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Organoleptic Characteristics and Nutritional Content of Wet Noodles Substituted with Banggai Yam and Moringa Flour

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ABSTRACT

Wet noodles are a boiled noodle product with a moisture content of approximately 35%. Wet noodles are rich in carbohydrates, several minerals, and energy, but their protein, fat, and vitamin contents are relatively low; their nutritional value can therefore be improved by incorporating Banggai yam and moringa leaves. This study aimed to produce Banggai yam and moringa leaf flour, develop wet noodle formulations, evaluate their organoleptic characteristics, and analyze the nutritional composition of the selected formulation. An experimental study using a completely randomized design was conducted from February to October 2020 at the Culinary and Organoleptic Laboratories, Nutrition Study Program, Widya Nusantara School of Health Sciences, Palu, while proximate and dietary fiber analyses were performed at Saraswanti Indo Genetech (SIG), Bogor, West Java. The Banggai yam flour produced was white and resembled wheat flour. Three formulations were prepared using different ratios of Banggai yam flour, moringa leaf flour, and wheat flour: 45%:15%:40% (F1), 50%:10%:40% (F2), and 55%:5%:40% (F3). Based on a hedonic test with 30 semi-trained panelists, formulation F2 was selected as the most preferred. The selected formulation contained 103.30 kcal energy, 4.30% protein, 1.14% fat, 18.96% carbohydrate, 0.39% ash, 25.21% moisture, and 3.86% dietary fiber, meeting the wet noodle quality requirements of the Indonesian National Standard (SNI 01-2987-1992).

INTRODUCTION

Wet noodles are a type of noodle product that undergoes a boiling process and have a moisture content of approximately 35%[1]. Noodles are widely consumed by people of all age groups in Indonesia, including children, adolescents, and adults, and are eaten either as a breakfast food or as a snack. Their basic ingredients generally consist of wheat flour, eggs, water, and a few additional components, so noodles mainly supply carbohydrates, protein, and minerals. Although they have relatively high carbohydrate, mineral, and energy contents, their protein, fat, and vitamin contents are comparatively low. The nutritional value of noodles can therefore be improved by incorporating vegetables and other local ingredients such as spinach, carrots, water spinach, katuk leaves, legumes (soybean and mung bean), corn, purple sweet potato, and fish, which can simultaneously enhance the color of the product[2].

Banggai yam (*Dioscorea* sp.) is a local tuber crop of Central Sulawesi that can be processed into flour and various food products, including noodles, and represents an important source of carbohydrates[3]. Its relatively high starch content makes it a promising substitute for wheat flour in noodle production. Banggai yam is further characterized by a high amylose content, which strongly influences gel formation, elasticity, and the retrogradation behavior of the resulting product[4]. To improve the macronutrient and micronutrient profile of noodles, moringa (*Moringa oleifera*) leaf flour can be added. Drying moringa leaves and processing them into powder concentrates their nutrients; the vitamin A content of moringa leaf powder is reported to be about ten times that of carrots, and its iron content about twenty-five times that of spinach[5]. Moringa leaves are also rich in protein, dietary fiber, minerals such as calcium, iron, and potassium, vitamins, and antioxidant bioactive compounds[6]. The incorporation of moringa leaf flour has been shown to improve the proximate and mineral composition of noodles[7], although sensory acceptability tends to decline as the level of moringa increases, so a maximum addition of about 5% is generally recommended[8].

Despite this potential, information on combining Banggai yam flour and moringa leaf flour in a single wet noodle product remains limited, and the balance between nutritional enrichment and sensory acceptability has not been well established. The specific objectives of this study were to: (1) produce Banggai yam (*Dioscorea* sp.) flour and moringa (*Moringa oleifera*) leaf flour; (2) develop wet noodle formulations based on these flours; (3) evaluate the organoleptic characteristics of the formulations; and (4) analyze the nutritional composition of the selected formulation.

