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Nutritional Content of *Dry Noodles* Made from Mocaf Flour and Porang Flour and the Addition of *Seaweed* Extract

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A B S T R A C T

Dry noodles are fresh noodles that are dried until the water content reaches 8-10% by either drying them under sunlight or in an oven. This study utilised mocaf flour and porang flour, along with the addition of seaweed. The use of mocaf flour as a substitute for wheat flour and porang flour to increase elasticity. The addition of seaweed is an alternative as a thickener for noodle base ingredients. The purpose of this study was to determine the effect of the treatment of the proportion of mocaf flour and porang flour and the addition of seaweed extract on physicochemical characteristics. This study aims to determine the characteristics of water content, ash content, protein content, fat content, and carbohydrate content of dry noodles with varying proportions of mocaf flour and porang flour (60:40, 50:50, 40:60) and seaweed extracts (Sargassum sp., Eucheuma cottoni, and Ulva lactuca sp.). The research design employed was a two-factor Completely Randomised Design (CRD) with two replications, and the data were analysed using ANOVA and DMRT at a 5% significance level. The results of the analysis showed that the best treatment was in the proportion of mocaf flour and porang flour (50:50) and the addition of seaweed extract of Ulva lactuca sp. with a water content of 7.80%, ash content of 1.43%, protein content of 7.37%, fat content of 2.24%, carbohydrate content of 81.20%.

Contribution to Sustainable Development Goals (SDGs):
SDG 2: Zero hunger
SDG 12: Responsible Consumption and Production
SDG 8: Decent Work and Economic Growth
SDG 14: Life Below Water

1. INTRODUCTION

1.1. *Research Background*

Noodles are a food product high in carbohydrates, making them popular among Indonesians. According to data from the World Instant Noodle Association (WINA) in 2022 [1], noodle consumption in Indonesia reached 12.37 billion servings in 2021, ranking second only to China, which consumed around 43.99 billion servings in the same year. Dry noodles are a type of noodle that is able to compete in the market. Dry noodles are fresh noodles that have been dried to a water content of 8-10% by either sun-drying or oven-drying [2].

The high increase in consumption and demand for noodles can result in a significant increase in wheat imports, the main raw material used in the manufacture of wheat flour. Wheat flour is an important raw material in making noodle dough. Based on the Central Statistics Agency for Wheat and Meslin Imports [3] (BPS, 2024), the volume of Indonesian wheat and meslin imports in 2023 increased to approximately 10.58 thousand tons, with a total value of US$3.66 billion, up from the previous year. The demand for wheat in Indonesia has increased, making it necessary to utilise local food sources that can reduce the reliance on wheat imports in Indonesia. One local food source that can be used as a substitute for wheat flour is mocaf flour.

Mocaf flour (Modified Cassava Flour) is a flour made from cassava that has been modified through a fermentation process [4]. Mocaf flour can provide a chewy texture to noodles. According to Ref. [5], food products added with mocaf flour produce a chewier texture. However, using too much mocaf flour can cause the resulting noodle texture to become sticky because mocaf flour has a high amylopectin content [6]. Therefore, it is necessary to add additional ingredients such as porang flour.

Porang flour is derived from the porang tuber plant (Amorphophallus muelleri), renowned for its high glucomannan content. Glucomannan is a water-soluble polysaccharide with a very high water absorption capacity, forming a gel and imparting a chewy texture to foods. The glucomannan content in porang flour enables it to bind and absorb water effectively, making it a useful stabiliser in product manufacturing [7].

In noodle making, the use of a thickening agent is very important to obtain a chewy and elastic texture [8]. One of the natural thickening agents often used is seaweed. Seaweed is known for producing carrageenan, which serves as a gelling agent in food. Seaweed in Indonesia comes in various types, including Sargassum sp., Eucheuma cottoni sp., and Ulva lactuca sp. Processing noodles using Sargassum sp. and Ulva lactuca seaweed is not yet widely used, compared to Eucheuma cottoni seaweed, which is already commonly used as an additional noodle ingredient.

1.2. Literature Review

Dried noodles are fresh noodles that have been steamed and then dried, resulting in a water content of 8-10% [9]. Dried noodles are processed using the oven drying method, where raw noodles are dried in the sun or in an oven at a temperature of approximately 50°C, resulting in a longer shelf life due to their lower water content. In general, the manufacture of dry noodles consists of several stages, namely mixing and stirring, forming sheets, cutting, steaming, drying, and cooling [10].

