agriTECH, 44 (2) 2024, 109-116

Effect of Varied NaCl Soaking Treatment on Chemical Composition of Lesser Yam Flour and Its Use in the Production of Gluten-Free Noodles

Laksmi Putri Ayuningtyas[1*], Devry Pramesti Putri[2]

[1]Food Technology Study Program, Faculty of Agriculture, Jenderal Soedirman University,
Dr. Soeparno Street, No. 63, Grendeng, North Purwokerto 53124, Indonesia
[2]Research Center for Appropriate Technology, BRIN, K. S. Tubun Street No. 5 Subang 41213, Indonesia
[*]Corresponding author: Laksmi Putri Ayuningtyas, Email: laksmiputria@gmail.com

Submitted: September 23, 2022; Revised: February 8, 2023, March 4, 2023; Accepted: September 6, 2023;
Published: May 31, 2024

ABSTRACT

In order to reduce dependence on wheat flour, it was necessary to use alternative options, such as lesser yam flour. The production of lesser yam flour consisted of soaking yam tubers in NaCl solutions of different concentrations (20% and 25%). This soaking process was necessary for enhancing the physical characteristics of the flour, resulting in reduced mucus and a whiter appearance. The diverse NaCl concentrations during soaking significantly affected chemical composition of lesser yam flour, impacting parameters, including moisture, ash, fat, total protein, reducing sugar, total sugar, glucomannan content, and calories. However, no discernible effect was observed on the crude fiber and carbohydrate content. In comparison to the 25% NaCl, the 20% NaCl had lesser yam flour with lower moisture, ash, protein, total sugar, and reducing sugar content, but higher fat, glucomannan, and calories. The 25% NaCl soaked lesser yam flour was selected for the production of gluten-free dry noodles. Dry noodles were prepared with various proportions of lesser yam flour and mocaf flour, including 0:100 (TG0), 50:50 (TG1), 50:40 (TG2), 70:30 (TG3), 80:20 (TG4), and 90:10 (TG5). An increase in the proportions of lesser yam flour resulted in increased hardness and chewiness, along with decreased springiness and cohesiveness. Therefore, lesser yam could be processed into flour by soaking in NaCl solutions to produce better flour, with the optimal flour composition being 80% lesser yam flour and 20% mocaf flour for gluten-free noodles production. This suggested the potential for further development of lesser yam flour as a raw material for the production of gluten-free noodles.

Keywords: Chemical composition; *Dioscorea esculenta*; flour; gluten-free; noodles

INTRODUCTION

Flour derived from lesser yam is used in various food products, particularly dry noodles, but processing the tubers into flour poses a challenge due to their high mucilage content. Several reviews have reported that soaking in NaCl solutions improve the physical quality of flour and affect chemical composition of tubers such as Indian three-leaved yam (*Dioscorea hispida* Densst) (Rastiyati et al. 2016), cocoyam (*Xanthosoma sagittifolium*) (Suharti et al. 2019), *Amorphophallus variabilis* Bi (Ulfa and Nafi'ah 2018).

Noodles are widely popular, particularly in Asian regions, where they serve as a staple food. This shows there is a wide range of noodles varieties based on types, characteristics, processing conditions, and ingredients (Wangtueai et al. 2020). In Indonesia, the staple food is typically made from wheat flour, which is

DOI: http://doi.org/10.22146/agritech.77976
ISSN 0216-0455 (Print), ISSN 2527-3825 (Online)

predominantly imported due to the necessity of forming a gluten network during the production. However, gluten consumption can potentially trigger genetic celiac disease, an autoimmune disorder affecting 0.5-1% of the general population (Caio et al. 2019). The partial digestion of gluten can lead to the formation of mixed peptides, which can trigger host responses, including increased intestinal permeability and adaptive immune responses (Lebwohl and Rubio-Tapia 2021). Therefore, it is necessary to explore and develop alternative solutions to reduce Indonesian reliance on wheat flour.

Lesser yam (*Dioscorea esculenta*) is a local tuber readily available in markets or growing wild in yards, typically consumed in traditional dishes prepared by boiling or steaming. The *Dioscorea* group offers bioactive compounds such as Dioscorin and Diosgenin, along with water-soluble polysaccharides, particularly glucomannan, which can generate mucus when mixed with water (Prabowo et al. 2014). Despite having high carbohydrate content, the use of lesser yam is limited due to insufficient information on its complete chemical composition.

