Asian Journal of Applied Research for Community Development and Empowerment. Vol 7 (2023), No.3

AJARCDE
ASIAN JOURNAL OF APPLIED RESEARCH FOR COMMUNITY DEVELOPMENT AND EMPOWERMENT

Journal home page: http://ajarcde-safe-network.org ISSN 2581-0405

Chemical Characteristics of Gluten-Free Noodle Made from Mocaf and Porang Flour

Rosa Andiani[1], Dedin Finatsiyatull Rosida[1] and Muhammad Alfid Kurnianto[1]

[1] *Food Science and Technology Department, Faculty of Engineering. Universitas Pembangunan Nasional "Veteran" Jawa Timur. Surabaya. Indonesia*

ARTICLE INFO

Article History:
Received: 29 September 2023
Final Revision: 15 November 2023
Accepted: 15 November 2023
Online Publication: 18 November 2023

KEYWORDS

Gluten-free Noodle, Modified Cassava Flour, Porang Flour

CORRESPONDING AUTHOR

*E-mail: *dedintp@upnjatim.ac.id*

A B S T R A C T

The development of gluten-free noodles has become an option for those with gluten intolerance or aiming to reduce their gluten intake. Mocaf (Modified Cassava Flour), rich in starch and porang flour with glucomannan content, can be used as the base ingredient for making gluten-free noodles. This research aims to determine the optimal proportions of gluten-free noodles based on mocaf and porang flour. This research used a completely randomized design (CRD) with 1 factor, namely the proportion of mocaf flour and porang flour in 3 levels (60:40, 50:50, and 40:60). Observation data were analyzed using Analysis of variance (ANOVA) and Tukey's further test at the 5% level. The results showed that the lowest water content of the noodles was found in treatment 60: 40 mocaf and porang flour, with a moisture content of 7.52%. The highest starch content was found in the treatment of 60: 40 mocaf and porang flour with a starch content of 44.04%. The highest crude fibre content was found in the 40: 60 mocaf and porang flour treatment with 6.52% crude fibre content.

1. INTRODUCTION

1.1. *Research Background*

Noodles are one of the foods consumed as a source of carbohydrates for people in Asia, including Indonesia. Many people choose noodles because they are practical and quick to serve, both as additional food and as a substitute for staple food [1]. Based on data from the World Instant Noodle Association (WINA) in 2022 [2], the level of noodle consumption in Indonesia in 2021 reached 12.37 billion servings or ranked second after China, which consumed around 43.99 billion servings in the same year. Along with the development of public tastes regarding more varied and healthy food choices, the development of non-gluten noodles can be an option for individuals who are intolerant to gluten or want to reduce gluten consumption in their diet.

The development of non-gluten noodles is driven by the abundance of natural resources in Indonesia, including nutrient-rich food crops as an alternative carbohydrate source, such as mocaf (Modified Cassava Flour). The use of mocaf has a disadvantage as it can cause the texture of the noodles produced to be sticky because it has a high amylopectin content [3]. Therefore, to produce noodles with better characteristics, adding other additives, such as porang flour is necessary. Porang flour is known to have glucomannan content with a level of 64.98%, fibre content of 2.5%, and low fat with a level of 0.02% [4]. The glucomannan content in porang flour can bind water and form a stable gel in hot conditions [5].

Based on the description above, research on developing non-gluten noodles from mocaf flour and porang flour with flour proportion treatment was conducted to find a combination of proportions of mocaf flour and porang flour that provides the best chemical characteristics of non-gluten noodles.

1.2. *Literature Review*

Non-gluten noodles are noodles made from ingredients that do not contain gluten. The main ingredients for non-gluten noodles can be flour and/or starch [6]. The starch gelatinization process influences the formation of non-gluten noodles to produce a firm noodle structure [7]. Mixing various flours with different characteristics aims to achieve noodle texture with good rheology (stickiness, hardness, and elasticity) [8]. The amylopectin content affects the product's characteristics due to the gel-forming ability

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of starch through its gelatinization process and the formation of strong adhesive power, which has the potential for elasticity [9].