Modified Cassava Flour or known as mocaf is a flour product from cassava that is processed using the principle of modifying cassava cells through fermentation, where the microbe LAB (Lactic Acid Bacteria) dominates during the fermentation of cassava flour [11]. Mocaf flour does not contain gluten. Mocaf flour has characteristics of viscosity (adhesion), gelation ability, rehydration power, and ease of dissolution that are better than wheat flour [12].

Porang flour contains glucomannan, which functions as a chewing agent, texture former, and food thickener [13]. Glucomannan is a type of hydrocolloid that can form colloids, can thicken or form gels [14]. The high levels of glucomannan in noodles can bind water, which tends to produce a higher water content when porang flour is added [13].

Starch is formed from two glucan polymers, namely amylose and amylopectin. Amylose content plays a crucial role in the gelatinisation and retrogradation processes because it has the ability to form hydrogen bonds and undergo retrogradation. During the drying process, materials with higher amylose content will release water more easily from the material, resulting in a decrease in water content [14]. Both amylose and amylopectin fractions affect the gelatinisation process in starch, the main component of noodle making. In noodle making, gelatinisation occurs during the steaming stage of the noodle-making process. Starch gelatinisation is a gel formation event that begins with the absorption of water molecules by starch molecules. If a suspension of starch granules in water is heated to a temperature of 60-70°C, the starch granules will gradually swell [15].

Seaweed is a type of macroalgae traded internationally, including green algae (Chlorophyta), brown algae (Phaeophyta), and red algae (Rhodophyta). Sargassum sp. is a tropical and subtropical brown seaweed. Carrageenan can be extracted with hot water, which can form a gel. Therefore, the proportion of mocaf flour and porang flour, with the addition of seaweed extract, is expected to form a chewy noodle texture and achieve the desired quality.

1.2.1. Research Objective

This study aims to determine the proportion of mocaf flour and porang flour that affects the physical characteristics of dry noodles made from mocaf flour and porang flour, as well as to identify the optimal proportion to achieve the desired product quality.

2. MATERIALS AND METHODS

2.1. Materials

2.1.1. Raw Material

The main raw materials include mocaf flour (Mocafine), porang flour (Natural Rasa), *seaweed (Sargassum sp.), Eucheuma cotton (Eucheuma cotton isp.), and Ulva lactuca (Ulva Lactuca sp.), obtained from online stores. Salt, water, and egg white ar*e obtained from grocery stores.

2.1.2. Analytical Material

Samples of dried noodles, distilled water, HCl solution (Merck), NaOH (Merck), H_2SO_4 (Merck), boric acid solution (H3BO3) (Merck), 2-2-Diphenyl-1-picrythrazine (DPPH) solution (Himedia), K_2SO_4 solution (Merck), Methanol PA (Smart Lab), and alcohol.

2.2. Methods

2.2.1. Experimental Design

This study employed an experimental method with a completely randomised design (CRD) consisting of two factors. The first factor was the proportion of mocaf flour and porang flour (60:40, 50:50, 40:60) and the second factor was seaweed extract (Sargassum sp., Echeuma cottoni sp., and Ulva lactuca sp.). Each treatment combination was repeated twice, resulting in 18 experimental units. The data obtained were analyzed using Analysis of Variance (ANOVA). If significant differences were found between treatments, a further Duncan's Multiple Range Test (DMRT) was performed at a 95% confidence level ($\alpha = 0.05$).

2.2.2. Seaweed porridge

The procedure for making seaweed powder involves several steps modified from the method by Syarifuddin et al. [16]. Three types of seaweed are first soaked for 12 hours, then washed and cleaned. Next, the three types of seaweed are cut and ground.

2.2.3. Dry Noodle Production

The procedure for making dry noodles is carried out in several stages modified from the method [17] Canti et al. (2020). Mocaf flour and porang flour are first mixed with a porridge of three types of seaweed, 2% salt, 50 ml of water, and 30% egg white. Next, the dough is kneaded for 15 minutes. The dough is formed into sheets and molded. After that, the moulded noodle dough is then steamed at a temperature of 100 °C for 15 minutes. The steamed noodles are then dried in a cabinet dryer at a temperature of 60°C for 3 hours. The dried noodles are then cooled. The final dry noodle product is then analyzed based on predetermined parameters..

