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Physical, chemical, and sensory quality of noodles fortification with anchovy (*Stolephorus* sp.) flour

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Abstract

Sago starch can be processed into flour and used as an alternative food ingredient to replace wheat flour. The lack of innovation in sago products is due to the very low protein and fat content of sago. Increasing the nutritional value of sago can be done by fortifying anchovies as a source of protein. This study was conducted to determine the effect of anchovy flour fortification on the physical, chemical, and sensory qualities of noodles. The study used a one-factor Completely Randomized Design. The results showed that with increased fortification of anchovy meal, the nutritional content of protein, fat, and noodle ash increased significantly. Rehydration power 34% to 52%, color intensity L* 42,87 to 55,70; redness a+ 1,91 to 2,85; and b+ yellowish 7,19 to 10,39, elongation 214,81 to 294,93. The composition of noodles with 9% anchovy flour fortification can be used to increase the nutritional content of noodles with physical and chemical characteristics, namely 4,08% protein content, 0,38% fat content, and 3,11% ash content. The sensory quality of noodle texture was 3,94; taste 3,32; and fragrance 4,66.

Keywords: anchovy flour; fortification; noodles; starch sago.

Practical Application: Research results can be applied to the noodle industry, especially in the non-wheat noodle industry because the raw material used is sago flour. In addition, the use of anchovy flour can be used to increase the nutritional content of noodles.

1 Introduction

Indonesia is the second-largest instant noodle-consuming country in the world after China. According to World Instant Noodles Association (WINA) (World Instant Noodles Association, 2021) data, in 2020 Indonesia will become the second country with the most instant noodle consumption after China/Hong Kong in the world with 12,640 Million servings. People in Indonesia like to consume noodles ranging from dry noodles to ready-to-eat noodles. Noodles are a staple food in many cultures made from unleavened dough, which is stretched, extruded, or rolled flat and cut into various shapes (Okoye et al., 2008). Other than that, noodles are a popular product due to their low cost, ease of transportation, long shelf life, and nutritional properties, as pasta provides significant amounts of carbohydrates, protein, and complex B vitamins (Fradique et al., 2013). The amount of consumption of instant noodles has caused an increase in the import of wheat because the primary raw material for making noodles is wheat flour.

Sago starch as a potential local raw material can be processed into flour and used as an alternative food to replace wheat flour. According to Meijer (1962), sago can be a source of food in the form of carbohydrates and from an economic aspect, sago is feasible to be developed because it can be an alternative source of food and energy (Tata & Susmianto, 2016). Other than that, sago becomes one of the sources of healthy food in the future because it has a high carbohydrate content, calorie content, calcium, phosphorus, and iron. Sago starch has high swelling power and low gelatinization temperature (Bantacut & Saptana, 2014). Sago so far has received less attention than starch, soybean commodities, and corn due to the lack of processed innovation. The lack of innovation is influenced by the very low protein and fat content of sago.

Increasing the nutritional value of sago can be done by fortification of animal protein such as fish. Fish is an excellent source of animal protein because it has a high nutritional content and benefits health. Fish is one of the animal proteins that have the best protein intake. Low intake of animal protein and poor food diversity greatly contribute to the high prevalence of stunting. According to Donadini et al. (2013) patterns of healthy diets that include fish consumption should be established in childhood. Including fish in school meals becomes a vital strategy to encourage younger Brazilians to develop the habit of eating fish (Marques et al., 2020). Anchovy can be used as a source of protein in the manufacture of noodles to improve the product's nutritional value. Fish consumption is important because fish has a chemical composition with many health benefits (de Brito et al., 2019). Lack of fish consumption will affect health and food security (Litaay et al., 2021).

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Anchovy has a high protein content and can be consumed by the whole body, the absorption of nutrients is very good. According to the Ministry of Health Indonesia (2005), the nutritional value of anchovy in 100g is 77 kcal of energy, 16 grams of protein, 1 gram of fat, 500 mg of calcium, 500 mg of phosphorus, and 0,05 mg of iron. Given the abundant nutritional potential and availability of anchovy in Indonesia, efforts to diversify fish into functional food need to be made into a fish meal used as a fortification in noodle products. Food fortification is one method that can be used to reduce micronutrient deficiencies and is an important element in food policy in Asian and Pacific countries (Darlan 2012). Therefore, this study was conducted to determine the effect of the fortification of anchovy fish meals on the physical, chemical, and sensory quality of noodles.

2 Material and method

2.1 Research materials

In this study, the raw materials used were sago starch (*Metroxylon* sp.) and anchovy (*Stolephorus* sp.) (Figure 1). Sago starch was obtained from Ambon, Maluku, while anchovy was obtained from Blanakan Subang, West Java. The freshly caught fish was weighed, iced, and was transported in a styrofoam box filled with ice to the processing laboratory. They were eviscerated, washed with water, and drained, then processing it into fish meal. Fish meal is an excellent source of protein because it can increase food consumption (Solangi et al., 2002).

