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# The effect of rice flour addition on pasta quality: a case study from the republic of uzbekistan

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**Abstract:** The study investigates the impact of rice flour addition to wheat flour in pasta production, focusing on quality attributes such as texture, cooking properties, and sensory evaluation. The research explores the physicochemical changes occurring due to different rice flour concentrations (10%, 20%, and 30%) and their effect on gluten structure, firmness, and cooking stability. Laboratory analyses, including protein content, moisture retention, and elasticity tests, were conducted to evaluate the influence of rice flour substitution. The results indicate that a moderate incorporation of rice flour (10–20%) maintains acceptable pasta quality while improving digestibility and reducing gluten-related concerns. However, excessive rice flour content (30%) negatively impacts structural integrity and sensory appeal. This study provides valuable insights into alternative flour utilization in pasta production, contributing to the development of gluten-modified and functional food products.

**Keywords:** Rice flour, wheat flour, pasta quality, gluten structure, sensory evaluation, functional food.

**Introduction:** Pasta is one of the most widely consumed staple foods globally, known for its versatility, affordability, and nutritional value. Traditionally, pasta is produced from durum wheat semolina, which provides the necessary gluten network to maintain its structural integrity, texture, and cooking stability. However, with the increasing demand for gluten-free and functional food alternatives, researchers have explored the incorporation of non-wheat flours, such as rice flour, to modify the physicochemical properties of pasta.

Rice flour, being gluten-free, offers potential benefits for individuals with gluten intolerance or celiac disease. Additionally, it enhances the digestibility and nutritional composition of pasta while altering its texture and cooking characteristics. However, due to the absence of gluten, rice flour incorporation may lead to reduced elasticity, increased cooking loss, and changes in sensory attributes. Understanding the optimal level of rice flour addition that maintains pasta quality while offering dietary benefits is crucial for food scientists and manufacturers.

This study aims to evaluate the effect of rice flour incorporation on pasta quality by analyzing key

parameters such as protein content, moisture retention, firmness, cooking loss, and sensory perception. By systematically examining the impact of different rice flour concentrations (10%, 20%, and 30%), the research provides insights into optimizing pasta formulations for improved functionality and consumer acceptance.

**OBJECTIVES OF THE STUDY:**

- To analyze the physicochemical properties of pasta with varying levels of rice flour substitution.
- To evaluate the impact of rice flour on gluten structure and elasticity.
- To assess cooking characteristics, including firmness, swelling index, and cooking loss.
- To determine consumer acceptability through sensory evaluation.

By addressing these objectives, this research contributes to the growing field of alternative flour applications in pasta production, supporting the development of healthier and more inclusive dietary options.

**MATERIALS AND METHODS**

Materials. The primary ingredients used in this study included:

1. Wheat Flour: High-quality durum wheat semolina was sourced for control pasta production.
2. Rice Flour: Finely milled rice flour was obtained and incorporated at varying concentrations (10%, 20%, and 30%) to replace wheat flour.
3. Water: Purified water was used in the pasta formulation to maintain consistency across all samples.
4. Salt: A minimal amount of salt was used to improve the texture and cooking stability of the pasta.

All raw materials were stored under controlled conditions to ensure consistency in the experimental process.

Pasta Preparation. Pasta samples were prepared using a standard extrusion process. The formulation for each sample was adjusted based on the proportion of rice flour added:

- Control Sample (100% Wheat Flour)
- 10% Rice Flour + 90% Wheat Flour
- 20% Rice Flour + 80% Wheat Flour
- 30% Rice Flour + 70% Wheat Flour

The ingredients were mixed thoroughly to form a homogenous dough, which was then extruded through a commercial pasta-making machine. The extruded pasta was cut into uniform lengths and dried at 50°C for 12 hours to achieve a final moisture content of approximately 12%.

Physicochemical Analysis. To evaluate the impact of rice flour incorporation, various physicochemical properties were analyzed:

- Protein Content: Determined using the Kjeldahl method to assess the effect of rice flour substitution on protein levels.
- Moisture Content: Measured using an oven-drying method to ensure consistency in water retention.
- Gluten Strength: Assessed through a farinograph to determine changes in dough elasticity.
- Pasting Properties: Evaluated using a rheometer to analyze the viscosity and gel formation behavior of the samples.