3. RESULT AND DISCUSSION

3.1 Moisture Content of Dry Noodles

The average water content of various treatments is presented in Table 1. Based on these data, the moisture content of dry noodles ranges from 6.65% to 7.86%. The lowest water content was obtained from the proportion of mocaf flour and porang flour (60:40) with the addition of Sargassum sp *seaweed* extract, while the highest moisture content was produced by the proportion of mocaf flour and porang flour (40:60) with the addition of Ulva lactuca sp *seaweed* extract.

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Table 1. Moisture content of *Dry Noodles*

Mocaf flour and Porang flour	Types of *seaweed* (%)	Moisture content (% ± SD)
60 : 40	*Sargassum* sp.	6,65 ± 0,01[a]
	Eucheuma Cottoni sp.	7,39 ± 0,01[d]
	Ulva Lactuca sp.	7,75 ± 0,01[f]
50 : 50	*Sargassum* sp.	6,71 ± 0,02[b]
	Eucheuma Cottoni sp.	7,43 ± 0,01[e]
	Ulva Lactuca sp.	7,80 ± 0,01[g]
40 : 60	*Sargassum* sp.	6,79 ± 0,01[c]
	Eucheuma Cottoni sp.	7,46 ± 0,01[e]
	Ulva Lactuca sp.	7,86 ± 0,01[h]

Different superscript letters indicate significant differences ($p \leq 0.05$).

All treatments in this study produced water content within the recommended range. Based on [19] SNI 01-2974-1996 for dry noodle products, the maximum allowable water content is 8%. Meanwhile, high-quality dry noodle products have a water content between 6.65% and 7.86%. Thus, the water content of the dry noodles produced in this study can be categorized as good and in accordance with quality standards.

The increase in water content in dry noodles is due to the relatively high water content in mocaf flour compared to porang flour. Glucomannan is a water-soluble fibre that binds water in noodles, thereby increasing the water content of the noodles. This is in accordance with the statement that porang flour has high solubility, easily absorbs water, and acts as a thickener, allowing it to be applied in noodle-making to provide elasticity. The high levels of glucomannan in noodles can bind water, which tends to produce a higher water content when porang flour is added [13]. The addition of porang flour will affect the water content; the more porang flour added, the higher the water content in the dry noodles will be.

The addition of seaweed extract also affects the water content of dry noodles. and sucrose causes an increase in the water content in the final product. The type of hydrocolloid in seaweed can also affect the water content of dry noodles because it can absorb and bind water strongly. This is in accordance with the statement from [18], which states that the fibre contained in seaweed is insoluble, allowing it to bind water and trap it in the matrix after gel formation.

3.2 Ash content of Dry Noodles

The average ash content of various treatments is presented in Table 2. Based on these data, the ash content of dry noodles ranges from 1.33% to 1.56%. The lowest ash content was obtained from the proportion of mocaf flour and porang flour (40:60) with the addition *of Sargassum sp seaweed* extract, while the highest ash content was produced by the proportion of mocaf flour and porang flour (60:40) with the addition *of Eucheuma cottoni sp seaweed* extract.

All treatments in this study produced ash content within the recommended range. Based on [19] SNI 01-2974-1996 for dry noodle products, the maximum permissible water content is 3%. Meanwhile, high-quality dry noodle products have a water content between 1.33% and 1.56%. Thus, the ash content of the dry noodles produced in this study can be categorized as good and in accordance with quality standards.

The increase in ash content in dry noodles is due to the presence of mocaf flour, which has an ash content of 0.33%, and porang flour, which has an ash content of 4.69%. This is in accordance with the literature, as stated by Pangestu and Darmawan [20], who reported that the ash content of mocaf flour is 0.4%. According to [21], porang flour has an ash content of 3.0%.

Table 2. Ash content of *Dry Noodles*

Mocaf flour and Porang flour	*Types of Seaweed* (%)	*Ash content* (% ± SD)
60 : 40	*Sargassum* sp.	1.46 ± 0.02[d]
	Eucheuma Cottoni sp.	1.33 ± 0.02[a]
	Ulva Lactuca sp.	1.41 ± 0.02[c]
50 : 50	*Sargassum* sp.	1.50 ± 0.01[e]
	Eucheuma Cottoni sp.	1.38 ± 0.02[b]
	Ulva Lactuca sp.	1.43 ± 0.02[c]
40 : 60	*Sargassum* sp.	1.56 ± 0.01[f]
	Eucheuma Cottoni sp.	1,46 ± 0,01[d]
	Ulva Lactuca sp.	1,47 ± 0,02[d]

Different superscript letters indicate significant differences ($p \leq 0.05$).