Mocaf or modified cassava flour is defined as flour that undergoes changes in molecular structure that can be done by several methods, either physically, chemically, or enzymatically [10]. The fermentation process in the making of mocaf flour resulted in changes in its properties, such as an increase in viscosity, gelling ability, rehydration power, and solubility, resulting in a better texture compared to tapioca flour or cassava flour [11]. A high starch content in the ingredients will result in a better quality of gluten-free noodles in manufacturing [12]. Mocaf has a high starch content of up to 80%. In addition to starch, mocaf has a moisture content of 7.53%, ash content of 0.59%, protein content of 1.20%, starch content of 63.13% and crude fiber content of 2.38% [13, 14, 15]. The use of mocaf has a drawback, as it can lead to a sticky texture in the resulting noodles [2]. Therefore, adding other flour, such as porang flour, is necessary.

Porang (Amorphophallus oncophyllus) is one of the tuber plant species [16]. Porang flour has a water content of 12.32% [17], ash content of 3.9% [17], protein content of 3.42% [18], starch content of 63.30% [19], crude fiber content of 5.02% [20], and glucomannan content of 64.98% [21]. Glucomannan is one type of hydrocolloid that can form a colloid, thicken, or form a gel [22]. The interaction between starch and hydrocolloid can enhance texture, slow down starch retrogradation, improve moisture retention, and contribute to the quality of starchy foods [23]. Macromolecules interacting in the starch and hydrocolloid system can result in a three-dimensional network matrix with relatively high elasticity, compactness, and resilience [24]. The effect of the addition of porang flour on the aroma of the noodles produced is like wet noodles sold on the market, but there is a rather chewy characteristic; this is due to the content of glucomannan, which functions as a gelling agent and absorbs water and is irreversible [25]

Porang consumption is known to have health benefits, such as lowering glucose levels [26]. Glucomannan, as a natural thickener during food processing, is also important because its natural fibre can accelerate fullness, making people less hungry [27]. The previous research showed that adding 15% porang flour can produce non-gluten noodles with physical, chemical, and organoleptic parameters most favoured by panellists [28]. The substitution of wheat flour with porang flour by 32% produced noodles that tended to be favoured by panellists [29].

1.3. Research Objective

This study aims to determine the optimal combination of gluten-free noodles from mocaf and porang flour with the best chemical characteristics.

2. MATERIALS AND METHODS

2.1. Materials and Tools

The raw materials used in this study were modified cassava flour and porang flour. Additional ingredients include water, salt, and eggs obtained from the Soponyono market in Surabaya.

The equipment used in noodle making includes an analytical scale, cabinet dryer, 100 mesh sieve, steamer, and noodle maker (Oxone OX356). The tools used for analysis are Memmert® Oven U055, hot plate (Thermo), UV-visible spectrophotometer (Milton Roy 21D), condenser, Kjeldahl flask, measuring glass, beaker glass, volumetric pipette, Erlenmeyer and desiccator.

2.2. Research Design

This research was designed by Completely Randomized Design (CRD) with one factor, which is the proportion of mocaf and porang flour. Research data was statistically tested using Analysis of Variance (ANOVA) with a confidence level of $\alpha = 0.05$. If there is a significant difference between treatments, further analysis will be conducted using Tukey's test with Minitab version 19. The factor consisted of three levels that are:

A1B1 : Mocaf 60% (w/w) : Porang Flour 40% (w/w)
A2B2 : Mocaf 50% (w/w) : Porang Flour 50% (w/w)
A3B3 : Mocaf 40% (w/w) : Porang Flour 60% (w/w)

2.3. Research Procedure

Mocaf flour and porang flour are prepared according to three proportions (70:30), (60:40), and (50:50). Both flours are mixed with additional ingredients: water, egg white, and salt. The mixture is compacted in a container and steamed for 5 minutes at 100°C for pre-gelatinization. The mixture is cooled to room temperature, stirred, and shaped using a noodle maker. The noodles dried in a cabinet dryer at 60°C for 2 hours.

2.4. Analytical methods

Observations were made on the dry noodles by measuring protein, starch, and crude fibre content.

