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Utilization of Spirulina (*Arthrospira Platensis*) in the Substitution of Taro Flour and Mocaf Flour in Dry Noodles as an Anti-Stunting Food Innovation

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ABSTRACT

Stunting is a chronic nutritional problem that affects children's physical and cognitive development. This study aims to develop dry noodles made from taro flour, mocaf flour, and Spirulina as a nutritious food alternative for stunting prevention. Taro flour was chosen because it is rich in complex carbohydrates and fiber, mocaf has functional properties as a gluten-free flour that is easily digested, while Spirulina is known as a source of high protein and essential micronutrients. The best combination was obtained from a variation in the composition of taro flour and mocaf (60%:40%) with the addition of Spirulina at 2%, resulting in a product with protein content of 10.72%, carbohydrates of 74.91%, and moisture content of 6%, according to SNI 8217-2015 standards for dry noodles. Organoleptic test results showed that this sample was most preferred by panelists with a taste score of 4.3, chewiness 4.7, aroma 4.85, color 4.95, and crispness 4.25. Spirulina fortification plays a significant role in increasing protein content, considering that protein plays an important role in increasing body growth and development, so the protein needs of stunted patients must be met optimally. To fulfill the AKG in children with stunting, it is recommended that protein should cover 10%-15% of the child's total daily calories. So with this innovation, it is hoped that it can help meet the nutritional needs of stunted children, support local food sustainability, and reduce dependence on imported ingredients.

INTRODUCTION

Child stunting is a problem that is not only associated with difficulty achieving optimal physical and cognitive development, but also with an increased risk of disease in the future. Based on the latest data, the prevalence of stunting in Indonesia still reached 21.6% in 2022, and the target is to reduce it to 14% by 2024. Considering that protein plays an important role in increasing the growth and development of the body, the protein needs of people with stunting must be met optimally. To meet the AKG in children with stunting, it is recommended that protein should cover 10%-15% of the child's total daily calories, and carbohydrate needs are usually not much different from normal children, namely 200-215 gr / day, but the fulfillment of total energy is more concerned. Because stunting is often accompanied by chronic malnutrition, children need additional energy and protein to catch up with stunted growth. To ensure optimal growth, stunted children need a diet that is not only high in carbohydrates but also contains protein, healthy fats, vitamins and minerals . (Kemenkes RI, 2024).

Stunting prevention can be done through nutritious food innovations, such as dry noodles made from taro flour, mocaf, and Spirulina. This combination produces highly nutritious food, superior to wheat flour. In addition to reducing import dependence, the utilization of local ingredients also empowers domestic farmers (Sutarto, et al., 2018). The use of beneng taro flour and mocaf as a substitute for wheat flour is still limited. The combination of the two can produce composite flour for noodle making, although taro flour requires gluten additives to provide chewiness. (Rara et al., 2019).

Previous research has assessed the development of dry noodles made from local ingredients such as taro flour and mocaf. The study by Wulandari (2022) showed that replacing wheat flour with beneng taro flour and mocaf can increase the crude fiber and carbohydrate content of dry noodles, despite a decrease in protein content. In contrast, research by Junianto (2022), showed that the addition of Spirulina to donuts significantly increased the protein content and overall nutritional value. Donuts fortified with 10% Spirullina received positive responses from consumers, in this case indicating that Spirullina as a fortification ingredient in dry noodles has the potential to increase nutritional content, especially in efforts to prevent stunting.

This condition highlights the challenges in creating noodles that are able to fulfill nutritional needs optimally for stunting prevention. One proposed solution is food fortification using Spirulina (Arthrospira platensis). This microalgae is known as a natural source of nutrients that is very complete compared to other sources (Asilla et al., 2022). High in nutrients, including 23,000 RE β-carotene in 10 grams of fresh Spirulina, this microalgae is expected to cover nutrient losses during food processing (Fitriya et al., 2018).

