ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 14, Issue, 09, pp. 66685-66687, September, 2024
https://doi.org/10.37118/ijdr.28760.09.2024

RESEARCH ARTICLE

OPEN ACCESS

THE PHYSICAL PROPERTIES OF DRY NOODLES ENRICHED WITH ANCHOVY PROTEIN THROUGH EXTRUSION PROCESS

[1]Christina Litaay, [1]Diana Atma Budiman, *[1]Sriharti, [2]Kenneth Francis Wibisono, [2]Nasha Bachtiar and [3]Daniel Deonisius Pelasula

[1]Research Center for Appropriate Technology, National Research and Innovation Agency, Subang 41213, West Java
[2]Institut Bio Scientia Internasional Indonesia, Jakarta
[3]Research Center for Deep Sea, National Research and Innovation Agency, Jakarta

ARTICLE INFO

Article History:
Received 11th June, 2024
Received in revised form
28th July, 2024
Accepted 29th August, 2024
Published online 30th September, 2024

Key Words:
Pregelatinization technology, Analyzed Statistically.

Corresponding Author:
Diana Atma Budiman Sriharti

ABSTRACT

Non-gluten food-based noodle products are an alternative to replace imported wheat flour. The application of extrusion and pregelatinization technology in the processing of noodles enriched with fish meal plays an important role in determining the quality of noodles. This study aims to determine the physical characteristics of noodles made from sago and cassava enriched with anchovy meal on cooking time, rehydration power, elongation, and color. This study used a simple complete random design with three treatments (M_1, M_2, and M_3). Data were analyzed statistically using analysis of variance (ANOVA). The results showed that dry noodles made from sago and cassava enriched with anchovy meal affected the physical characteristics of noodles. Cooking time ranged from 6.30-8.20 minutes, rehydration power ranged from 103.20-117.80%, elongation ranged from 114.20%-135.53%, and color ranged from 61.10%-67.77%. The use of an extruder is more efficient and practical compared to conventional methods. Gluten-free noodles have better physical characteristics using the extrusion method compared to the conventional method.

Citation*: *Christina Litaay, Diana Atma Budiman, Sriharti, Kenneth Francis Wibisono, Nasha Bachtiar and Daniel Deonisius Pelasula. 2024. *"The Physical Properties of dry Noodles Enriched with Anchovy Protein through Extrusion Process". International Journal of Development Research*, 14, (09), 66685-66687.

INTRODUCTION

Indonesia is the second largest instant noodle consuming country after China. Food diversification efforts are needed by using local foods as alternative foods to replace wheat. Noodles are usually made from wheat flour and contain gluten (Sabbatini *et al*., 2014). One of the materials that can substitute wheat flour is sago flour produced from sago palms. Sago (*Metroxylon* sp.) is one of the palm plants that produces starch and has potential as a source of carbohydrates in the manufacture of food products. Sago trees can thrive in acidic soils and are highly resistant to adverse conditions such as drought and floods. Therefore, sago trees play a significant role in maintaining food security (Zhu, 2019). Sago starch has been utilized by locals in Eastern Indonesia to make traditional foods such as papeda. This further indicates that sago plants have the potential to be used as alternative foods and developed into various types of foods that are popular, easy to process, and preferred by the public, for example, noodles (Heryani & Silitonga, 2018). However, despite the knowledge of the potential of sago plants as alternative foodstuffs, public interest in sago consumption is low. Data on sago flour consumption in Indonesia, which decreased from 0.366 kg/capita/year in 2018 to 0.335 kg/capita/year in 2022. In this regard, developing processed sago products must be increasingly encouraged. Nonetheless, the contents of protein, fat, minerals, and other nutrients in sago noodles are very low. Hence, the sago noodles should be fortified with other foods, such as fish and seaweed to enhance the nutritional value (Litaay *et al*., 2022b). Fish is one source of animal protein that is widely consumed by the public because of its relatively ready availability and affordable price. It is important to note that fish has economic value and can be processed into higher-value food, which will later help the economy of countries with large fishery resources, such as Indonesia (Buchari, 2014). Anchovies (*Stolephorus* sp.) are a type of fish rich in calcium and can be eaten from head to tail. In addition, they are even reported to be one of the least-cost nutritious fish that have the prevalence to be one of the solutions in preventing children stunting. This implies that low-income population in Indonesia can afford anchovies more easily than milk formula. Despite all of those, anchovies are still underutilized. One of the efforts that can be made is employing anchovies as fortification agents. The fortification of noodles with anchovies will increase protein levels in the sago-flour-based noodles (Robinson *et al*., 2022). In addition to fish, this study also incorporates seaweed into the noodles as a continuation study from Litaay *et al*. (2023). Seaweed has a high potential in the food processing industry because of the nutrients it contains. Macroalgae or seaweed is a natural commodity rich in antioxidants, polyphenols, proteins, minerals, and vitamins (Kumar *et al*., 2021). The macroalgae that will be utilized in this study is *Turbinaria ornata*. *Turbinaria ornata* is a brown alga that can be used as a source of iodine and alginate in the process of making human food. Like sago and anchovies, the utilization of macroalgae in Indonesia remains low despite its high potential, availability, and diversity. Sago is a gluten-free food, so the noodle process requires extrusion technology. An extruder machine was applied in the extrusion process of gluten-free noodles making. The use of an extruder is more efficient and practical compared to conventional methods. Additionally, the physical characteristics of gluten-free noodles made by extrusion are better than those made conventionally (Engelen *et al*., 2017). This study was conducted to determine the physical properties of dry noodles enriched with anchovy protein through the extrusion method.