2.4.1. Water Content

An empty aluminium cup that has been cleaned is dried in an oven at ±105ºC for one hour, then cooled in a desiccator for 15 minutes and weighed. Two grams of sample was put into the cup and then baked in the oven at 105 ºC for one hour. The sample is then cooled in a desiccator and weighed. Drying was repeated until it reached a constant weight [30]. The formula calculates water content:

$$\%\ \text{water content} = ((W1+W2)-W3)/\ W2 \times 100\%$$

Information:
W1 = weight of empty aluminum cup (g)
W2 = sample weight (g)
W3 = weight of the cup and sample after drying (g)

2.4.2. Starch Content

A sample of 1 gram was dissolved with 100 ml of distilled water in a beaker cup. The resulting suspension was filtered with filter paper and washed with distilled water until the filtrate volume was 250 ml. The suspension was filtered again with filter paper. The residue in the filter paper was transferred into an Erlenmeyer by washing with 200 ml of distilled water and adding 20 ml of 25% HCl. The Erlenmeyer was covered with a cooler and simmered in a water bath for 2.5 hours. Then, the Erlenmeyer was cooled at room temperature. The samples in the Erlenmeyer were neutralized with 1 N NaOH and diluted to a volume of 250 ml. Determined the sugar content expressed as glucose from the filtrate obtained using the Nelson Somogyi method [30]. Filtrate was obtained using the Nelson Somogyi method.

$$\%\ \text{starch content} = 0.9 \times \text{glucose weight}$$

2.4.3. Crude Fiber Content

A sample of 1 gram was put in Erlenmayer. H2SO4 was added and heated in a water bath at 100ºC for 30 minutes while stirring. Then filtered using filter paper then washed with hot water until neutral. Next, the residue was transferred quantitatively into an Erlenmayer; the rest was washed with NaOH solution. After that, it was heated in a water bath at 100ºC for 30 minutes while stirring. Then filtered using a constant filter paper that already knows its weight. Next, the residue was washed using 96% ethanol as much as 15 ml, and washed using K2SO4 solution, as much as 15 ml. Then washed using hot water until neutral. Residue in filter paper, then in the oven at 100ºC until constant weight and weighed [31].

3. RESULT AND DISCUSSION

3.1. Water Content

Table 1 shows that the average moisture content in gluten-free noodles ranged from 7.52% to 7.98%. The highest water content value is found in the treatment of the proportion of mocaf and porang flour (40:60). In contrast, the lowest water content value is shown by the treatment of the proportion of mocaf and porang flour (60:40). Based on a statistical analysis of variance (ANOVA), each proportion treatment showed a significant effect on the water content of the non-gluten noodles ($p \leq 0,05$).

Table 1. Water Content Average

Proportions (w/w)	Water (%)
60 : 40	7.52 ± 0.01^a
50 : 50	7.86 ± 0.07^b
40 : 60	7.98 ± 0.07^c

Note: Numbers followed by the same letter in the same column show insignificant differences based on the 5% Tukey test

The research results indicate that the higher the addition of porang flour, the greater the moisture content in the noodles. This happens because porang flour contains glucomannan, a soluble fibre that can bind water, thus raising the moisture content of the noodles. As more porang flour is added, its ability to bind water increases, leading to higher moisture levels in the noodles. This aligns with [32], stating that glucomannan in porang flour can absorb water up to 200 times its weight. The high glucomannan content in the noodles can bind water, so adding porang flour tends to produce higher water content [33]. The water-binding capacity is also affected by its crude fibre content. Crude fibre has a high water-binding ability, and the more water bound to crude fibre, the higher the moisture content because water bound to crude fibre is more difficult to evaporate [34].

Table 1 shows that adding mocaf causes a decrease in noodle water content. This aligns with research results, which state that the lower the protein, amylose, and fibre content accumulation in flour, the less water is bound to the noodles so the water content decreases [35]. In addition to that, drying at 60ºC for 2 hours still resulted in high moisture content. Therefore, it is suspected that a longer drying at a higher temperature can reduce the moisture content. Moisture content is one of the important quality parameters of dried noodles quality parameter, which will affect the shelf life. Dry noodles with moisture content that exceeds the standard will have a shorter shelf life [36]. The higher temperature will lower the levels of water.

