

# SORAME (sorghum and edamame) noodles: an innovative sorghum-based noodle enriched with edamame to enhance the nutritional value of noodles

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**Abstract.** Noodles are a widely favored staple food. In 2023, Indonesia ranked second in global instant noodle consumption with 14.54 billion servings. This high demand highlights the potential of instant noodles but also reflects a heavy reliance on wheat. To reduce this dependency, sorghum could be cultivated as a local alternative, while edamame can enhance protein content. This study investigates the impact of adding sorghum and edamame on the physical and chemical properties of sorghum noodles. This research was conducted using a Completely Randomized Design (CRD) with one factor, namely the ratio of sorghum addition at 6 levels (100% wheat flour without edamame, 100% wheat flour with edamame (4% of total wheat/sorghum flour), and wheat flour:sorghum ratios of 80:20, 60:40, 40:60, & 20:80 with the addition of edamame 4%) with four replications. The parameters tested included physical properties (lightness, redness, yellowness, elongation, and cooking loss) and chemical properties (carbohydrates and protein). The results showed that the addition of sorghum and edamame increased the noodle's carbohydrate and protein content, though they resulted in a darker color. Sorame noodles had lightness 26.90 – 77.36, redness –1.87 – 11.49, yellowness 12.15 – 32.85, elongation 26.67% – 176.17%, cooking loss 1.17% – 1.95%, carbohydrate content 48.81% – 77.81%, and protein content 3.33% – 5.58%.

## 1 Introduction

Noodles are one of the staple foods that are highly favored by the Indonesian population due to their practicality, affordability, and ease of preparation. In 2023, Indonesia ranked second in global instant noodle consumption with 14.54 billion servings, equivalent to 12% of global consumption [1]. This figure indicates a significant potential for instant noodle

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products, especially in Indonesia. However, most instant noodles available in the Indonesian market still use wheat as the primary raw material. This leads to a dependence on imported wheat, which is often affected by price fluctuations and supply stability from producing countries. To reduce this dependency, Indonesia has great potential to develop local food ingredients as alternatives to support the food security efforts currently being implemented by the government. One such programme could involve optimizing the use of sorghum as a noodle ingredient to replace wheat.

Sorghum (*Sorghum bicolor* (L.) Moench) is a food crop that holds great potential for development in Indonesia. Sorghum can be processed into flour as a substitute for wheat flour to support food diversification efforts that can be produced locally. The nutritional content of sorghum includes 70% carbohydrates, 8–12% protein, and 2–6% fat. Sorghum also contains essential minerals such as phosphorus (P), magnesium (Mg), calcium (Ca), iron (Fe), zinc (Zn), copper (Cu), manganese (Mn), molybdenum (Mo), and chromium (Cr) [2]. Sorghum noodles have been developed in Indonesia, but they are still not widely accepted by the public. This is due to the less appealing appearance of sorghum noodles and the lack of product innovation to improve the quality of the resulting noodles. The addition of edamame can be done in sorghum noodle production with the goal of increasing folic acid content, which is beneficial to the body. MyFoodData reports that prepared frozen edamame contains 311 µg of folic acid per 100 grams, which is equivalent to 78% of the daily folic acid requirement for adults [3].

The addition of edamame is expected to improve the physical, chemical, and organoleptic properties of sorghum noodles. Edamame is a promising and popular crop among communities in Jember Regency. According to BPS Jember (Statistics Indonesia) in 2020, edamame production in Jember increased to 12,641 tons [4]. Edamame contains folic acid, manganese, isoflavones, beta-carotene, and sucrose. The isoflavones in edamame consist of 64% genistin, 23% daidzin, and 13% glycitein [5]. The purpose of this research is to examine the effect of edamame addition on the resulting sorghum noodles. Therefore, the researcher aims to explore the development of "Mie Sorame" (Sorghum and Edamame Noodles) as an innovation to enhance the nutritional value of noodles and support national food security. Mie Sorame is expected to be developed as an alternative instant noodle made from local raw materials to replace wheat in Indonesia.

