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RESEARCH ARTICLE

EFFECT OF FORTIFICATION FISH MEAL ON THE PHYSICAL CHARACTERISTIC OF SAGO NOODLES

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ABSTRACT

Starch sago different from other types of noodles, such as wheat flour and pasta, because it is made from gluten-free starch.The implementation of the extruded technology and fortification fish meal plays an important role in determining quality of sago noodles. The study aimed to analyze the effects of different fortification of fish meal on the degrees white, cooking time, cooking losses and elasticity of sago noodles. Fortification method was done by using different concentration of fish meal 0%, 2%, 4%, 6%, and 8%. The result of the study showed that fortification method using concentration 8% resulted in the provide quality of noodles with degrees white 46.70, cooking time 8.0, cooking looses 23.8and elasticity 16.20.

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INTRODUCTION

The food availability crisis in Indonesia can be a serious threat if not addressed by taking preventive measures and providing solutions. The dependency on certain primary food commodities has been a cause of the difficulty in overcoming the food availability crisis. One of the attempts to address the food availability shortage is diversification of primary foods as energy sources for society (Liestiantyet *al*. 2016). One prospective use of sago is noodle, a popular product for Indonesian people.The rapid growth of noodles consumption suggests that noodles are the kind of food that suits the needs and preferences of Indonesian consumers. But on the other hand has the opportunity to reduce the country's foreign exchange. Currently, most noodles are made from imported wheat flour. In 2002,Indonesia imported wheat flour about 400,000 tons (Departemen Perindustriandan Perdagangan 2003); 29.7% of it was processed to noodles (wet noodles and instant noodles).According Prasetya (2011), the import value of wheat flour in 2009 reached US $ 223.2 million and increased to US $ 261.7 million in 2010. Noodles are a popular product due to their low cost, ease of transportation, long shelf life, and their nutritional properties, as pasta provides significant amounts of carbohydrates, protein, and complex B vitamins (Fradique *et al*., 2013). Starch sago different from other types of noodles, such as wheat flour and pasta, because it is made from gluten-free starch. Collado *et al*. (2001) using sweet potato starch, revealed that in the absence of gluten in the starch, pregelatinized starch must be used as binder then mixed with ungelatinized starch to facilitate extrusion in producing qualified noodle. Starch sago have high carbohidrat content of 83.35% but low protein content of 0.27% (Litaay 2012). This inclusion is a good way to increase fish intake in the country once people are buying more industrialized and fast food products, easy to prepare and nutritious, but low-calorie (Goes *et al*. 2016).

The implementation of the extruded technology and fortification fish meal is required to avoid this issue. Thus, the solution is needed to tackle the gluten-free starch and low nutritional value problem of the sago noodles quality. The aim of the experiment was to analyze the effect fortification fish meal on the degrees white, cooking time, cooking losses and elasticity of sago noodles.

MATERIALS AND METHODS

Materials

Materials used in this study consisted of sago starch of 100% and fish meal, water of 25%, salt of 2% and materials for physical analysis. Fortified sago starch was made by adding 0% in treatment A_0, 2% in treatment A_2, 4% in treatment A_6, 6% in treatment A_6, and 8% in treatment A_8 of fish meal.

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Methods

Color (Gaurav 2003): Color was determined with a chromameter CR-200 (Minolta, Japan). A provided white standard tile was used tocalibrate the chromameter. Noodle strains were spreaded on a white paper. L* indicate a lightness parameter (range between 0.0, for absolute black stimuli, and 100.0, for diffuse white stimuli). The a* and b* coordinates approximate, respectively, the red–green and yellow–blue of an opponent color space. A positive a* value approximates red, while a negative value approximates green. Similarly, a positive b* correlates to yellow, while negative values correlate to blue.

Cooking time (Collado *et al*., 2001): Noodles (5 g) were cut into 5-cm lengths and cooked in 200 ml boiling distilled water in a covered beaker. Optimum cooking time was determined by the removal of a piece of noodle every 30 second and pressing the noodle between 2 pieces of watch glasses. Optimum cooking is achieved when the center of the noodles becomes transparent or when the noodle is fully hydrated. Cooking was stopped by rinsing briefly in water.