MATERIALS AND METHODS

Study Design, Location, Materials, and Equipment

This study employed an experimental design using a completely randomized design (CRD) and was conducted from February to October 2020. The preparation of Banggai yam (*Dioscorea* sp.) flour and moringa (*Moringa oleifera*) leaf flour and the formulation of the wet noodles were carried out at the Culinary Laboratory, whereas the organoleptic evaluation was performed at the Organoleptic Laboratory, both within the Nutrition Study Program, Widya Nusantara School of Health Sciences, Palu. Proximate composition and dietary fiber analyses were conducted at Saraswanti Indo Genetech (SIG), Bogor, West Java.

The main raw materials were Banggai yam (*Dioscorea* sp.) obtained from Banggai Islands Regency, Central Sulawesi Province, and moringa leaves obtained from Tondo Village, Mantikulore District, Palu City. Additional ingredients for the wet noodles included Cakra Kembar wheat flour, eggs, garlic powder, salt, coconut oil, and water. The equipment used for flour production comprised an 80-mesh sieve, an oven, a knife, a blender, a cutting board, and baking trays; wet noodle preparation used a noodle-making machine (roll press), a digital scale, baking trays, a spoon, and a cooking pot; and the organoleptic evaluation used sample containers, tissues, pens, and hedonic evaluation forms.

Preparation of Banggai Yam Flour

The Banggai yam variety used was Butun, which has a cylindrical tuber, a pointed basal end, white inner skin, and white flesh. The flour preparation procedure was modified from Sovyani et al.[9] and Rahardjo et al.[3] Selected tubers were peeled, washed to remove dirt and microorganisms, and thinly sliced to accelerate drying. The slices were soaked in a 15% NaCl solution for 60 minutes to remove mucilage and then washed thoroughly with clean water. The washed slices were dried in an oven at 100 °C for 30 minutes, ground with a blender, and sieved (80 mesh) to obtain Banggai yam flour. The flour was stored in an airtight container protected from heat, moisture, and light. During preparation, particular attention was given to repeated washing to minimize residual mucilage, which can affect flour color.

Preparation of Moringa Leaf Flour

Moringa leaf flour was prepared following Muliyati and Hutagaol[10] and Kustiani et al.[11] Freshly harvested leaves were washed immediately to prevent heat build-up and quality loss, then drained on a rack. The leaves were separated from the stems by manual stripping, and yellow, spotted, immature, or damaged leaves were discarded. The clean leaves were dried in a layer no thicker than 2 cm and turned every three hours to ensure uniform drying; good-quality dried leaves remain green and free of stems. The dried leaves were ground into a fine powder and sieved to obtain moringa leaf flour, which was stored under airtight, light-protected, low-humidity conditions.

Wet Noodle Formulation

The wet noodles were prepared from Banggai yam flour, moringa leaf flour, and wheat flour. The incorporation of these local flours was intended both to support programs promoting the utilization of local food resources and to improve the nutritional content of the noodles[12,13]. The three formulations used ratios of Banggai yam flour, moringa leaf flour, and wheat flour of 45%:15%:40% (F1), 50%:10%:40% (F2), and 55%:5%:40% (F3), as detailed in Table 1. The preparation procedure was adapted from Setiyoko et al.[12] Ingredients were weighed and mixed into a homogeneous dough, which was rested and then compacted with the noodle-making machine at a 3-mm roller gap; two dough sheets were combined and passed through a 5-mm gap to form a single sheet. The roller gap was gradually reduced to a thickness of 1.5 mm, after which the sheet was cut into strands. The raw noodles were boiled for 3 minutes, rinsed under running water for 10 seconds, drained, and coated with 2% oil to prevent sticking.

Table 1. Wet noodle formulations

No	Ingredient	F1	F2	F3
1	Banggai yam flour (g)	22.5	25.0	27.5
2	Moringa leaf flour (g)	7.5	5.0	2.5

3	Wheat flour (g)	20.0	20.0	20.0
4	Egg (g)	15.0	15.0	15.0
5	Garlic powder (g)	1.25	1.25	1.25
6	Salt (g)	1.25	1.25	1.25
7	Water (mL)	25.0	25.0	25.0

Note: F1, F2, and F3 correspond to Banggai yam flour: moringa leaf flour: wheat flour ratios of 45%:15%:40%, 50%:10%:40%, and 55%:5%:40%, respectively.

