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Proportion of taro and wheat flour, and konjac flour concentration on the characteristics of wet noodles

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Abstract. To be consumed as healthy food, it is necessary to improve the process to reduce the calorie value of the wet noodles. For this reason, this study used taro flour to substitute wheat flour in the processing of wet noodles. However, the use of taro flour as raw material for making noodles will reduce the quality of the product, especially from the noodles' elasticity and texture. For this purpose, konjac flour containing glucomannan was added. Therefore, it is necessary to study the processing of wet noodles with various proportions of taro and wheat flour, and konjac flour concentration on the quality of wet noodles. This research used two factors treatment namely: the ratio of taro and wheat flour with three levels (30%:70%, 40%:60%, and 50%:50%) and konjac flour concentration with three levels (1.5%, 3.0%, and 4.5%) based on total flour weight. The parameters observed in this study were the content of water, ash, protein, fat, carbohydrate, calorie value, and the organoleptic test, which included taste, colour, aroma, and texture. Based on the analysis of variants, there was no interaction between factors. Still, the factor of the proportion of taro and konjac flour indicated the significant difference between levels for all chemical parameters except fat. Besides, the Friedman test indicates the significant difference for all organoleptic parameters. The results showed that the best treatment was the proportion of taro to wheat flour 30:70, and a concentration of 4.5% konjac flour with a total expected value of 7.86.

1. Introduction

Noodles are processed food products from wheat flour that are popular due to their practical and fast presentation, both as additional food and as a substitute for staple food. As a source of carbohydrates, noodles are often used as an alternative food to substitute rice. According to Atkinson et al. [1], after undergoing the boiling process, wet noodles have a low to moderate GI value of 53-56 with a glucose standard that has a GI value of 100. Wheat flour as the main ingredient for making noodles has a glycaemic index value of 70 [2]. To be consumed as healthy food, it is necessary to improve the process by substituting wheat flour to reduce the GI value.

The availability of wheat seeds is an obstacle because it is difficult to cultivate in Indonesia and need to be imported. Wheat imports were 304.11 tons in 2009, 419.52 tons in 2010, 502.99 tons in 2011,



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556.43 tons in 2012, and 655.97 tons in 2013. Based on data from the Indonesian Wheat Flour Producers Association (APTINDO) in 2017, wheat imports reached 11.48 million tons, increasing about 9% from 2016, which reached 10.5 million tons. If this situation is allowed to continue, Indonesia will depend on imported food, and there is an increase in foreign exchange expenditure, resulting in a concern in food insecurity. Therefore, it is necessary to have a food diversification program by reducing dependence on ethnic cuisine, namely by reducing the use of wheat or wheat as raw materials and replacing it with local food products.

Taro (*Xanthosoma sagittifolium*) as one of the root crops has an excellent opportunity to be developed as a potential non-rice carbohydrate producer [3] because it has various benefits and can be easily cultivated. The low taro price and the lack of utilization and high carbohydrate content (34.2 g/100g) allow it to be developed as a raw material for noodles making. For this reason, the taro flour was used as a substitute for wheat flour in wet noodles making.

However, the use of taro flour as a raw material for making noodles had disadvantages because taro does not contain gluten, so that it will reduce the quality of the noodle produced, especially from the chewiness and elasticity of the noodle texture. Konjac flour has the potential to improve the texture quality of the noodles. Konjac flour contains glucomannan, which is a water-soluble fibre. Glucomannan can absorb water higher than other food fibres [4]. In general, *Amorphophallus* tubers contain high amounts of glucomannan [5]. The glucomannan in local konjac flour from multilevel washing used for making noodles so that it can increase its practical value [6, 7]. According to Fang and Wu [8], glucomannan can reduce body weight, cholesterol levels [9], and blood sugar [10] and also functions well for the digestive system because it absorbs very high water.

The addition of konjac flour with a higher concentration than previous konjac noodle research [11] aims to produce noodles that are more beneficial to health and can still be accepted by consumers. The konjac flour containing glucomannan can improve the elasticity and texture of taro noodles [12]. Therefore, it is necessary to optimize the wet noodle processing process with various proportions of taro-wheat flour and the concentration of konjac flour on the quality of the resulting wet noodle products.

2. Materials and Methods

The materials used were taro flour, wheat flour, konjac flour, eggs, salt, oil, water, and chemicals for proximate analysis. The tools used were containers, noodle grinders, analytical scales, stoves, boilers, and proximate, physical, and organoleptic analysis tools.