Cooking losses (Collado *et al*., 2001): Cooking loss was determined by evaporating to dryness the cooking water and rinse water in a pre weighed glass beaker in an air oven at 110 8C. The residue was weighed and reported as a percentage of the weight of dry starch noodles before cooking. Rehydration weight was determined by weighing the wet mass after cooked noodles were drained in a strainer for 2min, and the excess moisture on the surface was wiped with paper towel. The cooked noodles were stored in a covered Petri dish to minimize drying.

Elasticity (Chen *et al*. 2002): Elasticity were measured using a Texture Analyzer TA-XT2, with the test speed was 1.00 mm/s and 5 kg force. Elasticity (gf) that is maximum force to break noodles by extention was determined by attaching a noodle strain on a sample.

Statistical Analyses

This study used a simple complete random design with four treatments (A_0, A_2, A_4, A_6 and A_8). The obtained data were tabulated by Ms-Excel and analyzed. Analyses the effect of fortification fish meal (0%, 2%, 4%, 6%, and 8%) on cooking time, cooking losses and elasticy used RAL.The advanced testof BNT performed when ANOVA on treatment had significant effect ($p<0.05$).

RESULTS AND DISCUSSION

Results

Color sago noodles: The color of sago noodles tends to be white which is indicated from the product receiver using chromameter (value L*, a+, b+). The color change in sago noodle at variation of fish starch fortification concentration was significantly different ($p<0.05$) at lightness level (L*), redness (a+) and yellowish (b+). The results of white degrees testing can be seen in Table 1. The present study showed high of white degrees in fortification fish meal A_8compared fortification to all other treatment. A complete randomized factorial of statistical analysis shows that treatment of fortified fish meal has a significant effect ($p<0.05$) on white degrees value.

Table 1.White degrees of sago noodle

Treatment	Lightness (L*)	Redness (a+)	Yellowish (b+)	White degrees
A0	42.49^{b}	9.15^{a}	16.44^{a}	39.49^{b}
A2	42.64^{b}	5.47^{bc}	10.9^{b}	41.35^{ab}
A4	42.58^{b}	6.59^{b}	12.5^{ab}	40.86^{ab}
A6	43.41^{ab}	7.28^{ab}	13.0^{ab}	41,48^{ab}
A8	48.34^{a}	6.51^{b}	11.39^{ab}	46.70^{a}

Description: A_0 = 0% without of fish meal, A_2 = 2% of fish meal, A_4 = 4% of fish meal, A_6 = 6% of fish meal, and A_8 = 8% of fish meal. The numbers followed by different superscript letters (a, b, c) show significantly different ($p <0.05$) in fortified of fish meal.

Cooking time

Figure 1 shows the treatment of fortification methods with fish meal concentration (0%, 2%, 4%, 6%, and 8%) affect the cooking time value.

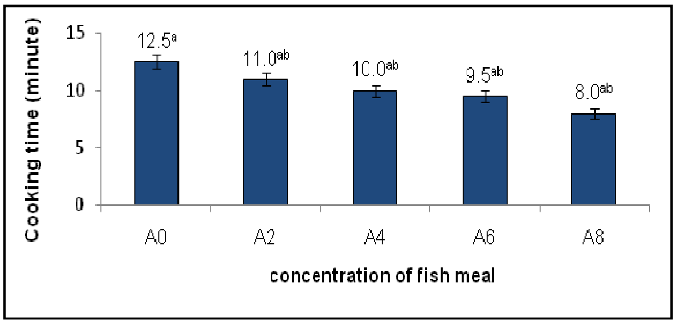

Figure 1. Histogram average cooking time of sago noodles with A_0 = 0% without of fish meal, A_2 = 2% of fish meal,A_4 = 4% of fish meal, A_6 = 6% of fish meal, and A_8 = 8% of fish meal. The numbers followed by different superscript letters (a, b) show significantly different ($p <0.05$) in fortified of fish meal

The results of this study indicated that the cooking time of sago noodles from 8.0 to 12.5 minutes. Sago noodle fortification of 8% fish meal (A_8) has cooking time for 8 minutes. Cooking time control sago noodles (A_0) for 12.5 minutes longer than sago noodles with fortified fish meal. The result of variance analysis showed that fortification of skipjack flour gave significant different effect ($p<0.05$) for cooking time of sago noodle.