Sorghum is a highly suitable crop for processing into dried noodle products. Previous research has shown that 100% sorghum flour can be used to replace wheat flour in the production of Chinese-style egg noodles [6]. Other studies have found that the addition of soy flour in noodle production is optimal at concentrations below 4% [7]. Another study found that adding fish meat in noodle making can reduce cooking loss in the final product [8]. Adding soybeans to instant noodle production has been shown to increase functional components and improve the physical quality of the noodles produced. However, the resulting noodles require a relatively longer cooking time. This research offers a novel alternative to support Indonesia's food security using local ingredients. This approach is grounded in the government's initiative to optimize the utilization of local food resources in order to enhance national food security.

## **2 Materials and Methods**

### **2.1 Materials**

The main ingredients used in this study include sorghum flour, wheat flour, edamame flour, cornstarch, salt, eggs, and water. The chemicals used for analysis include CaCO<sub>3</sub> (calcium carbonate), lead acetate, sodium oxalate, anthrone, 0.1 N HCl, methyl red, methylene blue,

NaOH (sodium hydroxide), H<sub>2</sub>SO<sub>4</sub> (sulfuric acid), K<sub>2</sub>SO<sub>4</sub> (potassium sulfate), and distilled water.

The equipment used in this study consists of tools for noodle production and chemical analysis. The tools used for noodle production include a mixer, noodle roller, pot, sealer, knife, and containers. Meanwhile, the tools used for analysis include a colorimeter CR-300 (Minolta, Japan), texture profile analyzer, ruler, spectrophotometer, Kjeldahl flask, and other glassware.

## 2.2 Preparation of sorame noodles

The production of Sorame noodles (sorghum and edamame) was carried out with modifications to the formulation by Liu et al. [6]. The raw materials prepared included wheat flour, sorghum flour, edamame flour, cornstarch, salt, eggs, and water. All ingredients were weighed accordingly for the following formulations:

- F0: 100 g wheat flour (without edamame)
- F1: 100 g wheat flour + 4 g edamame flour
- F2: 80 g wheat flour : 20 g sorghum flour + 4 g edamame flour
- F3: 60 g wheat flour : 40 g sorghum flour + 4 g edamame flour
- F4: 40 g wheat flour : 60 g sorghum flour + 4 g edamame flour
- F5: 20 g wheat flour : 80 g sorghum flour + 4 g edamame flour

All weighed dry ingredients were mixed using a standing mixer for 1 minute at speed level 2. Then, water was gradually added, and mixing was continued for another 1 minute. The dough was then folded and rolled using a noodle roller, with a thickness setting of 4 mm. After rolling, the noodles were lightly dusted with flour and stored in an airtight container for further analysis.

## 2.3 Physicochemical characteristics analysis of sorame noodles

Physical and chemical analyses were conducted on the resulting Sorame noodles, including color (L\*, a\*, & b\*), texture (elongation and cooking loss), carbohydrate content, and protein content. Color analysis was performed using a CR-300 colorimeter (Minolta, Japan) to obtain L\* (lightness), a\* (redness), and b\* (yellowness) values [9]. Elongation analysis was carried out by placing a sample of noodles on the tensile strength tool, then the machine was run to pull the noodles until they broke, the value listed on the tool was then calculated in the formula by subtracting 15 (the length of the reading scale limit on the tool), then divided by 3 (the length of the initial sample) and multiplied by 100%<sup>[10]</sup>. Cooking loss analysis was performed by subtracting the dry weight of the noodle sample before boiling from the constant dry weight of the noodle after boiling, then dividing by the dry weight of the sample before boiling and multiplying by 100% [10]. Carbohydrate content was analyzed using the anthrone method. Protein content was analyzed using the Kjeldahl method, with total nitrogen multiplied by 6.25 to estimate total protein [11].

## 2.4 Statistical analysis

Analysis of all parameters of this research was done with four replicates. The data obtained were analyzed by analysis of variance (ANOVA) using Minitab 17 software. Tukey HSD was used at  $\alpha < 0.05$ .

### 3 Result and Discussion

#### 3.1 Physical characteristics of sorame noodles

The ANOVA test results ( $\alpha < 0.05$ ) showed that the addition of sorghum and edamame had a significant effect on the lightness ( $L^*$ ), redness ( $a^*$ ), yellowness ( $b^*$ ), elongation, and cooking loss of the resulting noodles. The results of the physical characterization of Sorame noodles are showed in Table 1.