Organoleptic Evaluation and Nutritional Analysis

The organoleptic evaluation involved 30 semi-trained panelists using a hedonic (preference) test. Panelists rated aftertaste, texture, aroma, color, elasticity, and stickiness on a five-point scale (1 = strongly dislike, 2 = dislike, 3 = slightly like, 4 = like, 5 = strongly like). The selected formulation was determined from the mean acceptance scores across all attributes. The nutritional composition of the selected formulation was then analyzed for proximate composition (energy, protein, fat, carbohydrate, moisture, and ash) and dietary fiber. Mean hedonic scores were tabulated per attribute to identify the most preferred formulation.

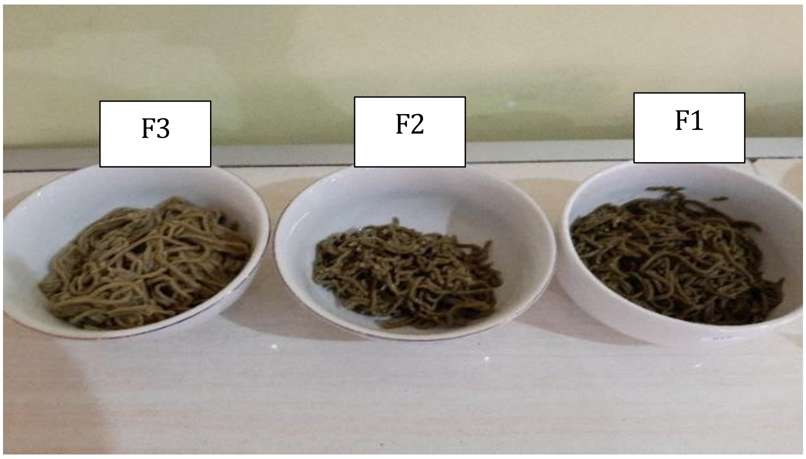
RESULTS

Characteristics of Banggai Yam Flour and Moringa Leaf Flour

The Banggai yam flour produced in this study was white and closely resembled wheat flour, which can be attributed to the naturally white flesh of the Butun variety used; a similar observation was reported by Rahardjo et al.[3] The moringa leaf flour obtained was a fine, green powder. Both flours were stored in airtight, light-protected containers to preserve their quality prior to noodle preparation.

Organoleptic Evaluation of the Wet Noodle Formulations

A hedonic test was performed on the three formulations (F1, F2, and F3). The wet noodles substituted with Banggai yam flour and moringa leaf flour are shown in Figure 1, and the most preferred formulation for each sensory attribute, together with its mean hedonic score, is summarized in Table 2.



Note: (F1) = Banggai yam flour 45% : moringa leaf flour 15% : wheat flour 40%; (F2) = Banggai yam flour 50% : moringa leaf flour 10% : wheat flour 40%; (F3) = Banggai yam flour 55% : moringa leaf flour 5% : wheat flour 40%.

Figure 1. Wet noodle formulations substituted with banggai yam flour and moringa leaf flour

Table 2. Most preferred formulation and mean hedonic score for each sensory attribute

Sensory attribute	Most preferred formulation	Mean hedonic score	Category
Aftertaste	F3	3.20	Like
Texture	F2	3.00	Like
Aroma	F3	3.07	Like
Color	F2	3.30	Like
Elasticity	F2	3.00	Like
Stickiness	F2	3.00	Like

Note: Scores are means from 30 semi-trained panelists on a five-point hedonic scale (1 = strongly dislike to 5 = strongly like).

For aftertaste and aroma, the highest mean preference scores were obtained by F3 (3.20 and 3.07, respectively), which contained the lowest proportion of moringa leaf flour. For texture, color, elasticity, and stickiness, F2 obtained the highest scores (3.00, 3.30, 3.00, and 3.00, respectively). When all attributes were considered together, F2 (50% Banggai yam flour : 10% moringa leaf flour : 40% wheat flour) was the most preferred overall formulation and was therefore selected for nutritional analysis.

Nutritional Composition of the Selected Formulation

The nutritional composition of the selected formulation (F2) is presented in Table 3.