Cooking losses

Cooking losses are the amount of solids contained in the dried noodles that come out and dissolve into the water during cooking. The value of cooking losses of sago noodles ranged from 21.87 to 24.47% (Figure 2). The result of variance analysis showed that fortification of skipjack flour gave an unreal effect ($p>0.05$) for cooking losses of sago noodles.

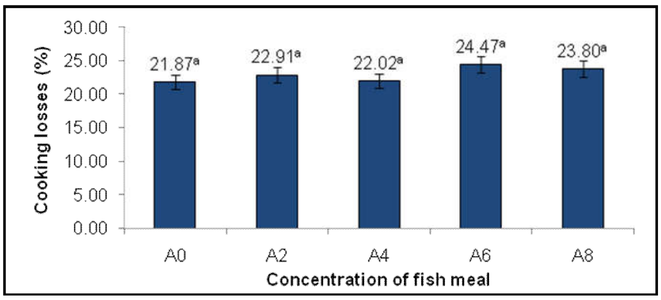

Figure 2. Histogram average cooking losses of sago noodles with A_0 = 0% without of fish meal, A_2 = 2% of fish meal,A_4 = 4% of fish meal, A_6 = 6% of fish meal, and A_8 = 8% of fish meal.The numbers followed by the superscript letters are the same (a) show no significantly different ($p>0.05$) in fortified of fish meal

The result of analysis shows that fortification of fish meal method no significantly affected the cooking looses of sago noodles ($p>0.05$). As shown in Figure 2, average values of the cooking looses with addition of fish meal 0%are lower than others. The treatments fortification of fish meal 0%, 2%, 4%, 6%, dan 8% resulted in the cooking losses scores of 21.87%, 22.91%, 22.02%, 24.47%, and 23.80% respectively.

Elasticity

Elasticity describes the force required by the noodles to return to its original form after the forces that cause the noodles to change shape are eliminated. Elasticity was measured using a TAXT2 texture analyzer tool. The peak of positive strength indicates the value of elasticity. Based on the analysis of variance, fortification of fish meal had significant effect ($p<0.05$) on the elasticity of sago noodles (Figure 3).

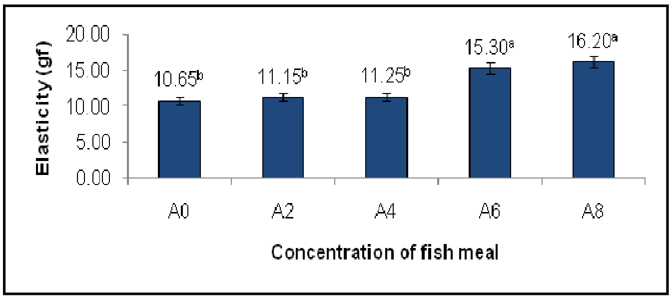

Figure 18. Histogram average of elasticity of sago noodles with A_0 = 0% without of fish meal, A_2 = 2% of fish meal, A_4 = 4% of fish meal, A_6 = 6% of fish meal, and A_8 = 8% of fish meal. The numbers followed by different superscript letters (a, b) show significantly different ($p<0.05$) in fortified of fish meal