MATERIALS AND METHODS

Materials

The materials that were used in the making of anchovy flour, macroalgae flour, and noodles included anchovies, *Turbinaria ornata* macroalgae, sago flour, sodium bicarbonate, water, and salt. Meanwhile, the materials that were used in proximate analysis consisted of noodle samples, nitrogen free tin foil, oxygen gas (O_2), and carbon dioxide gas (CO_2). The materials for physical tests were noodle samples, water, and distilled water.

Research Design: The research procedure involved the noodles made included a control (100% sago flour) and three treatments. Treatment M1 (75% sago flour, 20% anchovy flour, 5% macroalgae flour). Treatment M2 (75% sago flour, 15% anchovy flour, 10% macroalgae flour). Treatment M3 (75% sago flour, 10% anchovy flour, 15% macroalgae flour).

Cooking time: The water of 200 ml is heated until it boils, then 5 grams of noodles that have been cut into 3 cm long, are put into the boiling water. Every 30 seconds the noodle sheet is placed between the two watch glasses and then pressed. The optimum time is obtained when the entire noodle section absorbs water perfectly or when no white dots are formed when the noodles are pressed with the watch glass. The time is recorded from the boiling of the noodles to the cooking (Collado *et al*., 2001).

Rehydration capacity: Measurements were made by weighing 5 grams of raw noodles as a gram, then the noodles were boiled in 150 ml of water until perfectly gelatinized (7 minutes). After cooking, they were drained and weighed as b grams (Kang *et al*., 2017).

Elongation: The noodles that had been cooked during the cooking time of each sample were drained for 2 minutes at room temperature. The samples were wrapped around the probe with a distance between the probes of 2 cm and a probe speed of 0.3 cm/s. Elongation was measured using a TAXT2 texture analyzer at a speed of 3 mm/s and a force of 100 g (Chen *et al*, 2002).

Color: Color testing is done using a chromameter. The chromameter is first calibrated with the white color standard found on the device. Several samples are placed on a flat container. Color measurement is based on the whiteness index (Gaurav, 2003).

Statistical Analyses

This study used a simple complete random design with three treatments (M_1, M_2, and M_3). Data were analyzed statistically using analysis of variance (ANOVA). Analyses the physical characteristics dry noodles made from sago and cassava enriched with anchovy meal on *cooking time*, Rehydration power, elongation, and color used RAL. The advanced test of BNT performed when ANOVA on treatment had significant effect ($p<0.05$).

RESULTS AND DISCUSSION

Cooking time: The results of the analysis showed that dry noodles made from sago and *Turbinaria ornata* macroalgae enriched with anchovy meal had a significant influence ($P<0.05$) on cooking time. *Cooking time* ranges from 3.40-7.26 minutes (Table 1).