2.2 Methods

Noodles making

Noodle making consists of four stages as shown in Figure 2.

2.3 Physical analyses

Rehydration power (Kang et al., 2017)

Rehydration power is the ability of noodles to absorb water after gelatinization. Measurements were made by weighing 5 grams of raw noodles (A), then the noodles were put into 150 ml of water and cooked for 7 minutes. Next, the noodles were drained for 5 minutes and weighed (D). Percent rehydration power is calculated by the Formula 1:

$$Rehydration\ power\ (\%) = \frac{\text{cooked noodles weight - raw noodle weight}}{\text{rav noodeveight}} \cdot x \cdot 100\% \qquad (1)$$

Color (Sharma, 2003)

Color testing was carried out using a Minolta chromameter (type CR 200, Japan). The chromameter is first calibrated with the white standard found on the instrument. A number of samples are placed in a flat container. Measurements produce values of L, a and b. L represents the brightness parameter (achromatic color, 0: black to 100: white). The chromatic color of the red-green mixture is indicated by the value of a (a+ = 0-100 for red, a- = 0-(-80) for green. The chromatic color of the blue-yellow mixture is indicated by the value of b (b+ = 0-70 for yellow)., b- = 0-(-70) for the color blue. Measurement of color using the Equation 2:

$$W = 100 - \sqrt{(100 - L)^2 + a^2 + b^2} \qquad (2)$$

Description:

W = degree of whiteness

L = brightness

a = red if it is + and green if it is -

b = yellow if it is + and blue if it is –

Elongation (Chen et al, 2002)

Elongation was measured using the TAXT2 texture analyzer at a speed of 3 mm/s and a force of 100 g. One strand of noodles that had been boiled for 4 minutes was wrapped around the probe with a distance between probes of 2 cm and a probe speed of 0.3 cm/s. Percent elongation is calculated by the Formula 3:

$$Elongation(\%) = \frac{\text{sample dropond time(s)} \times 0.3\text{cm / s}}{2\text{cm}} \times 100\% \qquad (3)$$

Figure 1. Sago starch (Metroxylon sp.) (A), and anchovy (Stolephorus sp.) (B).

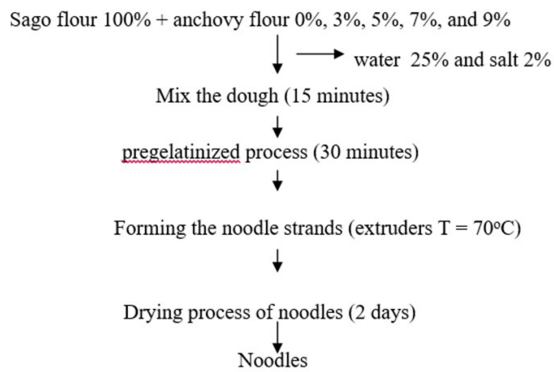

Figure 2. Flow chart of noodle processing (Litaay, 2012) modification.

2.4 Chemical analyses (Association of Official Analytical Chemist, 2005)

Moisture

Moisture content was measured using the oven method. The dish was dried in an oven at a temperature of 100-105ºC for 24 hours and cooled in a desiccator for ±15 minutes and then weighed. A total of 2 grams of the sample was put into a cup and recorded as the weight of the material in the cup (B_1), then dried in an oven at 100-105°C for 6 hours until the weight was constant. The cup is put in a desiccator for 15 minutes until it cools down and is weighed as the final weight of the sample (B_2). Ash content is calculated by the Formula 4:

$$Moisture\ (\%) = \frac{B1 - B2}{B2} \cdot \text{x} \cdot 100\% \quad (4)$$

Protein

A total of 0.1-0.5 g of sample was put in a 100 ml Kjeldahl flask and added 40 mg HgO, 1.9 mg K_2SO_4 and 2 ml H_2SO_4. The destruction process (heating in a boiling state) is carried out for 1-1.5 hours, until the solution is clear. After cooling, 1-2 ml of distilled water was added and 20 ml of 40% NaOH was added and then distilled. The results of the distillation were accommodated in a 125 ml Erlenmeyer flask containing a mixture of 5 ml H_3BO_3 and 2-4 drops of indicator (2 parts methyl red 0.2% in alcohol and 1 part methylene blue 0.2% in alcohol). Add the digested sample with 8-10 ml of NaOH-$Na_2S_2O_3$ (sodium thiosulfate). The distillation was stopped after the volume of the distillate became 15 ml. Dilute the contents of the Erlenmeyer to about 50 ml. The distillation result is titrated with 0.02 N HCl from the burette until it turns pink. The same treatment was carried out for the blanks. Total nitrogen content is calculated by the Formula 5:

$$\%N = \frac{(A - B) \times NHCl \times 14}{\text{mg sample}} \cdot \text{x} \cdot 100\% \quad (5)$$