DISCUSSION

This sago starch color will influence the color of the produced products. In this study, the highest L value was 48.34 in treatment A_8, a and b value was 9.15 and 16.44 in treatment A_0. According Gaurav (2003), the results of the color value was indicated by L, a, and b. L value is the parameter of lightness with score ranging from 0 (dark) to 100 (white), while the a value states the chromatic of mixed green-red, with +a value (positive) from 0 to +100 for red and –a (negative) from 0 to -80 for green color. The b value indicated the chromatic of mixed yellow-blue, with value +b (positive) from 0 to +70 for yellow and –b (negative) from 0 to -70 for blue color. Noodlecolor was significantly affected by sago starch origin (species) and HMT. Low value of lightness and highvalue of hue and yellowness was observed on the noodles from Ihur. Based on the concentration of fish meal, it was seen that sago noodle with A_8 formulation had higher white degree of 46.70% compared to other sago formulation noodles. This is because the sago formulation of A_8 has the highest protein content of 8%.The color of the noodles made from Ihur variety was rated below the lowest acceptable score, which means that the panelists did not familiar with the red Ihur noodle color since most noodles found in Indonesia are yellow or white (Purwani *et al*. 2006). The optimum cooking time was obtained when the cooked starch noodles strand was crushed between two pair of glass plates and the white hard core in the noodle strand disappeared (Liand Vasanthan, 2003) Figure 1 shows that the increase of fish meal concentration resulted in decreasing sago noodle cooking time. In this study, the highest cooking time value was 8 minute in treatment A_8.The optimum cooking time of sago noodles were comparable to those sweet potato, mung bean, and their bland starch noodles studied by Thao and Noomhorm (2011) which were ranging from 8 minutes-11 minutes. In general, increase in cooking time decreased the cooking losses and rehydration weight of the noodles. Cooking time of the sago starch noodles ranged from 7 to 9 minutes which were comparable to cooking time of commercial spaghetti marketed in Indonesia which was 9 minutes (Purwani *et al*., 2006). A high cooking loss gives an expectation of aless optimal eating quality. Cooking loss is also of great economic importance to the catering industry (Aaslyng *et al.,* 2003). Cooking losses were, however, mainly influenced by the cooking method (Panea *et al.,* 2008).

The results of this study indicate that the cooking loss of the starch noodle of A_6 was considerably higher than that of A_0, A_2, A_4 and A_8 (Figure 2). Figure 2 shows the effect of the cooking method on highest cooking losses value.This may be caused by thecooking method with fortification fish meal skipjack tuna. High cooking losses are also caused by less optimum matrix of starch gelatinized in binding to non-gelatinized starch (Chen *et al*. 2002). Panea *et al*. (2008) reported that cooking losses were affected neither by the method nor the ageing period, but were slightly affected by sample thickness; the determining factor was the cooking method. According Thitipranphunkul *et al*, 2003) loss in weight of noodles during cooking was mostly due to dissolving of loosely bound gelatinized starch on the surface of the noodles. That is, the extent of cooking loss would mainly depend on the degree of starch gelatinization and the strength of the gel network-like structure of the noodles. The higher cooking loss of HMT (heat moisture treatment) starch noodles was caused by partial breaking that would affect the internal bonding structure, making the HMT based starch gel on the surface unstable and weaker than the native ones in cooking stages. An optimal degree of rehydration is desirable. The water uptake during cooking was closely related to the the texture and cooking qualities of starch noodles (Lee *et al.,* 2005).

Elasticity (gf) that is maximum force to break noodles by extention was determined by attaching a noodle strain on asample holder. In study shows the elasticity of the cooked noodle of A8 was the highest and was significantly different from that of A2, A4 and A6. Chen *et al*. (2003) suggested that the starch gel properties can be used to predict the cooked noodle quality. The result of the measurement shows that fortification of skipjack fish meal can improve the elasticity of sago noodles. The results showed that the elasticity of sago noodles produced ranged from 10.65 to 16.20 gf (Figure 3). Fortification of fish meal by 8% has a high elasticity compared with other fish meal concentration of 16.20 gf. This is due to the protein content in fish meal that can make stable sago starch gel, which is indicated by increasing elasticity. According Purwani *et al*. (2006), sago starch noodles of Tuni have elasticity 11-16 gf. The results showed that sago formulation noodles had better elasticity compared with instant sago noodles, which were 1.00 gf (Sugiyono *et al*. 2009). Pregelatinized and facilitate extrusion in producing affected the qualified and elasticity sago noodle.

Conclusion

The result of physical characteristic for sago noodle shows that sago noodle affect the fortification of fish meal. Sago noodles with fortification of 8% fish meal (A_8) provided the best quality with degrees white sago noodles 46.70, cooking time 8.0, cooking looses 23.8and elasticity 16.20.

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