Table 3. Nutritional composition of the selected wet noodle formulation

Nutritional content	Selected formulation (F2)
Energy (kcal/100 g)	103.30
Protein (%)	4.30
Fat (%)	1.14
Carbohydrate (%)	18.96
Ash (%)	0.39
Moisture (%)	25.21
Dietary fiber (%)	3.86

DISCUSSION

Organoleptic Characteristics

Moringa leaf flour has a characteristic bitter taste and a distinctive grassy odor[14], and these attributes tend to lower sensory scores as its concentration increases. This explains why F3, with the lowest moringa content, was most preferred for aftertaste and aroma. Comparable results have been reported by Alemayehu et al.[15], Sirichokworrakit[16], and Vittal and Bhuvaneshwari[17], who found that adding moringa leaf flour at levels up to about 5% produced organoleptic characteristics not markedly different from the control, whereas higher levels progressively reduced acceptability[18]. Accordingly, limiting moringa leaf flour to a maximum of about 5% helps maintain acceptable sensory quality.

Aroma contributes substantially to palatability, as the odor released by a food is closely linked to the sense of smell and to overall acceptability; the addition of ingredients such as leaf or tuber flours can impart a distinctive noodle aroma[19]. Color is likewise an important quality cue, because it is one of the first attributes perceived and forms the consumer's initial impression; an unattractive color can reduce acceptability even when taste and texture are satisfactory[20]. The greener appearance of formulations with more moringa leaf flour is consistent with the lower color-preference scores observed at higher moringa levels.

Texture, elasticity, and stickiness are strongly governed by starch composition. Starch with a high amylose content forms stronger hydrogen bonds because of its greater proportion of linear chains, so more energy is required for gelatinization and a firmer, chewier, more elastic gel is produced[21]. Higher amylose content also increases susceptibility to retrogradation[22], a process driven mainly by the reassociation of amylose molecules during cooling[23]. Because Banggai yam is rich in amylose, formulations with a higher proportion of Banggai yam flour tended to be firmer and less sticky; the amylose in the raw materials reduces surface stickiness[24], while changes in starch granules during processing can further modify the stickiness of the finished noodles[1]. The balanced texture, elasticity, and stickiness of F2 reflect an intermediate amylose contribution combined with the structure-forming role of wheat gluten.

Nutritional Composition

The moisture content of the selected formulation was 25.21%, within the 20–35% (w/w) range required for wet noodles by SNI 01-2987-1992[27]. The relatively high moisture content is consistent with the protein content of the product, because proteins act as binding agents that raise its water-holding capacity[25]. The ash content of 0.39% was well below the maximum of 3% (w/w) permitted by the standard, and the protein content of 4.30% exceeded the minimum of 3% (w/w), so both parameters met the SNI requirements[27]. Protein content tends to rise as the proportion of protein-contributing flours in the blend increases[25].

The fat content of the selected formulation was 1.14%. Because moringa leaf flour is considerably higher in fat than wheat flour, formulations containing more moringa leaf flour would be expected to have a higher fat content. The carbohydrate content was 18.96% and was influenced by the moisture, ash, fat, and protein contents; SNI 01-2987-1992 does not specify a carbohydrate requirement. This value is supported by the high carbohydrate and starch content of Banggai yam, which is also rich in amylose[4]. Finally, the dietary fiber content of 3.86% reflects the contribution of moringa leaf flour; enrichment of noodle and pasta products with leaf-derived fiber improves their nutritional value but can also modify texture and sensory properties, reinforcing the need to balance fiber enrichment with acceptability[26].

CONCLUSION

The Banggai yam flour produced in this study was white and closely resembled wheat flour. Three wet noodle formulations were prepared using Banggai yam flour, moringa leaf flour, and wheat flour at ratios of 45%:15%:40% (F1), 50%:10%:40% (F2), and 55%:5%:40% (F3). Based on the hedonic evaluation, F2 was selected as the most preferred formulation. Its nutritional composition—103.30 kcal energy, 4.30% protein, 1.14% fat, 18.96% carbohydrate, 0.39% ash, 25.21% moisture, and 3.86% dietary fiber—met the wet noodle quality requirements of the Indonesian National Standard (SNI 01-2987-1992). Limiting moringa leaf flour to about 5% is recommended to maintain sensory acceptability while enhancing nutritional value.

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