Protein content = % N x Conversion factor

Description:

A= ml sample titration

B= ml titration blank

Conversion factor = 6.25

Fat

Determination of fat content was carried out by the Soxhlet method. The fat flask was dried in an oven for 24 hours (T = 100–105 °C) and then cooled in a desiccator for 15 minutes (A). A total of 2 grams of the sample was spread on a cotton swab then wrapped in filter paper, and put into a Soxhlet flask. Samples were extracted for 4-5 hours with 150 ml of fat solvent in the form of hexane. The extracted fat was dried in an oven at a temperature of (100-105 °C) for 60 minutes. The fat flask was cooled in a desiccator for 20-30 minutes and weighed (B). Fat content is calculated by the Formula 6:

$$Fat\ (\%) = \frac{B - A}{\text{sample weight}} \cdot \text{x} \cdot 100\% \quad (6)$$

Ash

Determination of ash content is done by dry ashing method. The cup was dried for 30 minutes in an oven at a temperature of 100-105 °C, then cooled in a desiccator for 30 minutes and then weighed (B1). A total of 5 grams of the sample was placed in a cup and then burned. The crucible is put into an ashing furnace and then burned at 400 °C until a gray ash or sample of constant weight is obtained. Then the temperature of the furnace is raised to 550 °C for 12-24 hours. The sample was cooled in a desiccator for 30 minutes and then weighed (B2). Ash content is calculated by the Formula 7:

$$Ash\ (\%) = \frac{\text{B2-B1}}{\text{sampleweight}} \cdot \text{x} \cdot 100\% \quad (7)$$

2.5 Sensory quality (Soekarto & Hubeis, 2000)

Sensory quality characteristics were determined by conducting assessment tests. The assessment was made on noodles that were cooked for 4 minutes, drained, and cooled. Noodles fortified with 0%, 3%, 5%, 7%, and 9% anchovy meal were randomly numbered and graded by 47 semi-trained panelists. The assessment includes texture, taste, smell, and color with a scale value ranging from 1 to 7 (very poor to very high).

2.6 Statistical analysis (Stell & Torrie, 1993)

Data were analyzed statistically using analysis of variance (ANOVA). Each parameter was tested between noodles fortified with anchovy flour (3%, 5%, 7%, and 9%) and control. If there was a significant difference ($p<0.05$), the BNT test was performed to determine the difference between the means.

3 Result and discussion

3.1 Physical analyses

Rehydration power

The results of the rehydration analysis showed that the fortification of anchovy flour had a significant effect ($P<0.05$) on the rehydration power of noodles. The rehydration value of noodles with the addition of anchovy flour ranged from 34% to 52%. The research results on the rehydration power of noodles with anchovy fortification can be seen in Figure 3. The highest rehydration value of noodles was treatment control, and the lowest was treatment anchovy flour (7%). The low rehydration power of noodles is due to a large amount of anchovy flour used. These results are in accordance with the research of Tuhumury et al. (2020), where noodles with the addition of flour (20%) have a low rehydration power of 49,54% compared to control noodles of 64,09%. Dried noodles with the fortification of 10% eel fish meal had the lowest rehydration power of 138,26% (Rahmawati et al. 2016). In terms of interaction, it shows that sago starch competes with large amounts of fish protein to bind water molecules.

The interaction of proteins and polysaccharides plays an important role in the structure of foodstuffs. Large amounts of fish protein will compete with carbohydrates to bind water molecules (Tuhumury et al. 2020). Sipayung (2014) explains that the rehydration power is inversely proportional to the water content. The higher the water content, the lower the rehydration power. This is consistent with a study where the fortification of anchovy flour increased the water content of noodles but decreased rehydration power.

Color intensity

Anchovy flour fortification had a significant effect ($p<0.05$) on the color values of L*, a*, and b* noodles (Figure 4). The L* value of noodles produced ranged from 42,86 to 55,70. The L value of noodles significantly ($p<0.05$) decreased with fortification of 3-9% anchovy flour, it could be seen from the decrease in the whiteness of the noodles. The effect of fish meal fortification on the L* value depends on the proportion of the mixture.

Noodles with 9% fortification of anchovy flour experienced a decrease in L value by 42,86 which was significantly higher than control noodles and other noodles. The results are similar result with the research of (Chhikara et al. 2019) where added 40% beetroot pulp increase in redness by 9,81 and decrease in lightness (L*) value 35,7; and Sofi et al. (2019) supplementation of chickpea by-products (protein isolate and flour) can cause the L* value of the rice-based noodles to decrease significantly. A decreasing L* value indicates that the lower luminosity, appearance, and subsequently darker brightness of the noodles (Chhikara et al., 2019).

