Product development of gluten-free dried noodle from composite flour of germinated organic brown rice, Vigna radiata, Sago and tapioca flour

Mutiara Nugraheni1,a , Windarwati2,b and Sri Palupi1,c

1Culinary art Education, Universitas Negeri Yogyakarta, Indoneisaeplace this text with an author’s affiliation
(use complete addresses, including country name or code).

 2Medical Faculty, Universitas Gadjah Mada, Indonesia

a) Corresponding author: mutiara\_nugraheni@uny.ac.id

b)windarwati@gmail.com

c)sripalupi@uny.ac.id

**Abstract.** The purpose of this study is to determine the chemical composition, color, and acceptance of gluten-free dried brown rice noodles among panelists. Water, ash, protein, fat, carbs, soluble dietary fiber, and insoluble dietary fiber were all tested for chemical composition. A tristimulus photoelectric colorimeter was used to assess color. The acceptance of panelists was assessed. Color, scent, taste, texture, and overall were evaluated by 50 untrained panelists on a scale of 1-9 for many sensory qualities. Gluten-free dried brown rice noodles had higher protein, fiber, and resistant starch content than commercial white rice noodles, according to the findings (control). The color test revealed that the higher the proportion of brown rice, the lower the brightness level. The brown rice noodle formulation I, received the best response from the panelists based on sensory analysis. Brown rice noodles outperform commercial white rice noodles (control) in terms of protein content (6.59±0.16) and fiber (6.17±0.01). 6.72±0.03 for starch resistance and 0.17±0.02 for low fat. Based on the findings of this study, gluten-free brown rice noodles may be an alternative functional carbohydrate source.

**Keywords:** noodle, germinated, mentik, rice

# INTRODUCTION

Organic pigmented rice (organic brown rice) is one of Indonesia's local potentials with bioactive compounds, fiber, and antioxidant properties. The disadvantage is that it contains phytic acid, which reduces the bioavailability of certain minerals [1]. As a result, the germinating process is required to reduce the level of phytic acid. Green beans have the advantage of being high in amylose, protein, fiber, and bioactive compounds. The disadvantages are anti-nutritional compounds and the off-flavor. The germination process can help to mitigate this weakness.

The presence of celiac disease, gluten allergy, non-celiac sensitivity, and the advancement of science and food consumption trends that eliminate allergenic proteins contribute to the growing demand for non-gluten products with functional properties for the body. Opportunities for functional food development should consider their popularity as well as their impact on health. The development of noodles as a functional food is based on the popularity of everyone, and noodle consumption in Indonesia is ranked second in the world.

Consuming functional and healthy foods raises awareness of their ability to prevent disease. The precision of the formulation of gluten-free organic brown rice noodles as a functional food can result in products rich in dietary fiber, resistant starch, and protein. This is a method for lowering the risk of degenerative diseases / comorbid covid-19 [2], [3]. The strategy for meeting the gluten-free rice noodles set specifications is to modify its constituent ingredients, specifically germination (organic brown rice and Mung bean/Vigna radiata).

The germination process on rice, for example, organic milk, can lower phytic acid levels, increase bioactive compounds [4], [5], increase antioxidant activity [6], anti-diabetic [7], anti-hypercholesterolemia [8], reduce the risk of cancer [9], and boost immunity [10]. The goal of developing gluten-free organic brown rice noodles is to create rice noodles appealing to consumers and have fiber and resistant starch benefits.

## MATERIALS AND METHODS

## The germinated of mung bean and mentik rice organik

## The germination process of Mung bean/Vigna radiata and brown rice takes 36 hours. Mung bean/Vigna radiata seeds and milk-stick rice were washed and soaked for 12 hours at room temperature. Excess water was removed, and the seeds of Mung bean/Vigna radiata and rice stick milk were planted in their place. Cover with a cloth and place in a dark place. Flowing water keeps Mung bean/Vigna radiata and brown rice moist every 12 hours. The germination process was terminated after 36 hours [11], [12]. Mung bean/Vigna radiata and brown rice sprouts are dried for 24 hours in drier cabinets at 50oC. Tyler's sieve mesh 80 is then used to grind and sift the process.