Currently, the use of beneng taro flour and mocaf together is still limited. These two types of flour can be utilized to reduce the use of wheat flour in making noodles by combining them into composite flour. Taro flour does not contain gluten so it does not provide elasticity to the noodles, therefore, in making products such as noodles, it is necessary to add ingredients that contain gluten (Rara, et. al., 2019). Mocaf flour is processed from modified cassava flour and is known as an alternative to wheat flour. Mocaf flour has different properties compared to tapioca flour, especially in terms of viscosity, gelling ability, rehydration power, and better solubility. This difference makes mocaf flour superior and suitable for use in various food products. (Lala, 2014).

Dry noodles are dry food products made from wheat flour with the addition of other ingredients and permitted food additives, and have a distinctive noodle-like shape. Dry noodles are raw noodles that are dried to reach a moisture content of around 10-12%, the process of making dry noodles can be done through drying in the sun or using a dryer with appropriate temperature and humidity control (Wulandari, et. al., 2022). Noodles made from taro flour, mocaf and Spirulina are designed to meet the protein needs of children with stunting. In addition to being nutritious, this product considers the tastes and eating habits of the Indonesian people. This innovation offers a potential solution to prevent stunting, support local food sustainability, and reduce dependence on imported ingredients, making it a nutritious food alternative that can be widely accepted.

RESEARCH METHODS

This research was conducted at the Chemical Engineering Foodstuff Technology Laboratory, Faculty of Industrial Technology, National Institute of Technology Malang. This research uses an experimental method that aims to determine the effect of substituting the weight of mocaf flour and the weight of taro flour in making dry noodles on protein content and sensory quality. This method was chosen because it controls certain variables that can affect the results, and this method can produce quantitative data on changes in dry noodles due to changes in raw materials. The variables in this study consisted of two variables, namely control variables and changed variables. Control variables include 30 mL water, 1 g salt, 10 ml cooking oil, 1 egg white, 0.5 g STPP, 10 cm noodle length. While the variables changed include the ratio of mocaf flour and taro flour, namely (100%: 0%), (90%: 10%), (80%: 20%), (70%: 30%), (60%: 40%) and the percentage of Spirulina Powder weight, namely 1%, 1.5%, and 2%.

Research Procedures

Mixing the raw materials of mocaf flour with taro flour according to the variables used. Then added with other additional ingredients such as salt, eggs, STPP, Spirulina Powder (with a mass of 1, 1.5, and 2 gr). After that, stir until the dough is evenly distributed. Next, resting the dough for 15 minutes. After that, making noodle dough sheets (Calendaring). Then cutting or forming noodles (Sheeting) with a noodle length of 10 cm. Next steaming for 10 minutes. Then the noodles are dried with a Dehydrator for 2.5 hours, for the first 1.5 hours using a temperature of 60 °C, and the next 1 hour, increasing the oven temperature to 70 °C. Increasing the temperature gradually can effectively reduce water content, and starting with a lower temperature can better maintain nutrient levels before raising the temperature (Tiwari, 2013). Then further tests were carried out which included protein test, water content, carbohydrate content, and organoleptic test.

Data Analysis

The analysis carried out is organoleptic (colour, taste, aroma and texture). From the organoleptic test results, further tests will be carried out, namely water content (gravimetric method) and protein content (kjehdal method) for 15 samples, for the results of organoleptic analysis, water content and protein are processed using statistical analysis using SPSS. Furthermore, from the test results, 1 best sample of carbohydrate content (spectophotometric method) will be taken.