Gluten-free noodles, where gluten is completely removed and replaced with high-carbohydrate ingredients, pose a significant challenge as they lack the gluten network found in wheat noodles, resulting in different characteristics (Sabbatini 2014). Achieving high-quality gluten-free noodles from alternative flour requires a well-balanced formulation and appropriate technology selection due to changes in rheological properties caused by the absence of gluten. Alternative ingredients, including corn, rice, and tuber flour or starch, supplemented with protein, gum, and emulsifiers, are expected to replace wheat flour (Padalino et al. 2016).

Dry noodles made from lesser yam flour have previously used wheat flour as a substitute (Winarti et al. 2017). An alternative to wheat flour is mocaf flour (Modified Cassava Flour), which has found extensive application in various food products, comprising dry noodles, wet noodles, analog rice, and bread (Philia et al. 2020). However, noodles produced from mocaf flour often lack texture due to the absence of gluten. Combining mocaf with lesser yam flour, which contains hydrocolloids, is expected to improve texture. To date, there have been no reviews examining the use of lesser yam flour alongside mocaf flour as a composite flour for gluten-free noodles production and assessing their characteristics. Therefore, this research aims to determine the effect of soaking lesser yam in NaCl solution on chemical composition of flour and evaluate how its composition affects the production of gluten-free noodles.

METHODS

Materials

Fresh lesser yam tubers sourced from farmers in the Banyumas area, along with soaking solutions, such as $Na_2S_2O_5$ and NaCl, were needed in the flouring process. The ingredients needed for making gluten-free dry noodles included mocaf flour, tapioca, eggs, water, salt, CMC, glycerol, and chemical composition. The required tools included a blender, filter cloth, cabinet dryer, noodles maker, analytical balance, aluminum cup, burette, oven (Memmert), desiccator, furnace, beaker glass, erlenmeyer, volumetric flask, test tube, Kjeldahl flask, Soxhlet flask, measuring cup, water bath (Shibata), spectrophotometer (Spectronic), and Texture Analyzer (TAXT-Plus, Stable Micro System, Surrey, UK).

Preparation of Lesser Yam Flour

Fresh lesser yam tubers were weighed and washed in running water to remove dirt before being subjected to blanching at 80°C for 2 minutes to inactivate enzymes, prevent browning, and facilitate peeling. Following blanching, the tubers were peeled and cut into smaller pieces, which were then soaked in a solution comprising 0.6% $Na_2S_2O_5$ and NaCl with varying concentrations of 20% and 25% for 2 hours before being rinsed and dried in an oven at 70°C for 24 hours. The selection of NaCl concentration during soaking was attributed to its ability to produce flour with good physical characteristics, including reduced mucilage content and a whiter color compared to other concentrations. Flour was then analyzed for physicochemical parameters comprising proximate (water, ash, protein, fat, carbohydrate by difference), crude fiber, total sugar, and reducing sugar (AOAC, 2005), calories (Seftiono et al. 2019), and glucomannan (Ulfa and Nafi'ah 2018).

Preparation of Gluten-Free Dry Noodles (Violalita et al. 2020 with Modifications)

The production of gluten-free dry noodles comprised a combination of lesser yam flour and mocaf flour. Initially, the ingredients were weighed according to predetermined proportions, including lesser yam flour and mocaf flour in ratios ranging from 0:100 (TG0) to 90:10 (TG5), alongside other components. All ingredients were thoroughly mixed and kneaded into a homogeneous dough, which was then passed through noodles maker to form strands with a thickness of 2 mm. These noodles strands were subjected to steaming for 5 minutes and were subsequently dried in an oven at 60 °C for 8 hours.

Analysis of Texture Characteristics of Gluten-Free Dry Noodles

Dry noodles were assessed for moisture content and texture profile, including hardness, springiness, cohesiveness, and chewiness, using a Texture Profile Analyzer based on the Stable Micro System guidelines (Afifah and Ratnawati 2017). Several strands of boiled noodles were positioned on a metal plate beneath the probe. The analysis was conducted using a P/36R cylinder with specific parameters, comprising trigger type, auto 0.5g, pre-test speed 2 mm/s, test speed 2 mm/s, post-test 10 mm/s, and 60% strain. Each treatment was analyzed five times, with a minimum strand length of 10 cm, and the research flow chart was presented in Figure 1.