Table 1. Physical Properties of Dried Sago Noodles

Treatment	Cooking Time (min)	Rehydration Capacity (%)	Elongation (%)	Color (W %)
Control	7.26 ± 0.22^{a}	78.93 ± 1.62^{a}	230.84 ± 2.44^{a}	64.32 ± 0.11^{a}
M1	3.40 ± 0.40^{b}	65.18 ± 0.54^{b}	73.29 ± 8.69^{b}	54.79 ± 2.79^{b}
M2	3.50 ± 0.40^{ab}	44.73 ± 0.35^{c}	91.52 ± 0.47^{ab}	49.02 ± 3.42^{bc}
M3	4.50 ± 0.40^{ab}	31.94 ± 1.24^{d}	134.87 ± 25.28^{ab}	45.46 ± 3.63^{c}

The control sample which consisted of sago flour only had the longest average cooking time of 7.26 min. The shortest average cooking time (3.40 min) was achieved by sample M1 which was incorporated by the highest amount of anchovy flour (20%) and the lowest amount of macroalgae flour (5%) (Table 8). It implies that higher concentration of anchovy flour in the sago noodles led to shorter cooking time. The results of the study are in line with the study of sago noodles fortified with skipjack tuna flour, namely the cooking time of the control noodles (12.5 minutes) decreased at a concentration of 8% skipjack tuna flour (8.0 minutes) (Litaay et al., 2022a). This shows that the addition of anchovy flour has a shorter cooking time compared to noodles from a mixture of dry sago and a binding agent which is 8-11 minutes (Thao & Noomhorm 2011). Sago noodles (control) have a longer cooking time due to their high starch content.

Rehydration capacity: The results of the analysis showed that dry noodles made from sago and *Turbinaria ornata* macroalgae enriched with anchovy meal had a significant influence ($P<0.05$) on the rehydration capacity of noodles. Rehydration capacity ranges from 31.94-78.93% (Table 1). The obtained results showed that the control sample had the highest rehydration capacity of 78.93%, then M1 of 65.18%. The decrement in the rehydration capacity was observed when the noodles were incorporated with anchovy and macroalgae flours. These findings are in line with Tuhumury et al. (2020) study in which noodles without fish flour addition had a higher rehydration capacity (64.09%) compared to the rehydration capacity of noodles added with fish flour (49.54%). Litaay et al. (2022b) study also had the same outcome where noodles incorporated with 7% anchovy flour had a lower rehydration capacity at 34% when compared to the control at 52%. In addition to that, Hasanah et al. (2021) study findings are also similar. Noodles made with an increasing seaweed flour led to a decreasing rehydration capacity. Additionally, according to Valentina et al. (2021), rehydration capacity is inversely proportional to moisture content. rehydration capacity is influenced by both protein and fibers available in the anchovy and seaweed flour that bind with water molecules through hydrogen bonding.

Elongation: The results of the analysis showed that dry noodles made from sago and *Turbinaria ornata* macroalgae enriched with anchovy meal had a significant influence ($P<0.05$) on the elongation of noodles. The elongation ranges from 73.29 %-134.87 % (Table 1). The obtained results showed that M3 sample had the highest rehydration capacity of 134.87%. These results are in accordance with Saloko et al. (2024) study in which dried noodles were made of mocaf-sorghum fortified with moringa leaves (*Moringa oleifera*) and seaweed (*Eucheuma cottonii*). This is also in line with Ersyah et al. (2022) study where increased elongation values were observed in noodles incorporated *Spirulina* at a higher concentration. Seaweed has a good water absorption ability which absorbs and retains water that contributes to producing elastic noodle dough because that indicates the ability of protein and starch to form a continuous network with water that attribute to dough elasticity (Yang et al., 2019). According to Litaay et al. (2022b) the quality and elongation of sago noodles are also affected by the extrusion and pregelatinization processes.