RESULTS AND DISCUSSION

1. Organoleptic Analysis

Crispness Test

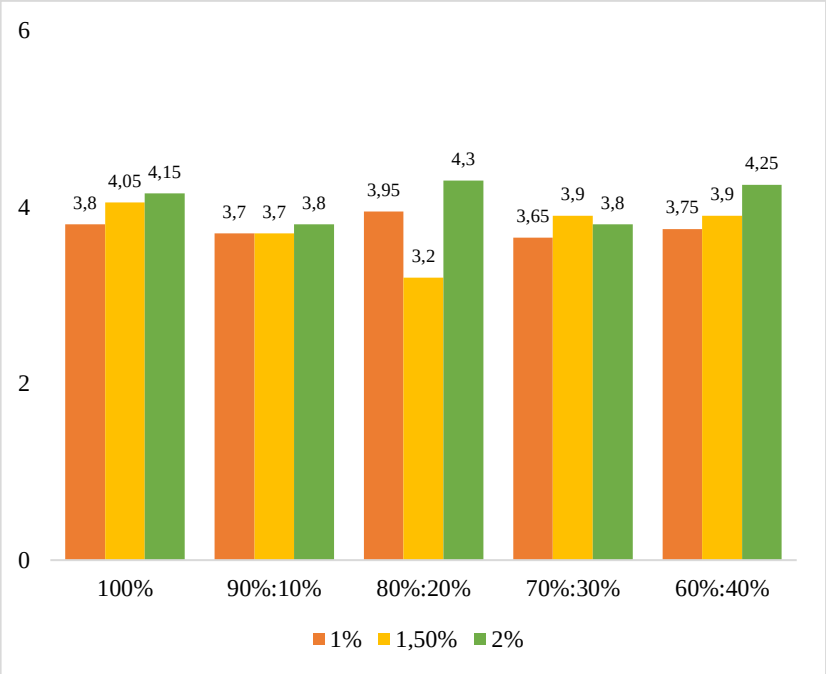

Figure 1. Results of Crispness test

Crispness test, based on the results of the ANOVA test at the 5% α level showed that the sig count was 0.001 <0.05, so Ho was rejected. Where the substitution of taro flour and mocaf flour with the addition of Spirulina affects the color of the dry noodles produced. This is because taro flour and mocaf flour do not contain gluten. In addition, the starch content (amylose and amylopectin) in mocaf flour and taro tuber flour affects the texture of the noodles produced. Because amylose and amylopectin play a role in the process of starch gelatinization, which can

increase the volume of the product (Sweeling Power) and provide a crisper texture to the final product (Yulianti, 2023).

Chewiness Test

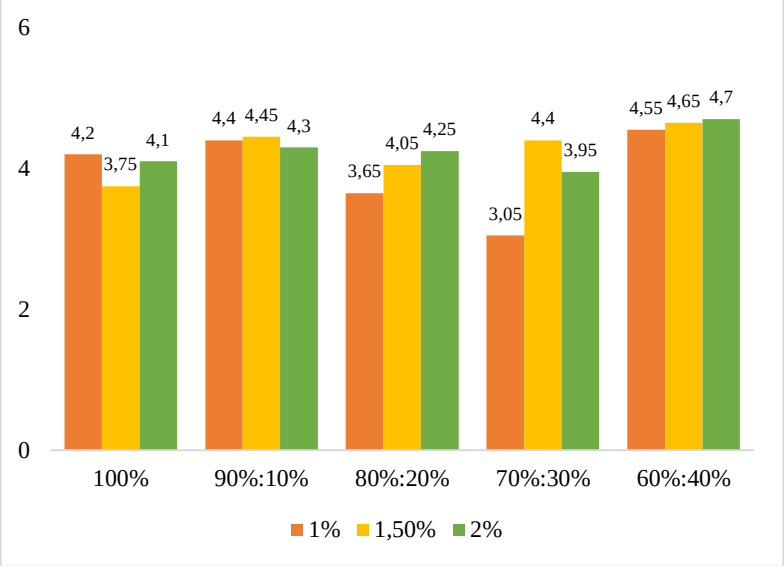

Figure 2. Results of chewiness test

The chewiness test, based on the results of the ANOVA test at the 5% α level, showed that the sig count was 0.001 <0.05, so Ho was rejected. Where the substitution of taro flour and mocaf flour with the addition of Spirulina affects the chewiness of the dry noodles produced. This is due to the high amylopectin content in taro tubers, which is 72-83% (Meliyana, 2019), which causes chewiness in the noodles.