The addition of seaweed extract to dry noodles will affect the ash content of dry noodles. This is because seaweed contains several minerals that can increase the ash content of dry noodle products. According to [22] Astriani et al. (2024), Sargassum sp. seaweed contains minerals such as sodium, magnesium, calcium, potassium, iron, and phosphorus. Eucheuma cottoni sp. seaweed contains minerals such as potassium, calcium, sodium, iron, and iodine [23] (Somala, 2022). Meanwhile, the seaweed Ulva lactuca has minerals, including potassium, calcium, magnesium, and iron [24]. According to [14], seaweed is rich in minerals, resulting in a high ash content.

3.3 Protein content of Dry Noodles

The average ash content of various treatments is presented in Table 3. Based on these data, the protein content of dry noodles ranges from 6.56% to 7.40%. The lowest protein content was obtained from the proportion of mocaf flour and porang flour (40:60) with the addition of *seaweed* extract of *Eucheuma cottoni sp.* Meanwhile, the highest protein content was produced by the proportion of mocaf flour and porang flour (60:40) with the addition of *seaweed* extract of Ulva lactuca sp..

Table 3. Protein Content of *Dry Noodles*

Mocaf flour and Porang flour	*Types of Seaweed* (%)	*Protein content* (% ± SD)
60 : 40	*Sargassum* sp.	6.85 ± 0.01[f]
	Eucheuma Cottoni sp.	6.66 ± 0.01[c]
	Ulva Lactuca sp.	7.40 ± 0.01[i]
50 : 50	*Sargassum* sp.	6.79 ± 0.01[e]
	Eucheuma Cottoni sp.	6.61 ± 0.01[b]
	Ulva Lactuca sp.	7.37 ± 0.01[h]
40 : 60	*Sargassum* sp.	6.74 ± 0.01[d]
	Eucheuma Cottoni sp.	6.56 ± 0.01[a]
	Ulva Lactuca sp.	7.34 ± 0.01[g]

Different superscript letters indicate significant differences ($p \leq 0.05$).

All treatments in this study produced protein levels that were still below the requirements of SNI 01-2974-1996. Based on [19] SNI 01-2974-1996 for dry noodle products, the minimum protein content allowed is 8%. Meanwhile, high-quality dry noodle products have a protein content between 6.65% and 7.40%. Thus, the protein content of the dry noodles produced in this study can be categorised as good, but it does not yet meet quality standards.

The decrease in protein content in dry noodles is due to the relatively high protein content of mocaf flour, at 2.91%, compared to porang flour, which has a protein content of 0.97%. According to [25] mocaf flour has a protein content of 2.17%.

The addition of seaweed extracts to dry noodles will affect the protein content of dry noodles. This is because Sargassum sp. seaweed has a protein content of 11.17%, Eucheuma cottoni sp. seaweed extract has a protein content of 10.25%, and Ulva lactuca sp. seaweed extract has a protein content of 20.28%. The addition of Ulva lactuca sp. seaweed extract increases the protein content. Protein is a primary source of nutrition, namely as a source of essential amino acids. Besides being a source of nutrition, protein also provides functional properties as a thickener, emulsifier, and gelling agent [26].

3.4 Fat content of Dry Noodles

The average ash content of various treatments is presented in Table 4. Based on these data, the fat content of dry noodles ranged from 1.39% to 2.42%. The lowest fat content was obtained from the proportion of mocaf flour and porang flour (60:40) with the addition of Sargassum sp. seaweed extract. Meanwhile, the highest fat content was produced by the proportion of mocaf flour and porang flour (40:60) with the addition of Eucheuma cotton sp. seaweed extract.

Table 4. Fat content of *Dry Noodles*

Mocaf flour and Porang flour	**Types of *Seaweed* (%)**	**Fat content (% ± SD)**
60 : 40	*Sargassum* sp.	1.39 ± 0.01^{a}
	Eucheuma Cottoni sp.	2.38 ± 0.01^{g}
	Ulva Lactuca sp.	2.22 ± 0.01^{d}
50 : 50	*Sargassum* sp.	1.42 ± 0.01^{b}
	Eucheuma Cottoni sp.	2.41 ± 0.01^{h}
	Ulva Lactuca sp.	2.24 ± 0.01^{e}
40 : 60	*Sargassum* sp.	1.46 ± 0.01^{c}
	Eucheuma Cottoni sp.	2.42 ± 0.01^{h}
	Ulva Lactuca sp.	2.27 ± 0.01^{f}

Different superscript letters indicate significant differences ($p \leq 0.05$).