Color: The results of the analysis showed that dry noodles made from sago and *Turbinaria ornata* macroalgae enriched with anchovy meal had a significant influence ($P<0.05$) on the color of noodles. The color ranges from 45.46 %-54.79 % (Table 1). The highest white degree value was obtained in the M1 treatment. In addition to the brown pigment of *Turbinaria ornata*, anchovy flour also plays a role in giving color. Wood (2009) reported that the color dried spaghetti generally became significantly ($P < 0.05$) less bright. Fish has six chromatophores, pigment-containing cells that are light reflective. They include melanophores, xanthophores, erythrophores, iridophores, leucophores, and cyanophores (Luo et al., 2021). According to Hata et al. (2021), the main chromatophore found in anchovies are melanophores, thus giving brown and black colors, contributing to the brown color of the sago noodles.

CONCLUSION

Dry noodles made from sago and cassava enriched with anchovy meal affect the noodle's characteristics. *Cooking time* ranges from 6.30-8.20 minutes, rehydration power ranges from 103.20-117.80%, the elongation ranges from 114.20%-135.53%, and the color ranges from 61.10%-67.77%. The use of an extruder is more efficient and practical compared to conventional methods. Gluten-free noodles have better physical characteristics using the extrusion method compared to the conventional method.

REFERENCES

Buchari, D. (2014). Fish Protein Concentrate Fortification Siam Patin on Amplang Snack Products and Mi Sago Instant Product as a Leading Regional Riau. *Jurnal Pengolahan Hasil Perikanan Indonesia, 17*(2). https://doi.org/10.17844/jphpi.v17i2.8719.

Chen, Z., Sagis, L., Legger, A., Linssen, J. P. H., Schols, H. A., & Voragen, A. G. J. (2002). Physicochemical properties of sweet potato starches and their application in noodle product. *Journal of Food Science*, 67(9), 3342-3347. http://dx.doi.org/10.1111/ j.1365-2621.2002.tb09589.x.

Collado, L. S., Mabesa, L. B., Oates, C. G., & Corke, H. (2001). Bihon type noodles from heat-moisture-treated sweet potato starch. *Journal of Food Science*, 66(4), 604-609. http://dx.doi. org/10.1111/j.1365-2621.2001.tb04608.x.

Engelen, A., Sugiyono, & Budijanto, S. (2017). Chemical characteristic on making of dried sago (Metroxylon sagu) noodles. *Jurnal Agroindustri Halal, 3*(1), 1–9. https://doi.org/ 10.30997/jah.v3i1.691.

Ersyah, D., Jaziri, A. A., & Setijawati, D. (2022). Effect of spirulina (Arthrospira platensis) powder on the Physico-chemical and sensory characterization of dry noodle. *Journal of Aquaculture and Fish Health, 11*(3), 277-288. https://doi.org/10.20473/jafh.v11i3.20908.

Hasanah, A. N., Munandar, A., Surilayani, D., Haryati, S., Aditia, R. P., Sumantri, M. H., Pratama, G., & Meata, B. A. (2021). Characterization of dried noodles from seaweed (*Kappaphycus alvarezii*) as potential substitute for wheat flour. *Food Scientech Journal, 3*(2), 113-120. https://doi.org/10.33512/fsj.v3i2.13001.

Hata, H., Lavoué, S., & Motomura, H. (2021). Taxonomic status of nominal species of the anchovy genus Stolephorus previously regarded as synonyms of Stolephorus commersonnii Lacepède 1803 and Stolephorus indicus (van Hasselt 1823), and descriptions of three new species (Clupeiformes:Engraulidae). *Ichthyological Research, 68*, 327-372. https://doi.org/10.1007/s10228-020-00792-0.

Heryani, S., & Silitonga, R. F. (2017). The use of sago (Metroxylon sp.) flour as the ingredient of chocolate cookies. *Warta Industri Hasil Pertanian, 34*(2), 53-57.

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.

Kumar, Y., Tarafdar, A., & Badgujar, P. C. (2021). Seaweed as a source of natural antioxidants: Therapeutic activity and food applications. *Journal of Food Quality*, 2021, 1-17. https://doi.org/10.1155/2021/5753391.

Litaay, C., Indriati, A., Mayasti, N. K. I., Tribowo, R. I., Andriana, Y., & Andriansyah, R. C. E. (2022a). Physical, chemical, and sensory quality of noodles fortification with anchovy (Stolephorus sp.) flour. *Food Science and Technology*, *42*, e75421. https://doi.org/10.1590/fst.75421.