Taste Test

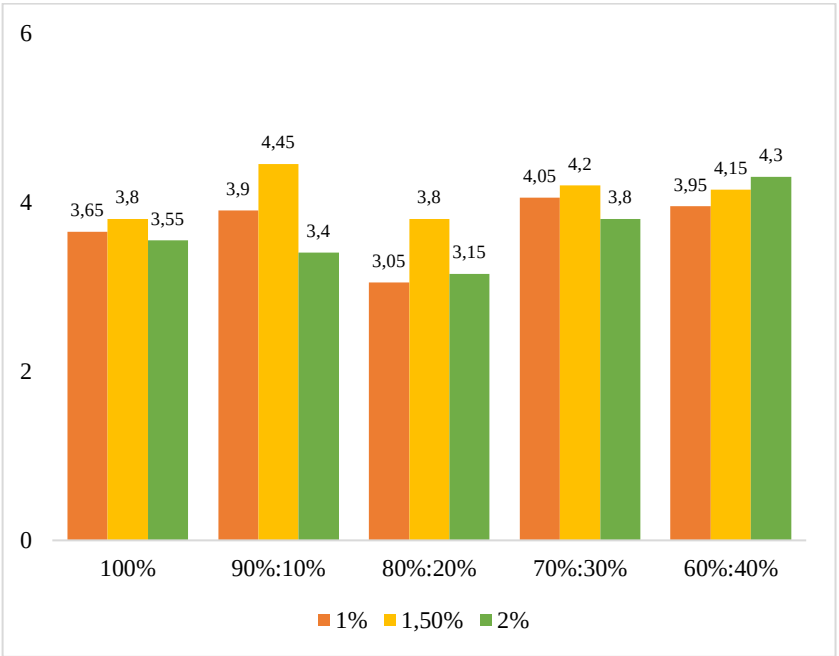

Figure 3. Results of taste test

The taste test, based on the results of the ANOVA test at the 5% α level, showed that the sig count was 0.002 <0.05, so Ho was rejected. Where the substitution of taro flour and mocaf flour

with the addition of Spirulina affects the taste of the dry noodles produced. This is due to the addition of Spirulina which causes a slightly fishy taste.

Aroma test

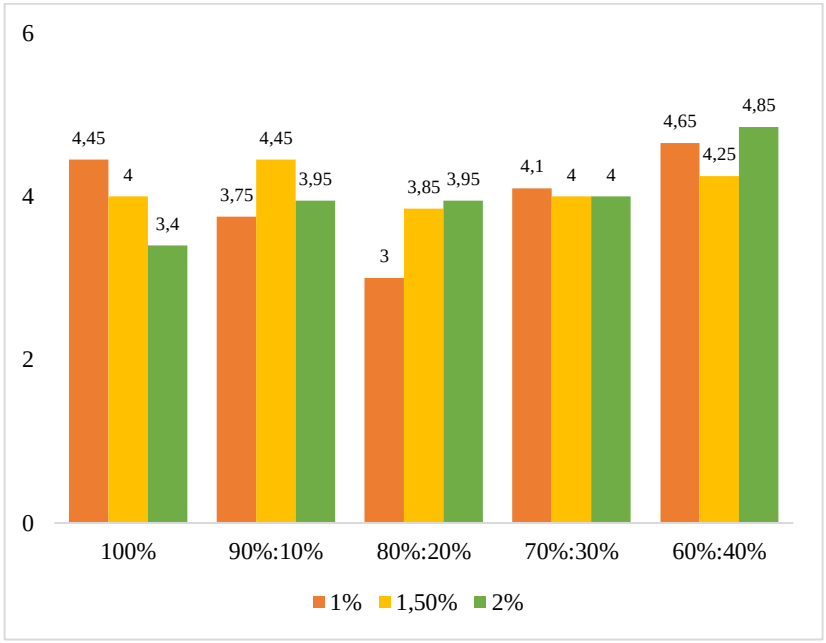

Figure 4. Results of aroma test

Aroma test, based on the results of the ANOVA test at the 5% α level showed that the sig count was 0.001 <0.05, so Ho was rejected. Where the substitution of taro flour and mocaf flour with the addition of Spirulina affects the aroma of the dry noodles produced. Where the aroma of dried noodles is dominant, smells like seaweed and is slightly fishy. This aroma arises from Spirulina which has a natural odor that resembles the aroma of fresh seaweed, with a fishy odor produced by the high protein content in it (Al- Baarri, 2020).