The research design used was a randomized block design (RBD) with two factors. The first factor is the proportion of taro flour to wheat flour, with three levels, namely 30%:70%, 40%:60%, and 50%:50%. The second factor is the concentration of konjac flour to total flour weight, with three levels, namely 1.5%, 3.0%, and 4.5%.

Noodles from various combination were analysed for water content [13], ash content [13], protein content [13], 1995), fat content [13], carbohydrate content [13], calorie value, and organoleptic tests, which includes taste, aroma, colour, and texture.

Parametric data obtained from the research results were then analysed using analysis of variance. If the results obtained through analysis of variance indicate the effect of significant differences between treatments, the analysis continued with the Duncan test with a confidence level of 95%. While the organoleptic test data, which is ordinal data, were analysed using the Friedman test and descriptive analysis.

The selection of alternatives used the expected value method. Calculating the expected value is the product quality results for each parameter and the probability of each baseline state. According to [14], the concept of the expected value decision is to choose a decision that has a maximum pay off or a minimum cost. The parameters used in selecting alternatives are protein content, carbohydrate content, texture, taste, and aroma. Determination of the weight of interest for each parameter using the analytical hierarchical process method [15].

3. Results and Discussion

3.1. Chemical properties

The chemical properties studied included water content, ash content, protein content, carbohydrate content, and calories value. Based on analysis of variance, there was no interaction between factors, but for the proportion of taro and wheat flour indicated a significant difference for water content, ash content, protein content, carbohydrate content, and calorie value. The Duncan test results for those parameters showed in Table 1.

Table 1. Duncan test results for chemical contents of taro wet noodles.

The proportion of taro and wheat flour	Water content (%)	Ash content (%)	Protein content (%)	Carbohydrate content (%)	Calories value (Cal)
30:70	61.88 ± 0.20 a	0.48 ± 0.03 a	4.46 ± 0.25 a	32.70 ± 0.23 b	157.45 ± 0.41 a
40:60	63.66 ± 0.66 a	0.53 ± 0.01 b	3.75 ± 0.12 b	31.72 ± 0.16 b	148.62 ± 0.27 b
50:50	69.64 ± 2.50 b	0.61 ± 0.04 c	3.02 ± 0.36 c	26.59 ± 2.17 a	124.80 10.51 c

3.1.1. Water content

Water content testing was carried out to determine the water content of the taro wet noodle products. The statistical analysis showed that there is no real interaction between treatments. The treatment of the proportion of taro flour and wheat flour had a significant effect on the water content of wet noodles. In contrast, the treatment of konjac flour concentration had no significant effect.

In Table 1, it is shown that the wet noodle's water content increases with increasing proportion of taro flour. That was due to differences in water content in the raw materials used. Taro flour contains 13.57% water [16], whereas wheat flour contains 11.97% water [17]. Besides, taro contains high amylose content of 16.29% [18], compared to wheat flour of 10.23% [17]. Amylose has a tight and straight structure so that it has the property of quickly absorbing water and releasing water. Materials that have a high amylose content, in the drying process, it will be more natural to release the water contained in the product [19].

3.1.2. Ash content

Total ash content aimed to evaluate the nutritional value of a product or food material, especially total minerals. The statistical analysis results showed that there was no significant interaction between treatments, but the proportion of taro and wheat flour had a significant effect.

Table 1 shows that the higher the proportion of taro flour, the higher the ash content of the noodles produced. That was due to the higher ash content in taro than wheat flour. The ash content in taro flour was 2.7%, while in wheat flour was 0.72%. Taro flour contains minerals Fe, Zn, Mg, Cu, K, P, Na, and Ca [16, 17].

3.1.3. Protein content

The results of statistical analysis showed that there was no significant interaction between treatments. However, the proportion of taro flour and wheat flour had a significant effect.

In Table 1, it shows that the higher the proportion of wheat flour, the greater the protein content of the noodles produced. That was presumably because the protein content of wheat flour is higher than that of taro flour. Wheat flour contains 11.80% protein [22]. Protein in wheat flour is specific and functionally required to improve the elasticity and texture of carbohydrate-based dough by forming a three-dimensional structure. The protein structure change in during the wet noodle process [23].

3.1.4. Fat content

The statistical analysis results showed that there were no significant interactions between treatments, and each treatment was also not significantly different. That was presumably because the fat content in the raw materials is relatively low, namely taro flour of 0.22% and flour of 2.7%. When mixed, this low-fat content will not have an impact on the fat content of the noodle products produced.