## Formulation of gluten-free brown rice organic noodle

## The formulations of gluten-free dried brown rice noodles were germinated organic brown rice flour (55%, 60%, 65%), tapioca flour (25, 22.50, 20%, ), Sago starch (15, 12.50,10%), germinated Vigna radiata flour (5%). The first process of making rice noodles was the process of gelatinization of tapioca flour. The ratio of tapioca flour and water is 3:2 (b/v). Tapioca flour is added water then heated to form a transparent gel. The composite flour (organic brown rice flour, sago starch and germinated Vigna radiata flour) was steamed for 30 min, and the mixed with the tapioca flour gel, until dough is formed. The formed dough is passed on the roller noodle maker so that it is in the form of a sheet. The sheet is cut to a certain shape and size, then steamed for 50 minutes until all parts of the noodles are gelatinized. The noodles obtained are winded, then dried with a drier cabinet 6 hours. Noodles are packed in plastic until further analysis.

## Chemical composition analysis

## The chemical composition analysis included the moisture content, ash content, fat, protein, and dietary fiber and was carried out by AOAC guidelines, difference determined the carbohydrate content. The method of resistant starch analysis was used. [13].

## Colors Analysis

## Color analysis used a tristimulus photoelectric colorimeter "Minolta" Chroma meter CR 400, with light source D, standard viewer 65º and light beam diameter of 8 mm. The result expressed as CIE Lab color L\*a\*b\*. L stands for brightness, which changes from black (L\*\*=0) to white (L=100). a\*\*parameters are blue for negative, yellow for positive (variable in the range –60 b ≤ 60) and green if negative and red if positive (varying in the range –60 ≤ a\* ≤60). Results are expressed as the mean of psychrometer light, L\*, psychrometer tone, a\*, and psychrometer chroma, b\*.

## Sensory evaluation

## Gluten-free dried brown rice noodles were sensory evaluated by 50 untrained panelis. The dried noodles were soaked in boiled water for 20 minutes, then served to the panelists to be sensory evaluated e.g., color, aroma, taste, texture and overall reception. Each panelist prepared mineral water to neutralize the mouth before evaluating each sample. All evaluations are carried out at room temperature. The hedonic scale on a scale of 9 is used to determine the sensory response of panels at a significance level of 5% (p≤0.05).

## Statistical analysis

## The data obtained is displayed as the average value and standard deviation. The samples were triplicate. The statistical analysis was conducted with ANOVA and continued with at least least significant difference test at p < 0.05. The SPSS version 16.0 (SPSS Inc., South Wacker Drive, Chicago, United States of America) was used. (Use the Microsoft Word template style: *Heading 2*) or (Use Times New Roman Font: 12 pt, Bold, Centered)

## RESULTS AND DISCUSSIONSFormulation and chemical analysis of brown rice noodles

Several constituent ingredients are combined to make gluten-free organic brown rice noodles. The main ingredient was rice noodles. Organic brown rice through a germination process modification. This germination process has a positive effect, as it reduces the content of phytic acid while increasing the content of bioactive compounds [14]. Phytic acid affects the bioavailability of some minerals [1]. Another constituent material is required because native rice flour has poor elastic gel-forming properties, shear force resistance, thickening power, and viscosity properties. Tapioca flour is another component used in rice noodles' production as an adhesive for the other constituent ingredients. Hydrocolloids are required to improve the texture of rice noodles. [15]. Table 1 shows the composition of gluten-free organic brown rice noodles developed in formulations I, II, and III, and commercial white rice noodles (control).

Table 1. Chemical composition of gluten-free organic brown rice noodles and commercial white rice noodles (control)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | White noodle Commercial | Formulation I | Formulation II | Formulation III |
| Moisture content (%) | 13.11±0.10c | 14.74±1.23d | 12.14±0.05a | 12.22±0.14b |
| Ash (%) | 0.45±0.08a | 1.41±0.05c | 1.41±0.08c | 0.93±0.05b |
| Protein (%) | 6.23±0.12a | 6.59±0.16b | 8.13±0.11c | 8.41±0.07d |
| Lipid (%) | 0.42±0.01d | 0.17±0.02b | 0.19±0.04c | 0.12±0.01a |
| Carbohydrate (%) | 75.65±0.03c | 71.98±0.39a | 73.21±0.13b | 74.97±1.67b |
| Resistant starch (%) | 6.07±0.03a | 6.72±0.03b | 6.93±0.02d | 6.80±0.01c |
| Non-soluble dietary fiber (%) | 6.28±0.02a | 10.56±0.36d | 9.59±0.22b | 10.15±0.07c |
| Soluble dietary fiber (%)) | 0.06±0.02a | 0.70±0.01b | 0.69±0.01b | 0.82±0.08c |

Different letters within the raw indicate significant differences at P<0.05.