The smaller the proportion of mocaf flour and porang flour with the addition of Eucheuma cottoni sp. seaweed extract, the higher the fat content of the dry noodles. The increase in fat content is due to the presence of porang flour as a raw material, which has a higher fat content of 2.69% compared to mocaf flour, which has a fat content of 1.63%. According to [25], the fat content in mocaf flour ranges from 0.4% to 0.8%. The fat content in porang flour is 3.25% [27]. Fat content is an organic compound and a source of energy in food. According to [28], the addition of more porang flour also increases the fat content [13].

The addition of seaweed extracts can increase the fat content in dry noodles. This is because in Sargassum sp. seaweed at 0.85%, Eucheuma cottoni sp. seaweed. by 1.71%, and Ulva lactuca sp. seaweed by 1.69%. The addition of Eucheuma cottoni sp. seaweed extract resulted in higher fat content in dry noodles.

3.5 Carbohydrate Content of Dry Noodles

The average ash content of various treatments is presented in Table 5. Based on these data, the carbohydrate content of dry noodles ranges from 81.17% to 83.65%. The lowest carbohydrate content is obtained from the proportion of mocaf flour and porang flour (40:60) with the addition of Ulva Lactuca sp seaweed extract. In contrast, the highest carbohydrate content is produced by the proportion of mocaf flour and porang flour (60:40) with the addition of Sargassum sp seaweed extract.

Table 5. Carbohydrate Content of *Dry Noodles*

Mocaf flour and Porang flour	**Types of *Seaweed*(%)**	***Carbohydrate content* (% ± SD)**
60 : 40	*Sargassum* sp.	83.65 ± 0.02^{h}
	Eucheuma Cottoni sp.	82.27 ± 0.02^{e}
	Ulva Lactuca sp.	81.23 ± 0.01^{b}
50 : 50	*Sargassum* sp.	83.63 ± 0.02^{gh}
	Eucheuma Cottoni sp.	82.21 ± 0.02^{d}
	Ulva Lactuca sp.	81.20 ± 0.01^{ab}
40 : 60	*Sargassum* sp.	83.60 ± 0.02^{f}
	Eucheuma Cottoni sp.	82.12 ± 0.02^{c}
	Ulva Lactuca sp.	81.17 ± 0.02^{a}

Different superscript letters indicate significant differences ($p \leq 0.05$).

The glucomannan content in porang flour and the fermentation process of mocaf flour can cause starch degradation. Glucomannan in porang flour is responsible for the gel formation and chewy texture of the resulting noodles. Glucomannan absorbs water, forming a stable gel [29] (Rahmawati et al., 2021). The greater the addition of mocaf flour, the higher the carbohydrate content in dry noodles. This is because the carbohydrate content in mocaf flour is around 80.09% [30].

Carbohydrates in flour are found in the form of pentoses, cellulose, small sugars, dextrin, and starch. Starch is a carbohydrate consisting of amylose and amylopectin. Carbohydrate content can be influenced by the amylose and amylopectin content in the flour. Factors that influence the increase in carbohydrate content include processing. The drying process can increase carbohydrate content. This is in accordance with the opinion of Akbar et al. [31], carbohydrate content increases when the heating temperature is high. The higher the drying temperature, the faster the starch hydrolysis rate increases, resulting in the breakdown of simple compounds [32].

The addition of seaweed extracts also affects the carbohydrate content. This is because the seaweeds tested have high carbohydrate content. Sargassum sp. seaweed has a carbohydrate content of 67.24%. Eucheuma cottoni sp. seaweed has a carbohydrate content of 71.86%, and Ulva lactuca sp. seaweed has a carbohydrate content of 57.48%. The carbohydrate content of dry noodles with the addition of Sargassum sp. seaweed extract is higher than that with the addition of Ulva lactuca sp. seaweed extract.

4 ONCLUSION

Dry noodles are noodle products made from mocaf flour and porang flour with the addition of seaweed extract. The development of dry noodles is one of the strategies for increasing gluten-free food consumption among both children and adults. The best formulation was obtained at a proportion of 50:50 mocaf flour and porang flour, with the addition of seaweed extract (Ulva lactuca sp.) containing 7.80% water content, 1.43% ash content, 7.37% protein content, 2.24% fat content, and 81.20% carbohydrate content.

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