3.1.5. Carbohydrate content

The results of statistical analysis showed that there was no real interaction between treatments, but the proportion of taro and wheat flour had a single effect ($p < 0.05$). In Table 1, it shows that the higher the proportion of wheat flour, the greater the carbohydrate content of the noodles produced. That was because the carbohydrate content in taro flour is 70.73% [18]. Besides, taro flour also has a high amylose content of 16.29% [18]. When the starch is put into cold water, the starch granules can absorb moisture and swell, but this is limited and is called gelatinization. The starch that has undergone gelatinization can be dried and able to absorb large amounts of water again [19].

The low amylose content in taro flour also causes the noodles to stickier. The smaller the amylose content or, the higher the amylopectin content, the material is stickier [19]. These were supported by the opinion of Behera and Ray [24], that the starch in tubers can be used for various types of food that require an elastic and sticky texture.

3.1.6. Calorie value

Energy is a result of the metabolism of carbohydrates, proteins, and fats. Energy has a function as a powerful substance for metabolism, growth, temperature regulation, and physical activity. The energy value is affected by the material content, namely carbohydrate content, protein content, and fat content. Table 1 shows that the higher the proportion of wheat flour, the greater the calorie value of the noodles produced.

3.2. Organoleptic parameters

The organoleptic test was carried out to determine the level of consumer preference for the taste, aroma, colour, and texture of the wet noodle products by treating the proportion of taro flour and wheat flour (P). Tests were carried out using the scoring method, with a total of 30 panellists. Panellists asked to rate product samples based on parameters assessed using five score scales, namely for a score of 1 (strongly dislike), 2 (dislike), 3 (neutral), 4 (like), and 5 (strongly like). Based on the descriptive analysis, the results obtained the percentage of panellists' preference for the parameters of taste, aroma, colour, and texture of taro noodles. The results of these preferences show in Figure 1.

3.2.1. Taste

Taste is one of the factors that play an essential role in determining consumers' final decision to accept or reject foods. The results of Friedman's analysis showed that there were significant differences between the treatments for the taste parameters. The treatment that most panellists liked was the treatment using the proportion of taro and wheat flour of 50:50, and the concentration of konjac flour weighing 3.0%, which was 70% of the panellists liked it (Figure 1).

The preference increased with the use of wheat flour because the panellists do not like the specific taste of taro. Besides, the addition of konjac flour also affects the taste of the noodles produced, because, with the addition of konjac flour, the texture of the wet noodles is slightly coarse.