According to chemical complicity analysis, gluten-free organic brown rice noodles formulations I, II, and III contain macronutrients (carbohydrate, fat, protein). Gluten-free organic brown rice noodles outperform commercial white rice noodles in protein, fiber, resistant starch, low carbohydrate, and low fat (p<0.05). The water content of commercial white rice noodles and organic brown rice noodles is 12.80±0.57 and 14.74±1.23 grams. This moisture content is within the acceptable range for a long-lasting product.

Gluten-free organic brown rice noodles contain protein, dietary fiber, and dietary fiber, all of which have the functional potential to manage glucose and lipid profiles. Dietary fiber and resistant starch cannot be digested in the colon, but they can be fermented by microflora. Slow gastrointestinal processes can delay blood glucose rises, control the glycemic response, and lower the risk of colon cancer.

It contains more fiber than commercial white rice noodles made from rice sprout flour and Mung bean/Vigna radiata. Food can be used as a source of dietary fiber if it contains at least 3% fiber [16]. According to the findings of this study, the fiber content of rice noodles reduces milk by 7%. As a result, brown rice noodles can be considered a source of fiber. Foods high in dietary fiber can reduce glycemic response and influence the low glycemic index [17].

Gluten-free brown rice noodles formulations, i.e., I, II, and III have lower carbohydrate content than commercial white rice noodles (p<0.05). Based on chemical composition analysis, carbohydrates have the highest percentage when compared to other chemical compositions. Carbohydrates are one of the components that contribute to the body's dominant energy availability. Gluten-free organic brown rice noodles can be used as an alternative carbohydrate source based on the carbohydrate content.

**Color Analysis**

Food color is a characteristic that can provide the first impression of a product before the panelists provide another sensory response. The color of food may influence consumer/panelist acceptance of a product [18]. Compared to commercial white rice noodles, the formulation of gluten-free organic brown rice noodles affects the amount of warn amie produced. The composition of brown rice sprout flour, mung bean/Vigna radiata and tapioca flour varies between rice noodles organic formulations I, II, and III. Table 3 shows how increasing the amount of rice flour in milk affects brightness.

Table 3. Color comparison of commercial rice and different formulation gluten-free organic brown rice noodles

|  |  |  |  |
| --- | --- | --- | --- |
|  | L | a | b |
| White rice noodle (control) | 72.56±1.16d | 0.49±0.06a | 11.41±1.18a |
| Formulation I | 43.25±0.09b | 3.42±0.18b | 17.80±0.05c |
| Formulation II | 44.23±2.14c | 3.86±0.45c | 19.37±1.05d |
| Formulation III | 32.02±0.19a | 7.89±0.22d | 13.17±1.18b |

Different letters within the column indicate significant differences at P<0.05.

According to the findings of this study, rice noodles injected with formulas I, II, and III have lower L\* values than commercial white rice noodles (p<0.05). This means that the brightness of brown rice noodles (43.25±0.09) is lower than that of commercial white rice noodles (72.56±1.16). Gluten-free brown rice formulation III has the lowest brightness level compared to the other two gluten-free brown rice noodles formulations. This is due to the high proportion of tapioca flour in the composition of its constituents.

According to the number, a, commercial white rice noodles have the least intensity of red color compared to gluten-free brown rice noodles (p<0.05). Similarly, number b indicates that commercial white rice noodles have the least yellow color than the three gluten-free organic brown rice noodles formulations. Compared to the other two formulations, gluten-free organic brown rice noodle formulation III has the least yellow color.

**Sensory evaluation**

The physical, color, shape, and texture of a food product strongly influence its acceptance. The physical appearance of food is the first thing consumers evaluate when purchasing a product [19]. Table 3 shows that gluten-free organic brown rice noodles received a favorable response from the panelists. However, commercial white noodles continue to have the highest acceptance rate compared to milk-injected rice noodles in formulations I, II, or III.

Table 4. Sensory evaluation of three formulations of gluten-free noodle rice

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Color | Aroma | Taste | Textur | Overall |
| Formulation I | 5.98±0.68c | 6.38±0.53c | 5.98±0.68c | 6.12±0.72c | 6.44±0.54b |
| Formulation II | 5.14±0.61b | 5.52±0.58b | 5.14±0.61b | 5.16±0.71b | 5.10±0.74a |
| Formulation III | 3.82±0.72a | 3.74±0.66a | 4.20±0.92a | 4.00±0.76a | 5.10±0.68a |
| Kontrol | 7.30±0.74d | 7.24±0.62d | 7.3±0.74d | 7.38±0.85d | 7.58±0.50c |
|  |  |  |  |  |  |

Different letters within the column indicate significant differences at P<0.05.