With more incorporation of anchovy flour into respective starch sago, the effects of anchovy flour on the decline of L* value were more significant. The higher the concentration of fish meal fortification to the dry noodle making, the darker the color of the dry noodles. The results of this study are by the research of Irsalina et al. (2016), where the lowest dry noodle brightness value is treated with the addition of 20% mean fish meal and the Maillard reaction. According AACC (American Association of Cereal Chemists, 2000), the L* value usually reduced when non-wheat flours, such as sweet potato flour, soy flour (Collins & Pangloli, 1997), and barley flour (Pangloli et al., 2000) were incorporated into wheat flour to produce noodles. The color dried spaghetti generally became significantly ($P < 0.05$) less bright (lower L*) (Wood, 2009).

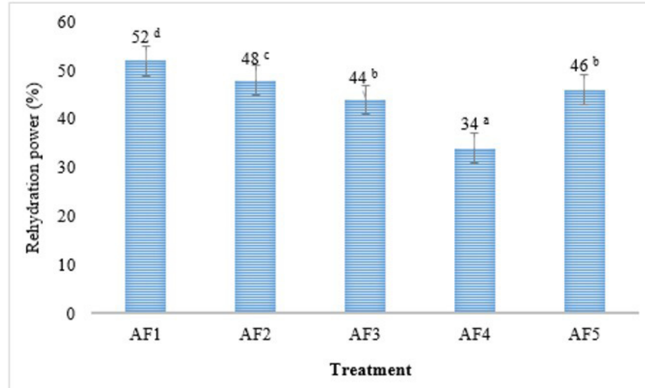

Figure 3. Rehydration power of noodles with fortification of anchovy flour Different letters (a-d) had a significant effect ($p < 0,05$).

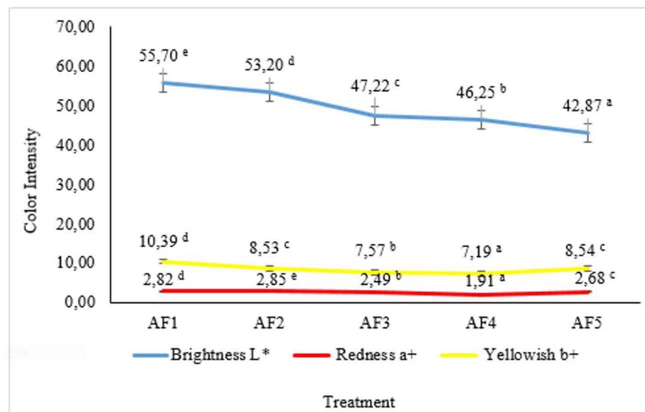

Figure 4. Color intensity of noodles (a) brightness L*, (b) reddish (a+), and (c) yellowish (b+). Different letters (a-e) had a significant effect ($p < 0,05$).

The redness (a*) values of noodles sago showed significant increments with added anchovy flour. The color a* value varied from 1,91 to 2,85. The a* value of redness in 3% anchovy flour fortified noodles by 2,85 higher than 0% control noodles. Research results in accordance with Debbarma et al. (2017), indicated that redness a* value of noodles was higher with added 20% fish meat catfish. According to Chhikara et al. (2019), there was an increase in the value of redness and a decrease in the value of brightness with an increasing concentration of coloring pigment. Increases in redness of noodle sheets by supplementation of non-wheat flour have also been reported by Collins & Pangloli (1997).

The yellowish b* value of control noodles was 10,39 and noodles with anchovy flour fortification decreased from 8,54 to 7,19. The interaction of the protein with polysaccharides in the manufacture of sago noodles can cause decreased yellowish b* value. An increase in anchovy flour from 0% to 9% had a significant effect on the color of cooked noodles, as seen from the changes in L*, a*, and b*. Brown and melanoid discoloration are caused by non-enzymatic browning reactions between reducing sugars and proteins during frying (Chhikara et al., 2019). Sofi et al. (2020) explain that color values of protein-enriched noodles have significant differences causes attributed to pigments associated with protein and the Maillard reaction.

Elongation

Elongation increases the maximum length of the noodles that are given a pulling treatment before the noodles break. Noodles have an elongation of 214,81% to 294,93%. The results of statistical analysis showed a significant (p<0.05) fortification of anchovy flour on noodle elongation. The average value of the elongation of noodles can be seen in Figure 5.

Noodle elongation is influenced by the amylose and amylopectin content. The ability of amylose to form a more compact crystal structure causes the propagation of the noodle strands to increase (Miftakhussolikhah et al., 2016). The elongation of the noodles was lower along with the higher the concentration of motan fish meal added (Irsalina et al., 2016). The results of a similar study showed that the elongation of noodles decreased significantly due to the addition of a snakehead fishbone meal (Stevani, 2015), and the increase in the proportion of white sword koro flour because the elasticity of the noodles decreased (Murdiati et al., 2015).