**Table 1.** Physical characteristics of Sorame Noodles

Formulation	$L^*$	$a^*$	$b^*$	Elongation (%)	Cooking Loss (%)
F0	77,36±2,11 <sup>a</sup>	-1,87±0,91 <sup>d</sup>	12,15±1,33 <sup>d</sup>	176,17±14,63 <sup>a</sup>	1,95±0,28 <sup>a</sup>
F1	54,22±0,73 <sup>b</sup>	5,96±0,83 <sup>c</sup>	19,22±1,49 <sup>c</sup>	94,00±5,57 <sup>b</sup>	1,81±0,16 <sup>a</sup>
F2	37,39±3,60 <sup>c</sup>	8,68±0,49 <sup>b</sup>	20,73±2,30 <sup>bc</sup>	74,00±3,61 <sup>b</sup>	1,69±0,19 <sup>a</sup>
F3	34,38±1,59 <sup>cd</sup>	9,67±0,65 <sup>ab</sup>	21,81±0,45 <sup>bc</sup>	39,33±8,14 <sup>c</sup>	1,70±0,15 <sup>a</sup>
F4	28,91±2,09 <sup>de</sup>	10,97±0,65 <sup>a</sup>	25,31±3,57 <sup>b</sup>	32,67±2,52 <sup>c</sup>	1,47±0,07 <sup>ab</sup>
F5	26,90±3,57 <sup>c</sup>	11,49±0,62 <sup>a</sup>	32,82±1,22 <sup>a</sup>	26,67±5,01 <sup>c</sup>	1,17±0,16 <sup>b</sup>

Notes: Means of 4 repetitions  $\pm$  standard error. The same symbol shows the insignificant difference on Tukey's HSD test  $\alpha=0.05$

The lightness values ( $L^*$ ) of the tested noodles ranged from 26.90 to 77.36. F0, which consisted of 100% wheat flour without the addition of sorghum or edamame, had the highest lightness, indicating the brightest color. In contrast, F5, which had the highest proportion of sorghum along with edamame, showed the lowest lightness value, indicating the darkest color. This result suggests that the addition of sorghum and edamame reduces the lightness of the noodles. Sorghum flour tends to have a darker color compared to the lighter, cleaner white of wheat flour. A higher proportion of sorghum flour darkens the color of dried noodles due to its tannin content (0.21%), unlike wheat flour, which is bright white. Tannins contribute to the darkening of food through protein-tannin interactions and oxidation by phenol oxidase. Additionally, the Maillard reaction during steaming also affects noodle color [10].

The redness values ( $a^*$ ) of the noodles ranged from -1.87 to 11.49. F5, which contained the highest proportion of sorghum and edamame, had the highest redness level. On the other hand, F0, made from 100% wheat flour without edamame, had the lowest redness value. These results indicate that the addition of sorghum and edamame increases the redness of the resulting noodles.

The yellowness values ( $b^*$ ) of the noodles ranged from 12.15 to 32.85. The yellowness values correlated with the lightness and redness values. F5 had the highest yellowness value among all samples, while F0 had the lowest. This is due to the yellow-brown color of sorghum flour being more prominent than the pure white color of wheat flour.

The elongation of noodles ranged from 26.67% to 176.17%. F0 had the highest elongation value, while F5 had the lowest. This indicates that the addition of sorghum and edamame reduces the elongation ability of the resulting noodles. This is highly influenced by the elastic properties of the flour used. Wheat flour has significantly better elongation ability compared to sorghum flour. This also explains why noodles made with 100% sorghum could not be produced in this study, as increasing sorghum content results in noodles that are more brittle and prone to breaking. Elongation value indicates the maximum length change of noodles after being subjected to a tensile force until breaking [12].