Color Test

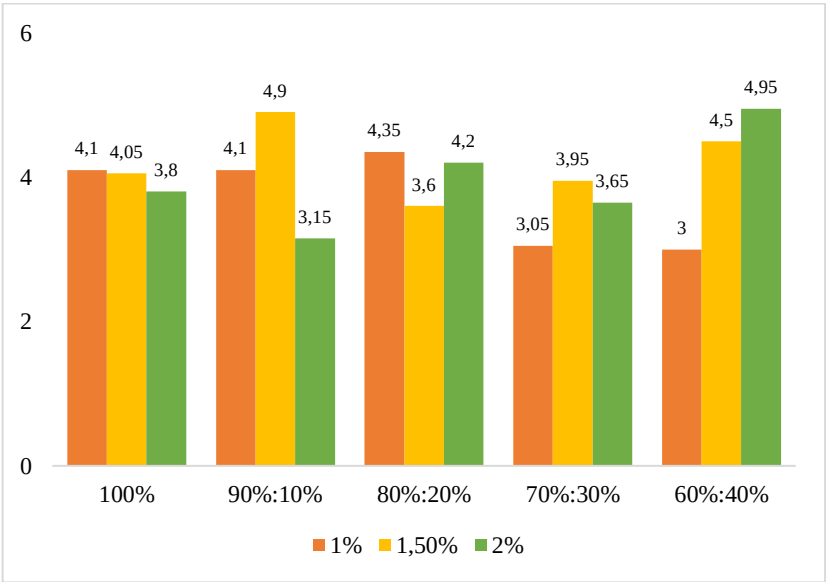

Figure 5. Results of colour test

Color Test, based on the results of the ANOVA test at the α level of 5% showed that the sig count was 0.001 <0.05, so Ho was rejected. Where the substitution of taro flour and mocaf flour with the addition of Spirulina affects the color of the dry noodles produced. This is because the

addition of Spirulina makes the color of the dried noodles change color to green. Spirulina has a Cyanophyin dye or commonly known as Cyanobacterium which has a bluish green color (Kabinawa, 2006).

2. Moisture Content Analysis

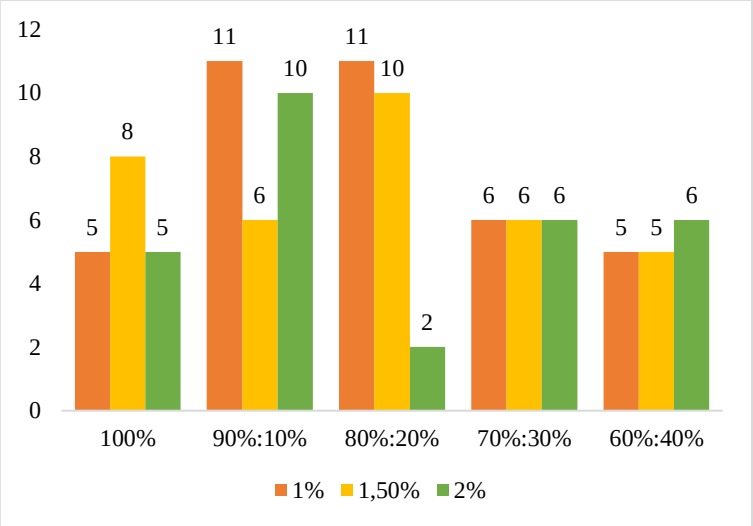

Figure 6. Results of Moisture Content Analysis

The proportion of taro flour and mocaf flour and the addition of Spirulina affect the moisture content of dry noodles. In Figure 6, the results on water content are not constant. This is due to the different properties of taro flour and mocaf flour. Mocaf flour has a high water absorption that affects the binding of water in the dough (Salim, 2011). Meanwhile, taro flour is hygroscopic because it has high fiber (Jumaidil, 2024). So that during processing or storage of noodles, taro flour can absorb moisture from the air, which causes the moisture content of the noodles to change. From the results of the water content, it shows a value below 13%, so the dried noodle sample is in accordance with SNI for making dried noodles with the dried method.