3.2 Chemical analyses

Anchovy flour addition significantly improved (p<0.05) chemical characteristics. The results of chemical analysis can be seen in Figure 6. The moisture content of noodles produced ranged from 10,25 to 13,16%. The fortification of anchovy flour causes the high moisture content of noodles. The high moisture content is due to the protein contained in fish meal having the ability to bind water; besides that, Sago starch has a reasonably high starch content and a large number of hydroxyl groups in starch molecules so that the ability to absorb water is also tremendous. Sago starch has the moisture and carbohydrate content was very high that is 40,21% and 80,45% (Mustafa et al., 2019).

Noodles have a protein content of 22.68% to 29.52%. The highest protein content was found in noodles with 9% treatment of 4,08% compared to 0% control noodles (0,03%) and commercial sago noodles (0,25%). According to Wood (2009), protein content generally increased (P < 0.05) with fortification. The protein content of the 30% enriched spaghetti was 17,4% compared to the control spaghetti of 12,4%. These results indicate that the protein content of noodles is not much different from the study of Litaay et al. (2022), where the addition of 8% skipjack fish meal was 3,64%.

The protein content of the results of this study is still relatively high when compared with the protein content of noodles the addition of seaweed flour ranged from 0,28 to 0,34% (Pujiastuti, 2009). Marconi & Messia (2021) argue that the addition of raw materials rich in proteins resulted in pasta products with higher protein contents and have better nutritional values than in conventional semolina pasta. Protein has nutritional value that can enrich various food products and direct consumption (Corapci & Guneri, 2020).

The fat content of noodles produced ranged from 0,01% to 0,38%. The results showed that the fat content of the fortification

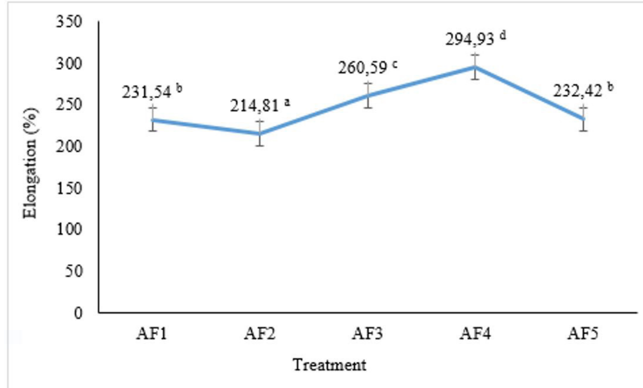

Figure 5. Elongation value of noodles. Different letters (a-d) had a significant effect (p < 0,05).

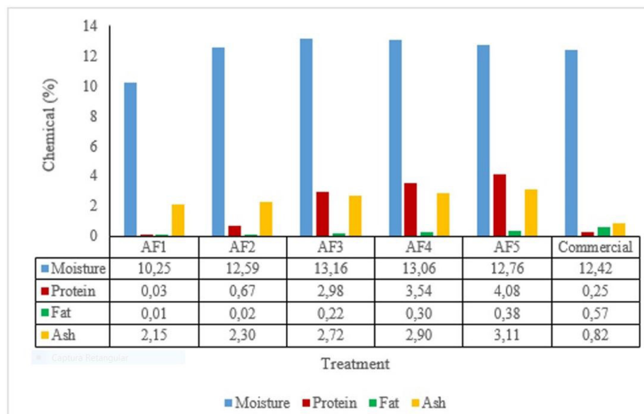

Figure 6. Chemical characteristics of noodles with fortification of anchovy flour.

anchovy flour 9% noodle (0,38%) product was high when compared to the protein content of the control noodles 0%, but not much different from commercial noodles. When compared with the fat content of the noodles research by Litaay et al. (2022) is 0,17% then the fat content of the research results is still high. In this study, the higher the concentration of fortified anchovy flour, the higher the fat content. The results of this study are in accordance with the research of Irsalina et al. (2016), where noodles with the addition of 10% Motan fish flour have a fat content of 0,94%. The increased fat content was caused by the use of ingredients that contain high enough fat.

The ash content of the research results is 2,15% to 3,11%. Noodles with 9% treatment had the highest ash content value of 3,11% compared to control (0%) noodles and commercial sago noodles. Fortification of anchovy flour increases the mineral content of the product. Fortification of the anchovy flour into the mixture significantly affects the ash content of the noodles. The research of Chhikara et al. (2019) found that noodles with the addition of 40gr of beet pulp increased the ash content by 4,36% compared to the control (3,67%). Pangesthi (2009) states that the proportion of soda ash affects the aroma of the noodles. That is by the research of Litaay et al. (2022), where dry noodles with the addition of 14% skipjack fish meal can increase the value of ash content compared to other treatments. The consumption of fish is significant for human health. Marques et al. (2020) reported that Brazil has a level of fish consumption below the world average. Considering nutritional fish the high, then one of the solutions make fish into burger products.