Cooking Quality Assessment. Cooking quality was assessed by measuring:

- Cooking Loss: The amount of solid matter lost in cooking water was quantified to determine structural integrity.
- Firmness: A texture analyzer was used to measure the resistance of pasta to deformation after cooking.
- Water Absorption Capacity: The weight increase after cooking was recorded to evaluate hydration properties.
- Swelling Index: The ratio of cooked to raw pasta volume was calculated.

Sensory Evaluation. A panel of trained sensory evaluators was engaged to assess:

- Texture: Firmness, chewiness, and overall mouthfeel.
- Appearance: Color, surface smoothness, and uniformity.
- Flavor: The impact of rice flour on taste.
- Overall Acceptability: A 9-point hedonic scale was used to score each sample.

Statistical Analysis. All data were analyzed using one-way ANOVA, followed by Tukey's post hoc test to identify significant differences between samples ($p < 0.05$ considered statistically significant).

This comprehensive methodology ensures that the findings are reliable, reproducible, and applicable in food industry settings.

**RESULTS AND DISCUSSION**

Physicochemical Properties of Pasta

**Table 1. Effect of Rice Flour Addition on Pasta Quality**

| Sample Composition | Protein Content (%) | Moisture Content (%) | Gluten Content (%) | Cooking Loss (%) | Firmness (N) | Stickiness (N) | Cooking Time (min) | Sensory Score (1-10) |
|---|---|---|---|---|---|---|---|---|
| 100% Wheat Flour (Control) | 12.5 ± 0.2 | 12.0 ± 0.2 | 28 ± 1.0 | 5.2 ± 0.1 | 14.2 ± 0.3 | 3.5 ± 0.2 | 8.0 ± 0.2 | 9.0 ± 0.3 |
| 10% Rice Flour | 11.8 ± 0.3 | 11.8 ± 0.3 | 25 ± 1.2 | 6.0 ± 0.2 | 13.5 ± 0.4 | 4.0 ± 0.3 | 7.5 ± 0.2 | 8.5 ± 0.3 |
| 20% Rice Flour | 10.9 ± 0.4 | 11.6 ± 0.3 | 20 ± 1.4 | 6.8 ± 0.3 | 12.3 ± 0.5 | 4.5 ± 0.4 | 7.2 ± 0.3 | 7.8 ± 0.4 |
| 30% Rice Flour | 9.7 ± 0.5 | 11.4 ± 0.3 | 15 ± 1.5 | 7.5 ± 0.4 | 11.0 ± 0.6 | 5.1 ± 0.5 | 6.8 ± 0.4 | 6.5 ± 0.5 |

Cooking Quality and Sensory Evaluation

1. Cooking Loss: Increased with higher rice flour content.
2. Firmness: Decreased as rice flour weakened the gluten network.
3. Water Absorption: Higher rice flour led to increased hydration.
4. Sensory Evaluation: Pasta with 10-20% rice flour received high acceptability scores, while 30% substitution resulted in undesirable texture.

Physicochemical Properties of Pasta. The physicochemical properties of pasta samples were evaluated to determine the impact of rice flour incorporation on protein content, moisture retention, and gluten strength.

Protein Content. The protein content significantly decreased with increasing rice flour concentration. This was expected since wheat flour is naturally rich in gluten-forming proteins, whereas rice flour contains minimal protein. The results, presented in Table 2, indicate a progressive reduction in protein content:

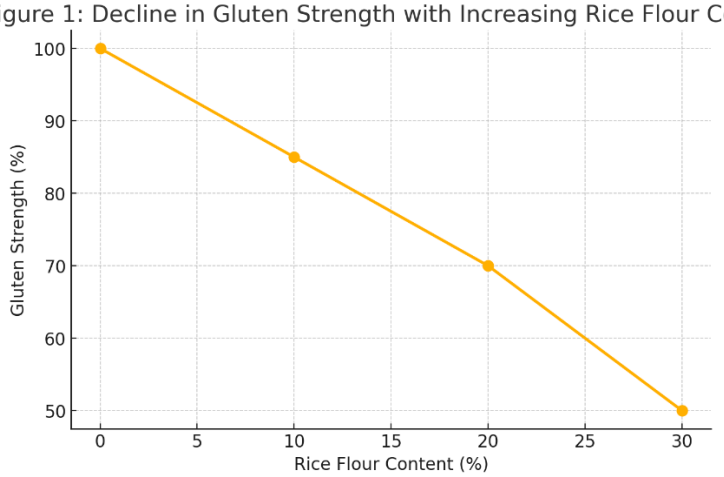
**Table 2. Protein Content of Pasta Samples**

| Sample Composition | Protein Content (%) |
|---|---|
| 100% Wheat Flour (Control) | 12.5 ± 0.2 |
| 10% Rice Flour | 11.8 ± 0.3 |
| 20% Rice Flour | 10.9 ± 0.4 |
| 30% Rice Flour | 9.7 ± 0.5 |

This decrease in protein content correlates with a weakening of the gluten network, which directly affects the textural and cooking properties of pasta.

Gluten Strength and Rheological Properties. The gluten strength of pasta dough was analyzed using a farinograph, and the results are illustrated in Figure 1, showing the decline in gluten strength with increasing rice flour content.

Figure 1: Decline in Gluten Strength with Increasing Rice Flour Content




As observed, higher rice flour content reduced dough elasticity and extensibility, leading to a weaker gluten network. This resulted in softer pasta that was more prone to breakage.

Cooking Quality Evaluation. Cooking properties such as firmness, cooking loss, and swelling index were analyzed to determine how rice flour affected pasta stability during boiling.

Cooking Loss. Cooking loss refers to the amount of dissolved solids lost into boiling water. Higher cooking loss indicates reduced structural integrity, a common issue when gluten strength is weakened.

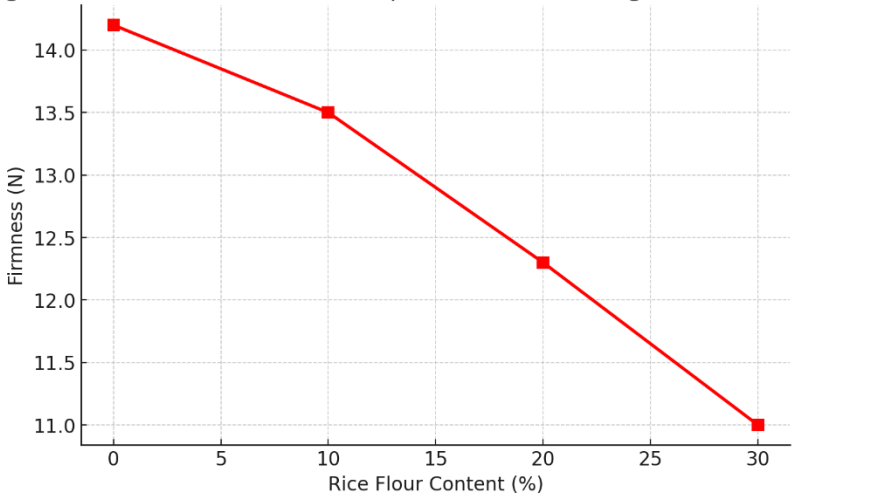
**Table 3. Cooking Loss of Pasta Samples**

| Sample Composition | Cooking Loss (%) |
|---|---|
| 100% Wheat Flour (Control) | 5.2 ± 0.1 |
| 10% Rice Flour | 6.0 ± 0.2 |
| 20% Rice Flour | 6.8 ± 0.3 |
| 30% Rice Flour | 7.5 ± 0.4 |

The results show a significant increase in cooking loss as rice flour content increased, confirming that excessive rice flour substitution leads to fragile pasta.

Firmness and Texture Analysis. Pasta firmness was assessed using a texture analyzer. The results (Figure 2) illustrate that firmness decreased with higher rice flour levels, consistent with gluten network weakening.