3. Protein Content Analysis

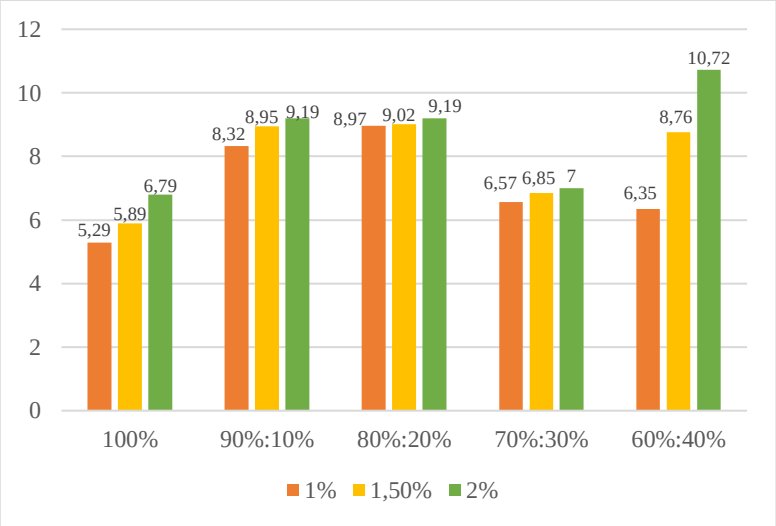

Figure 7. Result of Protein Content Analysis

From figure 7 that the substitution of taro flour and mocaf flour with the addition of Spirulina affects the protein content in dry noodles. The higher the weight percentage of Spirulina, the higher the protein content. This is due to fortification by adding Spirulina. Spirulina has a

protein content of 55-70% (Junianto, 2022). The addition of Spirulina significantly increased the protein content in noodles made from mocaf flour, while maintaining sensory quality at an acceptable level (Rahmadini, 2020).

4. Carbohydrate Test Analysis

Table 1. Results of Carbohydrate Test Analysis

Sampel	Hasil (%)
60%:40% (2 %)	74,91 ± 0,14

In Table 1, the substitution of taro flour and mocaf flour with the addition of Spirulina affects the carbohydrate content in the dry noodles. This is because taro flour has a high starch content of 80% (Rara, et.al., 2019), and mocaf flour has a high starch content of 87.3% (Nurdin, 2018). Taro flour and mocaf flour contain a fairly low amount of protein, namely taro flour 1.4% (Khairunnisa, 2018), mocaf flour 1.2% (Nurdin, 2018). Thus, most of the nutrients consist of carbohydrates. This condition makes noodles made from both types of flour have a high carbohydrate content..

CONCLUSION

From the results of this study it was found that the substitution of taro flour and mocaf flour with the addition of Spirulina had an effect on crispness, chewiness, colour, aroma, taste, water content, protein content and carbohydrate content in dry noodles. And it was found that the 60%: 40% sample with 2% spirulina became the best sample because it was most favored by panelists with its nutritional content of 10.72% protein, 74.91 ± 0.14% carbohydrate, and 6% moisture content. Where it is in accordance with SNI 8217-2015 on dry noodles. It is hoped that this dry noodle will help meet the daily protein requirements of children and make an important contribution to supporting stunting prevention programs in an efficient and sustainable way.

ACKNOWLEDGEMENTS

Conduct further tests on product stability during storage, including shelf life tests in various environmental conditions. And conduct clinical trials or long-term studies to ensure the impact of product consumption on improving the nutritional status of stunted children.

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