3.3 Sensory quality

The results of the sensory quality test of noodles with anchovy fortification are shown in Figure 6. The results of the analysis of the texture and aroma of noodles significantly ($P<0.05$) showed an increase in the panelist's acceptance value. The average value of the sensory quality test of noodles showed that noodles with anchovy flour fortification (9%) had the highest score on texture and aroma characteristics of 4,66 and 3,94, respectively, compared to control and other fortified noodles. A similar increase in panelists' acceptance of noodle texture by fortified skipjack fish meal was reported by Litaay et al. (2022). This research is not in accordance with the statement of Iman (2017), Ismanadji et al. (2000) state that more fortification of fish meal can cause panelists' assessment of texture and aroma to decrease.

The average value of the sensory quality test of noodles showed that the control noodles had the highest score on the characteristics of taste and color (Figure 7). Noodles with 9% anchovy flour fortification had a high taste score compared to other fortified noodles. This result is not in accordance with the statement of Marsaoly & Mahmud (2020) which states that the more concentration of fishbone meal is added, the panelists' preference level decreases. The results of the color analysis of noodles significantly ($P < 0.05$) showed a decrease in quality with the fortification of anchovy flour. Noodles fortified 7% showed the lowest value for color properties. Research by Debbarma et al. (2017) showed that noodles mixed with 20% green seaweed puree showed the lowest value for color properties. The addition of protein isolate (10%) and chickpea flour (30%) can cause a decrease in the overall acceptability of rice noodles (Sofi et al., 2019). Color sensory decreased with the fortification of anchovy flour. The results of research by Litaay et al. (2022), high skipjack tuna flour fortification can cause dark noodle color. The color will be darker due to the high use of fish meals, but it does not affect the panelists' acceptance rate (Iman, 2017).

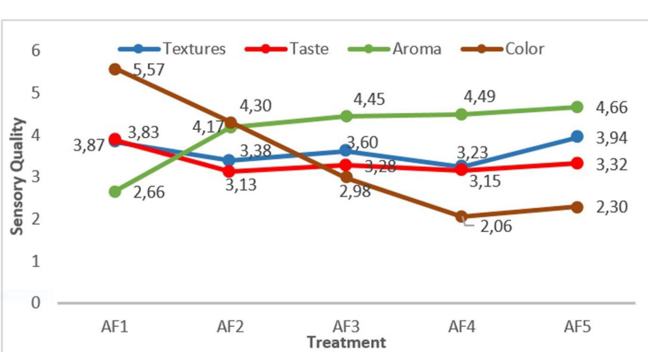

Figure 7. Sensory quality test of noodles with anchovy fortification.

Conclusion

Fortification of noodles with anchovy flour affects the noodle's characteristics. The composition of noodles with 9% anchovy flour fortification can be used to increase the nutritional content of noodles with physical chemical characteristics of 4,08% protein content, 0,38% fat content, and 3,11% ash content. The sensory quality of texture noodles was 3,94; taste 3,32; and aroma 4,66.

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References

American Association of Cereal Chemists – AACC. (2000). *Approved Methods of the american association of Cereal Chemists* (11th ed.). St Paul: AAAC.

Association of Official Analytical Chemist – AOAC. (2005). *Official methods of analysis of the Association of Official Analytical Chemists* (18th ed.). Arlington: AOAC.

Bantacut, T., & Saptana, (2014). Food politics based on composite flour industry. *Forum Penelitian Agro Ekonomi*, 32(1), 19-41. http://dx.doi.org/10.21082/fae.v32n1.2014.19-41.

Brito, B. M., Lira, G. M., Pinheiro, A. G. A., Santana, C. M. A. S., & Amaral, I. L. (2019). Effect of cooking with interesterified margarine in the chemical composition of fish. *Food Science and Technology (Campinas)*, 39(Suppl. 2), 640-645. http://dx.doi.org/10.1590/fst.29618.

Chen, Z., Sagis, L., Legger, A., Linssen, J. P. H., Schols, H. A., & Voragen, A. G. J. (2002). Evaluation of Starch noodles made from three typical Chinese sweet-potato starches. *Journal of Food Science*, 67(9), 3342-3347. http://dx.doi.org/10.1111/j.1365-2621.2002.tb09589.x.

Chhikara, N., Kushwaha, K., Jaglan, S., Sharma, P., & Panghal, A. (2019). Nutritional, physicochemical, and functional quality of beetroot (Beta vulgaris L.) incorporated Asian noodles. *Cereal Chemistry*, 96(1), 154-161. http://dx.doi.org/10.1002/cche.10126.