3.2. Starch Content

Table 2 shows that the average value of starch content in non-gluten noodles is 38.09% - 44.04%; the highest starch content value is found in the treatment of the proportion of mocaf and porang flour (60:40), while the lowest starch content value is shown by the treatment of the proportion of mocaf and porang flour (40:60). Based on a statistical analysis of variance (ANOVA), each proportion treatment showed a significant effect on the starch content of non-gluten noodles produced ($p \leq 0,05$)

Table 2. Starch Content Average

Proportions (w/w)	Starch (%)
60 : 40	44.04 ± 0.07^a
50 : 50	42.08 ± 0.04^b
40 : 60	38.09 ± 0.01^c

Note: Numbers followed by the same letter in the same column show insignificant differences based on the 5% Tukey test

The results showed that the more the addition of mocaf flour and the less the addition of porang flour, the starch content of the noodles will increase. This is because mocaf contains higher starch content than porang flour. The protein content of mocaf flour in the research was 63.13% [15], it was higher than the starch content in porang flour, which was 7,55% [17]. The high starch content in mocaf is due to the fermentation process of growing microbes that produce pectinolytic enzymes and cellulolytic enzymes, which can break down the cassava cell wall, resulting in the liberation of the starch granules [37]. A high starch content in the ingredients will result in a better quality of gluten-free noodles in manufacturing [12]. The higher starch content in food ingredients will accelerate the process of starch gelatinization and water absorption [38].

3.3. Crude Fiber Content

Table 3 shows that the average value of crude fiber content of noodles in the treatment of the proportion of mocaf flour and porang flour ranges from (4.60% - 6.51%) was shown in table. The highest crude fibre content of noodles is found in the treatment of the proportion of mocaf flour and porang flour (40: 60), which is 6.51%, while the lowest crude fibre content is found in the treatment of the proportion of mocaf flour and porang flour (60: 40) which is 4.60%. Based on statistical analysis of variance (ANOVA), it shows that each proportion treatment has a significant effect on the crude fibre content of the non-gluten noodles produced ($p \leq 0,05$)

Table 3. Crude Fiber Content

Proportions (w/w)	Crude Fiber (%)
60 : 40	4.62 ± 0.03^a
50 : 50	5.08 ± 0.04^b
40 : 60	6.52 ± 0.01^c

Note: Numbers followed by the same letter in the same column show insignificant differences based on the 5% Tukey test

The results showed that the higher the proportion of porang flour, the higher the crude fibre content in the noodles. This is because porang flour has a higher crude fibre content (2.38%) [15] than mocaf flour (5.02%) [20]. This stated that the amount of crude fibre content in a product depends on the crude fibre

 https://doi.org/10.29165/ajarcde.v7i3.346

content in the formulation of the ingredients used. The increase in fibre content is possibly caused by glucomannan content in porang flour, a water-soluble fibre with cellulose-like bonds but a smaller molecular weight [39]. Research showed that noodles with substitutions of porang flour and mocaf flour had a crude fibre content of 4.58% [40]. The crude fibre in food is generally lower than dietary fibre because sulfuric acid and sodium hydroxide can hydrolyse food components more than digestive enzymes.

4. CONCLUSION

The results showed that the lowest water content of the noodles was found in treatment 60: 40 mocaf and porang flour, with a moisture content of 7.52%. The highest starch content was found in the treatment of 60: 40 mocaf and porang flour, with a starch content of 44.04%. The highest crude fibre content was found in the 40: 60 mocaf and porang flour treatment with 6.52% crude fibre content. Further research is needed to determine non-gluten noodles' physical and organoleptic characteristics based on mocaf and porang flour.

ACKNOWLEDGMENT

The authors sincerely thank all the lecturers and other parties at Universitas Pembangunan Nasional "Veteran" Jawa Timur who have helped and been involved in this research process.

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