Litaay, C., Indriati, A., Mayasti, N. K. I., Tribowo, I., Andriansyah, R. C. E., & Daryanto, A. A. (2022b). Characteristics of sago noodles high in protein and calcium. IOP Conference Series: Earth and Environmental Science, 1033(1), 012061–012061. https://doi.org/10.1088/1755-1315/1033/1/012061.

Litaay, C., Arfah, H., & Pattipeilohy, F. (2022c). Potensi sumber daya hayati rumput laut di pantai pulau ambon sebagai bahan makanan. *Jurnal Pengolahan Hasil Perikanan Indonesia, 25*(3), 405-417. https://doi.org/10.17844/jphpi.v25i3.41647.

Litaay, C., Mutiara, T. A., Indriati, A., Novianti, F., Nuraini, L., & Rahman, N. (2023). Fortification of Anchovy (*Stolephorus* sp.) Flour on Physical Characteristics and Microstructures of Sago-Based Noodles. *Jurnal Pengolahan Hasil Perikanan Indonesia, 26*(1),127-138. https://doi.org/10.17844/ jphpi.v26i1.45159.

Luo et al., 2021). Luo, M., Lu, G., Yin, H., Wang, L., Atuganile, M., & Dong, Z. (2021). Fish pigmentation and coloration: Molecular mechanisms and aquaculture perspectives. Reviews in Aquaculture, 13(4), 2395-2412. https://doi.org/10.1111/ raq.12583.

Robinson, J. P., Mills, D. J., Asiedu, G. A., Byrd, K., Mancha Cisneros, M. D. M., Cohen, P. J., Fiorella, K. J., Graham, N. A. J., MacNeil, M. A., Maire, E., Mbaru, E. K., Nico, G., Omukoto, J. O., Simmance, F., & Hicks, C. C. (2022). Small pelagic fish supply abundant and affordable micronutrients to low-and middle-income countries. *Nature food, 3*(12), 1075-1084. https://doi.org/10.1038/s43016-022-00643-3.

Sabbatini, S. B., Sanchez, H. D., Torre, M. A., & Osella, C. A. (2014). Design of a premix for making gluten free noodles. *International Journal of Nutrition and Food Sciences, 3*(5), 488-492. https://doi.org/10.11648/j.ijnfs.20140305.29.

Saloko, S., Paramartha, D. N. A., & Sukmawati, M. (2024). Fortification of moringa leaves (*Moringa oleifera*) and seaweed (*Eucheuma cottonii*) on the quality of Mocaf sorgum dried noodles. *BIO Web of Conferences*, 99, 1-15. https://doi.org/10.1051/bioconf/20249902020.

Shang, J., Zhao, B., Li, L., Liu, M., Hong, J., Fan, X., Wu, T., Liu, C., & Zheng, X. (2023). Impact of A/B-type wheat starch granule ratio on rehydration behavior and cooking quality of noodles and the underlying mechanisms. *Food Chemistry*, 405,134896. https://doi.org/10.1016/ j.foodchem.2022.134896

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

Thao, H. M., & Noomhorm, A. (2011). Physicochemical properties of sweet potato and mung bean starch and their blends for noodles production. *Journal of Food Processing & Technology*, 2(01), 1-9. http://dx.doi.org/10.4172/2157-7110.1000105.

Tuhumury, H. C. D., Ega, L., & Sulfiyah, P. (2020). Physical characteristics of wet noodles with variations of wheat flour, mocaf flour, and tuna fish flour. *The Journal of Fisheries Development, 4*(1), 43-50.

Valentina, A., Masirah, M., & Lailatussifa, R. (2021). Effect of fortification of different types to fish on organoleptic level and physical characteristics of wet noodles. *Chanos Chanos, 19*(1), 125-134. https://doi.org/10.15578/chanos.v19i1.9610.

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.

Yang, Y., Guan, E., Zhang, T., Li, M., & Bian, K. (2019). Influence of water addition methods on water mobility characterization and rheological properties of wheat flour dough. Journal of cereal science, 89, 102791. https://doi.org/10.1016/j.jcs.2019.102791.

Zhu, F. (2019). Recent advances in modifications and applications of sago starch. *Food Hydrocolloids*, 96, 412-423. https://doi.org/ 10.1016/j.foodhyd.2019.05.035.

****