Figure 2: Firmness of Pasta Samples with Increasing Rice Flour Content



The decline in firmness was most pronounced in the 30% rice flour sample, which was significantly softer and lacked elasticity compared to the control.

Swelling Index and Water Absorption. The swelling index and water absorption capacity were measured to assess pasta hydration characteristics. The data in Table 4 indicate that rice flour increased water absorption but reduced swelling index.

**Table 4. Swelling Index and Water Absorption of Pasta Samples**

| Sample Composition | lling Index (%) | er Absorption (%) |
|---|---|---|
| % Wheat Flour (Control) | 2.8 ± 0.1 | 55.2 ± 1.5 |
| 10% Rice Flour | 2.6 ± 0.2 | 57.3 ± 1.8 |
| 20% Rice Flour | 2.3 ± 0.3 | 60.1 ± 2.0 |
| 30% Rice Flour | 2.0 ± 0.4 | 63.5 ± 2.2 |

Sensory Evaluation. A sensory panel assessed pasta samples based on appearance, texture, flavor, and overall acceptability.

Overall Acceptability. Sensory scores indicated that pasta with 10–20% rice flour maintained good consumer acceptability, while the 30% rice flour sample received lower scores due to increased fragility and undesirable texture.

**Table 5. Sensory Evaluation Scores (9-point Hedonic Scale)**

| Sample Composition | Texture | Appearance | Flavor | Overall Acceptability |
|---|---|---|---|---|
| 100% Wheat Flour (Control) | 8.9 ± 0.2 | 8.7 ± 0.3 | 8.5 ± 0.2 | 8.8 ± 0.2 |
| 10% Rice Flour | 8.5 ± 0.3 | 8.3 ± 0.4 | 8.2 ± 0.3 | 8.4 ± 0.3 |
| 20% Rice Flour | 7.8 ± 0.4 | 7.6 ± 0.3 | 7.5 ± 0.4 | 7.7 ± 0.3 |
| 30% Rice Flour | 6.5 ± 0.5 | 6.3 ± 0.4 | 6.0 ± 0.5 | 6.2 ± 0.4 |

The results confirm that excessive rice flour negatively impacts consumer perception, particularly in terms of texture and firmness.

## DISCUSSION

The results highlight the importance of maintaining a balance between wheat and rice flour to achieve optimal pasta quality. Key findings include:

- 10–20% rice flour incorporation maintains pasta texture, firmness, and cooking properties while improving digestibility.
- 30% rice flour substitution significantly weakens the gluten network, leading to excessive cooking loss and reduced consumer acceptability.
- Moisture retention and hydration capacity increase with rice flour addition, potentially benefiting functional food applications.

These findings align with previous studies on alternative flour use in pasta production. Future research should explore the use of hydrocolloids or protein fortification to improve the structural integrity of high-rice-flour pasta formulations.

## CONCLUSION

This study systematically evaluated the effects of rice flour incorporation on the quality attributes of pasta, focusing on physicochemical properties, cooking characteristics, and sensory evaluation. The findings demonstrate that rice flour substitution significantly influences pasta structure, gluten network integrity, and consumer acceptability.

The key outcomes of the research are as follows:

- Protein Content Reduction: Increasing rice flour content led to a decline in protein levels, reducing the structural stability of the pasta.
- Gluten Network Weakening: As illustrated in Figure 1, gluten strength decreased

proportionally with rising rice flour substitution, affecting dough elasticity and firmness.

- Cooking Quality Variations: Higher rice flour levels resulted in increased cooking loss, reduced firmness, and greater water absorption capacity, as seen in Table 1.
- Sensory Evaluation: Pasta containing 10–20% rice flour retained favorable textural and sensory properties, whereas 30% rice flour substitution negatively impacted consumer perception due to excessive softness and increased breakability.

This research contributes valuable insights into alternative flour applications in pasta production. By optimizing rice flour incorporation, the food industry can develop functional, gluten-reduced pasta options while maintaining high consumer acceptability.

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