Collins, J. L., & Pangloli, P. (1997). Chemical, physical and sensory attributes of noodles with added sweetpotato and soy flour. *Journal of Food Science*, 62(3), 622-625. http://dx.doi.org/10.1111/j.1365-2621.1997.tb04446.x.

Corapci, B., & Guneri, N. (2020). Comparative assessment of nutritional composition and physicochemical properties of fresh, freeze-dried and rehydrated rainbow trout (Oncorhynchus mykiss walbaum, 1792) mince. *Food Science and Technology (Campinas)*, 40(Suppl. 1), 163-169. http://dx.doi.org/10.1590/fst.08419.

Darlan, A. (2012). *Fortifikasi dan Ketersediaan Zat Besi pada Bahan Pangan Berbasis Kedelai dengan Menggunakan Fortifikan FeSO4.7H2O Campuran FeSO4.7H2O+Na2H2EDTA .2H2O DAN NaFeEDTA* [Tesis]. Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Indonesia, Depok.

Debbarma, J., Viji, P., Rao, B. M., & Prasad, M. M. (2017). Nutritional and physical characteristics of noodles incorporated with green seaweed

(*Ulva reticulata*) and fish (*Pangasianodon hypophthalmus*) mince. *Indian Journal of Fisheries*, 64(2), 90-95. http://dx.doi.org/10.21077/ijf.2017.64.2.58918-14.

Donadini, G., Fumi, M. D., Porretta, S., & Porretta, S. (2013). Hedonic response to fish in preschoolers. *Journal of Sensory Studies*, 28(4), 282-296. http://dx.doi.org/10.1111/joss.12043.

Fradique, M., Batista, A. P., Nunes, M. C., Gouveia, L., Bandarra, N. M., & Raymundo, A. (2013). Isochrysis galbana and Diacronema vlkianum biomass incorporation in pasta products as PUFA's source. *Lebensmittel-Wissenschaft + Technologie*, 50(1), 312-319. http://dx.doi.org/10.1016/j.lwt.2012.05.006.

Iman, M. (2017). Fortification of tilapia meat against characteristics of small organoleptics and nutritional content. *Journal of Marine Fisheries*, 8(2), 161-167.

Indonesia. Ministry of Health of the Republic of Indonesia. (2005). *List of food ingredients*. Jakarta (ID): Ministry of Health of the Republic of Indonesia.

Irsalina, R., Lestari, S. D., & Herpandi. (2016). Physicochemical and sensory characteristics of dry noodle minnows carp (*Thynnichthys thynnoides*) fish meal addition. *FishtecH - Jurnal Teknologi Hasil Perikanan*, 5(1), 32-42. .

Ismanadji, I., Djazuli, N., Widarto, I. T., Herawati, N., & Ismarsudi, L. (2000). *Laporan Perekayasaan Teknologi Pengolahan Limbah*. Jakarta: Balai Bimbingan dan Pengujian Mutu Hasil Perikanan, Direktorat Jenderal Perikanan.

Kang, J., Lee, J., Choi, M., Jin, Y., Chang, D., Chang, Y. H., Kim, M., Jeong, Y., & Lee, Y. (2017). Physicochemical and textural properties of noodles prepared from different potato varieties. *Preventive Nutrition and Food Science*, 22, 246-250. PMid:29043225.

Litaay, C. (2012). *Fortifikasi Tepung Ikan Cakalang (Katsuwonus pelamis) Terhadap Karakteristik Mie Sagu* [Tesis]. Institut Pertanian Bogor, Bogor.

Litaay, C., Indriati, A., & Mayasti, N. K. I. (2022). Fortification of sago noodles with fish meal skipjack tuna (*Katsuwonus pelamis*). *Food Science and Technology (Campinas)*, 42, e46720. http://dx.doi.org/10.1590/fst.46720.

Litaay, C., Pelasula, D. D., Horhoruw, S. M., & Arfah, H. (2021). Effect of bait availability on pole and line fisheries and the impact on the amount of fish consumption. *IOP Conference Series: Earth and Environmental Science*, 763(1), 012048. http://dx.doi.org/10.1088/1755-1315/763/1/012048.

Marconi, E., & Messia, M. C. (2021). Pasta from non traditional materials. *Cereal Foods World*, 46, 522-530.

Marques, C., Lise, C. C., Lima, V. A., & Daltoé, M. L. M. (2020). Survival analysis and cut-off point to estimate the shelf life of refrigerated fish burgers. *Food Science and Technology (Campinas)*, 40(1), 171-177. http://dx.doi.org/10.1590/fst.36918.

Marsaoly, M & Mahmud, M. (2020). Pembuatan Sagu Lempeng Dengan Substitusi Tepung Tulang Ikan Tuna (*Thunnus albacores*). *Global Health Science*, 5(1), 28-33.

Meijer, W. (1962). Palms of Indonesia. *Principles*, 6(4), 15-25.

