butterflies'* Arrowroot Starch Substitution

The results of the physical quality test on the water absorption aspect were carried out three times. Based on the analysis using the ANOVA test, it was found that arrowroot starch substitution did not have a significant effect on the water absorption of farfalle pasta, either before or after the boiling process. The lowest average value was recorded in the 40% substitution treatment at 118.18, while the highest value was found in the 50% treatment at 180.56. This difference is related to the higher amylose content in arrowroot starch, which is 28.12%, compared to wheat flour at 25%. During the boiling process, water will penetrate into the starch granules (Sekarjati, 2022). Amylose has a higher water absorption capacity than amylopectin, so the higher the amylose content in the dough, the greater the water absorption capacity of the pasta. Conversely, starch with a high amylopectin content tends to produce a stickier texture, absorbs less water, and requires a longer boiling time.

f) Physical Quality Aspect of Water Content Reduction of Pasta *Butterflies'* Arrowroot Starch Substitution

The results of the physical quality test on the aspect of reducing water content with three repetitions. Based on the results of the ANOVA test conducted, it showed that there was no significant effect on reducing water content in pasta *butterflies'* arrowroot starch substitution before and after the drying process. The lowest average score was 8.57 for 40% and the highest was 8.84 for 30%. This is because arrowroot starch has a larger granular structure and does not contain gluten. This causes the water-binding capacity of arrowroot starch to be lower than that of wheat flour, which contains gluten that can form a network and bind water. The gelatinization ability of arrowroot starch can also affect the reduction of water content in pasta. Gelatinization in arrowroot starch can cause more efficient water release during the drying process.

4. The knot

Based on the results of research on the effect of arrowroot starch substitution on the sensory quality and physical quality of pasta butterflies. Sensory quality was analyzed using Kruskal-Wallis test with Tuckey's advanced test, while physical quality was analyzed using Anova test and Duncan's advanced test. This study showed that arrowroot starch substitution with a percentage of 30%, 40%, and 50% affected the sensory quality and physical quality of farfalle pasta. Treatment with 30% substitution produced the best sensory quality, indicated by the highest scores in the aspects of color, aroma, texture, and taste for both dry and cooked pasta. Meanwhile, the results of the physical quality test (water absorption and water content reduction) showed that increasing the percentage of substitution did not have a significant effect. Thus, arrowroot starch substitution of 30% can be recommended as the best formulation in making farfalle pasta, because it is able to produce superior sensory quality without significantly affecting physical quality.

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6. Declarations

Author Contribution :

Riya Anna N. T.	**:** Conceptualization, Writing - Original Draft, Editing and Visualization; Writing - Review & Editing, Formal analysis, and Methodology;
Dr. Ir. Mahdiyah, M.Kes	: Supervision 1
Dr. Rina Febriana, M.Pd	: Supervision 2

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