The color of brown rice, which is typically light brown, influences rice noodles' color. One of the constituent ingredients is germinated Mung bean/ Vigna radiata flour, which is thought to affect the taste and aroma of gluten-free brown rice noodles produced. Compared to formulations II and III, the gluten-free brown rice noodles with the lowest proportion (formulation I) have a chewy texture. This is because tapioca flour is one of the constituent ingredients. Tapioca flour and sago were used in the production of noodles as a binder for other ingredients.

According to sensory evaluation, gluten-free organic brown rice noodles formulation I has the highest sensory response compared to formulations II and III, indicating that it can be developed as one of the carbohydrate food sources.

**CONCLUSION**

Gluten-free organic brown rice noodles formulation I was a rice noodle with the best sensory response and is the most popular of the formulations II and III. The benefits of this May include its high protein, dietary fiber, low fat, and carbohydrate content. Gluten-free organic brown rice noodles are expected to be developed into functional foods for diabetes, lipid disorders, or indigestion.

**ACKNOWLEDGMENT**

The authors would like to thank the Directorate General of Higher Education of the Republic of Indonesia and Yogyakarta State University, which funded this research with contract number….

**CONFLICT OF INTEREST**

The authors do not have any conflict of interest.

# References

1. V. Kumar, A. K. Sinha, H. P. S. Makkar, and K. Becker, Food Chem., vol. 120, no. 4, pp. 945–959, 2010.

2. P. Daliu, A. Santini, and E. Novellino, Expert Rev. Clin. Pharmacol., vol. 12, no. 1, pp. 1–7, 2019.

3. A. Santini and E. Novellino, Multidisciplinary Digital Publishing Institute, 2017.

4. D.-H. Cho and S.-T. Lim, Food Chem., vol. 196, pp. 259–271, 2016.

5. F. Cornejo, P. J. Caceres, C. Martínez-Villaluenga, C. M. Rosell, and J. Frias, Food Chem., vol. 173, pp. 298–304, 2015.

6. Y.-T. Lin, C.-C. Pao, S.-T. Wu, and C.-Y. Chang, Biomed Res. Int., vol. 2015, 2015.

7. M. U. Imam, N. H. Azmi, M. I. Bhanger, N. Ismail, and M. Ismail, Evidence-based Complement. Altern. Med., vol. 2012, 2012.

8. F. B. Matias, Q, Wen，L. Wen, R. Li, D Tu，S. He，Z. Wang，H. Huang and J. Wu, J., J. Microbiol. Biotechnol. Food Sci., vol. 2019, pp. 295–298, 2019.

9. C.-H. Oh and S.-H. Oh, J. Med. Food, vol. 7, no. 1, pp. 19–23, 2004.

10. F. Wu, H. Chen, N. Yang, X. Duan, Z. Jin, and X. Xu, Cereal Chem., vol. 90, no. 6, pp. 601–607, 2013.

11. X. Guo, T. Li, K. Tang, and R. H. Liu, J. Agric. Food Chem., vol. 60, no. 44, pp. 11050–11055, 2012.

12. H.-M. Lee, J.-S. Im, J.-D. Park, J.-S. Kum, H.-Y. Lee, and Y.-T. Lee, Korean J. Food Sci. Technol., vol. 45, no. 3, pp. 333–338, 2013.

13. H. N. Englyst, S. M. Kingman, and J. H. Cummings, Eur. J. Clin. Nutr., vol. 46, p. S33, 1992.

14. O. N. Donkor, L. Stojanovska, P. Ginn, J. Ashton, and T. Vasiljevic, Food Chem., vol. 135, no. 3, pp. 950–959, 2012.

15. Y. K. Low, M. E. Effarizah, and L. H. Cheng, Food Rev. Int., vol. 36, no. 8, pp. 781–794, 2020.

16. M. Foschia, D. Peressini, A. Sensidoni, and C. S. Brennan, J. Cereal Sci., vol. 58, no. 2, pp. 216–227, 2013.

17. K. Foster-Powell, S. H. A. Holt, and J. C. Brand-Miller, Am. J. Clin. Nutr., vol. 76, no. 1, pp. 5–56, 2002.

18. S. Westland and M. J. Shin, JAIC-Journal Int. Colour Assoc., vol. 14, 2015.

19. S. Grujić, B. Odžaković, and M. Ciganović, in Proceedings of II International Congress Food Technology Quality and Safety, 2014, pp. 28–30.