Miftakhussolikhah, Ariani, D., Rnh, E., Angwar, M., Wardah, W., Karlina, L. L., & Pranoto, Y. (2016). Cooking characterization of arrowroot (*maranta arundinaceae*) noodle in various arenga starch substitution. *Berita Biologi Jurnal Ilmu-Ilmu Hayati*, 15(2), 141-148.

Murdiati, A., Anggrahini, S., & Alim, A. (2015). Peningkatan kandungan protein mie basah dari tapioca dengan substitusi tepung koro pedang putih (*Canavalia ensiformis* L.). *Jurnal Agritech*, 35(3), 251-260. http://dx.doi.org/10.22146/agritech.9334.

Mustafa, K. M., Baini, R., Lim, S. F., Rahman, M. R., Mohamaddan, S., & Hussain, H. (2019). Drying effect on the properties of traditionally processed sago starch. *International Food Research Journal*, 26(6), 1861-1869.

Okoye, J., Nkwocha, A., & Ogbonnaya. (2008). Production, proximate composition, and consumer acceptability of biscuits from wheat/soybean flour blends. *Continent Journal Food Science Technology*, 2, 6-13.

Pangesthi, L. T. (2009). Pemanfaatan Pati Ganyong (*Canna Edulis*) Pada Pembuatan Mie Segar Sebagai Upaya Penganekaragaman Pangan Non Beras. *Jurnal Media Pendidikan, Gizi Dan Kuliner*, 1(1), 1-6.

Pangloli, P., Collins, J. L., & Penfield, M. (2000). Storage conditions affect quality of noodles with added soy flour and sweet potato. *International Journal of Food Science & Technology*, 35(2), 235-242. http://dx.doi.org/10.1046/j.1365-2621.2000.00333.x.

Pujiastuti, L. T. (2009). *Pemanfaatan tepung rumput laut (Kappaphycus alvarezii) dalam pembuatan mi sagu*. Bogor: IPB.

Rahmawati, S. C., Yunianta, Y., & Maligan, J. M. (2016). Karakteristik Kimia, Fisik dan Organoleptik Mie Kering dengan Penambahan Kombinasi Tepung Ikan Sidat (*Anguilla bicolor*). *Jurnal Pangan dan Agroindustri*, 4(3).

Sharma, G. (2003). *Digital color imaging handbook*. Boca Raton: CRC Press.

Sipayung, M. Y. (2014). *Pengaruh pengukusan terhadap sifat fisika kimia tepung ikan rucah.* Pekanbaru: Universitas Riau.

Soekarto, S. T., & Hubeis, M. (2000). *Metodologi penelitian organoleptik*. Bogor: Program Studi Ilmu Pangan, IPB.

Sofi, S. A., Singh, J., Chhikara, N., & Panghal, A. (2019). Effect of incorporation of germinated flour and protein isolate from chickpea on different quality characteristics of rice-based noodle. *Cereal Chemistry*, 90, 1-10.

Sofi, S. A., Singh, J., Chhikara, N., Panghal, A., & Gat, Y. (2020). Quality characterization of gluten free noodles enriched with chickpea protein isolate. *Food Bioscience*, 36, 100626. http://dx.doi.org/10.1016/j.fbio.2020.100626.

Solangi, A. A., Memon, A., Qureshi, T. A., Leghari, H. H., Baloch, G. M., & Wagan, M. P. (2002). Replacement of fish meal by soybean meal in broiler ration. *Journal of Animal and Veterinary Advances*, 1(1), 28-30.

Stell, R. G. D., & Torrie, J. H. (1993). *Principles and procedures of statistics indeks*. Jakarta: PT Gramedia Pustaka Utama.

Stevani, M. (2015). *Karakteristik mi basah dengan penambahan tepung tulang ikan gabus (Channa striata) dan iota karagenan*. Inderalya: Universitas Sriwijaya.

Tata, H. L., & Susmianto, A. (2016). Indonesian peat ecosystem paludiculture prospect. In H. L. Tata & A. Susmianto. *Indonesian: Prospek Paludikultur Ekosistem Gambut Indonesia*. Australia: Forda Press.

Tuhumury, H. C. D., Ega, L., & Sulfiyah, P. (2020). Karakteristik fisik mie basah dengan variasi tepung terigu, tepung mocaf, dan tepung ikan tuna. *The Journal of Fisheries Development*, 4(1), 43-50.

Wood, J. A. (2009). Texture, processing and organoleptic properties of chickpea-fortified spaghetti with insights to the underlying mechanisms of traditional durum pasta quality. *Journal of Cereal Science*, 49(1), 128-133. http://dx.doi.org/10.1016/j.jcs.2008.07.016.

World Instant Noodles Association. (2021). *Global Demand of Instant Noodles. World Instant Noodles Association (WINA)*. Retrieved from https://instantnoodles.org/en/noodles/demand/table/.