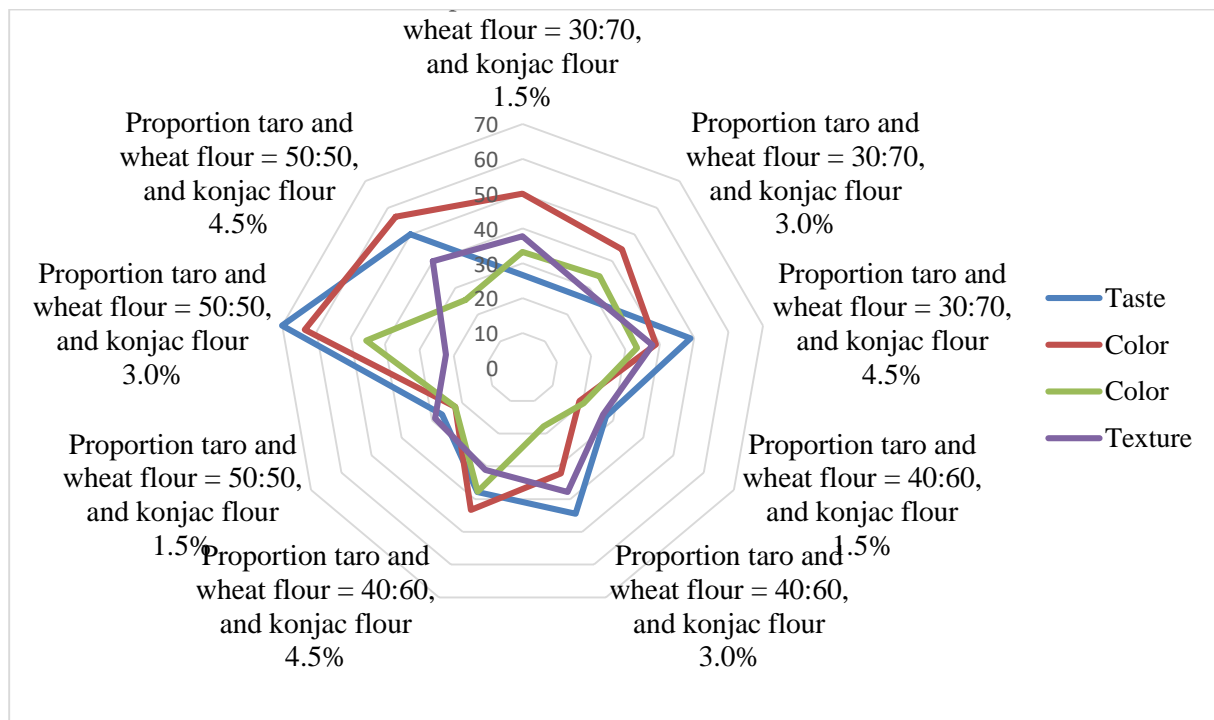


Figure 1. Panellists preference result of aroma, colour, and taste of taro noodles.

3.2.2. Aroma

The aroma is an essential factor for consumers to choose food products. The smell of food is also an important indicator in determining the quality of food ingredients. Generally, consumers will like food ingredients with a distinctive aroma and do not deviate from the usual aroma. The aroma is one of the main attractions for panellists in determining the value of liking for a product. The panellist preference of aroma parameters shown in Figure 1. The treatment that most panellists liked was the treatment using the proportion of taro and wheat flour of 50:50, and the concentration of konjac flour weighing 3.0%, which was 63% of the panellists liked it.

The use of taro flour affects the decreasing level of preference for panellists, which was presumably due to taro flour's aroma, which tends to be sour. Likewise, the aroma of konjac flour tends to be mustier and slightly pungent compared to wheat flour. That was following the opinion of [25] that konjac flour has a fishy aroma.

3.2.3. Colour

Colour is the first impression a panellist receives before recognizing other factors. Colour is crucial for any food because it affects the panellists' acceptance rate. The colour used as an indicator in determining the quality, freshness, or maturity of a product. Besides, colour is an indicator in the mixing or processing of a product, which indicates whether the product is evenly distributed [19]. The panellist preference of colour parameters shown in Figure 1. The treatment that most panellists liked was the treatment using the proportion of taro and wheat flour of 50:50, and the concentration of konjac flour weighing 3.0%, which was 46% of the panellists liked it.

The lower the proportion of taro flour, the higher the panellists' preference. That thought to be due to the presence of phenolic compounds in taro flour, which causes browning in foodstuffs. Besides, the raw material for konjac flour is brown, so the higher the concentration of konjac flour that is added will cause a decrease in the panellists' preference for colour. That was following the opinion of [25] that the konjac flour is creamy.

3.2.4. Texture

Food texture is a physical property that comes from the structure of food and is related to shape, breakdown, and flow due to the applied force (rheological properties). The texture is measured subjectively with the senses of taste, listener, and sight. The treatment that most panellists liked was the treatment using the proportion of taro and wheat flour of 50:50, and the concentration of konjac flour weighing 4.5%, which was 40% of the panellists liked it (Figure 1).

The use of high wheat flour instead of taro flour will increase the panellists' preference. That was due to gluten in wheat flour, which is not found in taro flour. The high use of konjac flour will also increase the panellists' preference for the dry noodle texture. That was due to glucomannan's presence, which can absorb more water, the glucomannan content in *porang* flour can be used as a thickening agent and gelling agent [25].

3.3. Alternatives selection

Based on the calculation of expected value method, the highest expected value score is in the treatment of proportion of taro and wheat flour of 30:70 and concentration of konjac flour of 4.5% with an expected value of 7.86. Hence, the selected process is the wet noodle processing with the proportion of taro flour and wheat flour of 30%:70% with the addition of konjac flour of 4.5%.

4. Conclusions

The proportions of taro and wheat flour have a significant effect on water content, ash content, protein content, carbohydrate content, and calorie value. In contrast, the konjac concentration factor has no significant impact. The organoleptic results showed that the proportion of taro and wheat flour and the concentration of konjac flour significantly affected all organoleptic parameters, namely taste, aroma, colour, and texture. The alternative process chosen was the use of the proportion of taro and wheat flour of 30%:70% with the addition of konjac flour of 4.5%.

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