The cooking loss of noodles varied, ranging from an average of 1.17% to 1.95%. F0 exhibited the highest cooking loss, while F5 had the lowest among all samples. This result

shows that the addition of sorghum and edamame reduces cooking loss in the resulting noodles. This finding correlates with the elongation ability of the noodles. The gelatinization capability of the flours used in noodle making influences the level of cooking loss observed. This increase can be attributed to the fiber content in sorghum and edamame, which promotes competitive hydration and uneven water distribution within the protein-starch matrix. When this matrix is disrupted, it gradually breaks down during cooking, releasing starch particles during gelatinization, which leads to increased cooking loss [13].

### 3.2 Carbohydrate and protein content of sorame noodles

The ANOVA test results ( $\alpha < 0.05$ ) indicated that the addition of sorghum and edamame had a significant effect on the carbohydrate and protein content of the resulting noodles. The results of the carbohydrate and protein content analysis are showed in Table 2.

**Table 2.** Carbohydrate and protein content of Sorame Noodles

Formulation	Carbohydrate content (%)	Protein content (%)
F0	48,81±2,30 <sup>c</sup>	5,58±0,59 <sup>a</sup>
F1	52,73±1,65 <sup>bc</sup>	4,89±0,35 <sup>ab</sup>
F2	54,00±1,39 <sup>bc</sup>	4,66±0,72 <sup>abc</sup>
F3	55,54±2,43 <sup>b</sup>	4,07±0,52 <sup>bcd</sup>
F4	56,30±3,46 <sup>b</sup>	3,50±0,01 <sup>cd</sup>
F5	77,81±0,71 <sup>a</sup>	3,33±0,18 <sup>d</sup>

Notes: Means of 4 repetitions  $\pm$  standard error. The same symbol shows the insignificant difference on Tukey's HSD test  $\alpha=0.05$

The carbohydrate content of the tested noodles ranged from 48.81% to 77.81%. F5 had the highest carbohydrate content, while F0 had the lowest. This result suggests that the addition of sorghum and edamame increases the carbohydrate content of the noodles. This is consistent with the research by Dwimargiyanti [14], which studied noodles substituted with sorghum flour in place of wheat flour. The study found that the carbohydrate content of noodles made with 100% wheat flour was lower than that of noodles with added sorghum flour. The carbohydrate content of sorghum flour ranges from 75.4% to 79.8%, while that of wheat flour ranges from 75.3% to 77.7% [15].

The protein content of the noodles ranged from 3.33% to 5.58%. F0 produced Sorame noodles with the highest protein content, while F5 had the lowest. These findings indicate that the addition of sorghum and edamame decreases the protein content in the resulting noodles. In general, sorghum protein content is higher compared to corn, rice, and job's tears, but still lower than wheat. Although wheat flour has a higher total protein content than sorghum flour, sorghum contains certain amino acids, such as leucine and tryptophan, in higher amounts than wheat [16]. Some amino acids found in sorghum at higher levels than in wheat include alanine (0.82–0.85%), aspartic acid (0.63–0.69%), serine (0.33–0.38%), and leucine (1.31–1.39%). Certain amino acids in sorghum are also higher compared to other cereal crops like rice and corn, including aspartic acid, threonine, alanine, proline, valine, methionine, leucine, isoleucine, and lysine. Based on this, the development of food products from different protein sources will increase the variety and levels of amino acids contained [17]. Meanwhile, edamame contains high levels of protein, vitamins, minerals, dietary fiber, and isoflavones [18, 19]. The proteins of soybean products characterized much quantity of lysine, tryptophane, isoleucine, valine and threonine however sulphuric amino acids are less than in protein of rape products [20].

## 4 Conclusion

Adding sorghum and edamame significantly affected the noodles' physical properties, including colour ( $L^*$ ,  $a^*$ ,  $b^*$ ), elongation and cooking loss. It also impacted the carbohydrate and protein content significantly. Using sorghum and edamame as substitutes for wheat flour decreased the lightness and elongation ability of the noodles, as well as their cooking loss and protein content. However, it increased redness and yellowness, as well as carbohydrate content. Sorame noodles showed the following ranges based on the analysis: lightness ( $L^*$ ) 26.90–77.36, redness ( $a^*$ ) –1.87–11.49, yellowness ( $b^*$ ) 12.15–32.85, elongation 26.67–176.17%, cooking loss 1.17–1.95%, carbohydrate content 48.81–77.81%, and protein content 3.33–5.58%.

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