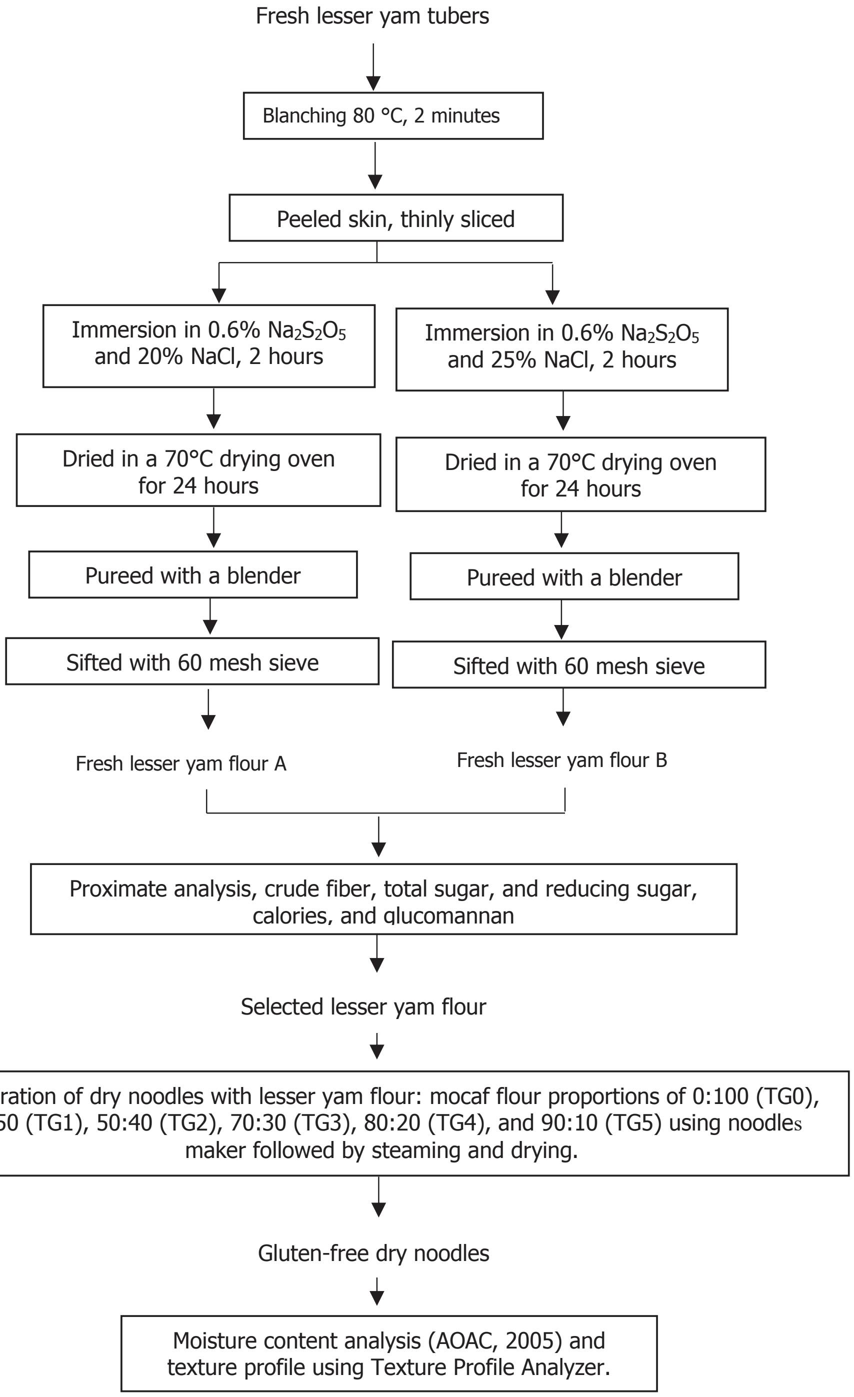

Figure 1. Research flowchart

Statistical Analysis

The obtained data were statistically analyzed using a T-test for flour samples and an F-test for dry noodles samples. Significant differences were assessed through one-way ANOVA followed by Duncan's post-hoc test at a 95% significance level (P<0.05), and statistical analysis was performed using SPPS 16 software.

RESULTS AND DISCUSSION

Lesser Yam Flour Chemical Parameters

Lesser yam was cut and soaked in 0.6% $Na_2S_2O_5$ and NaCl solutions with varying concentrations of 20 and 25% for 2 hours before being rinsed and dried. Preliminary research showed that soaking in NaCl solutions below 20% resulted in tuber pieces containing excessive mucus, making flour production challenging. Soaking at different NaCl concentrations, specifically 20% and 25%, significantly affected all chemical parameters tested, except crude fiber and carbohydrate content. Chemical composition of lesser yam flour was presented in Table 1, and mocaf flour was reported to contain 11.9% water, 1.3% ash, 1.2% protein, 0.6% fat, 85% carbohydrate, and 6% dietary fiber (Rahman et al. 2021), rendering noodles a low-fat and relatively high-fiber food product.

Moisture Content

The moisture content of lesser yam flour soaked in 20% and 25% NaCl solutions was 6.54 ± 0.02 and 7.33 ± 0.01%, respectively, lower than the results reported by (Saskiawan and Nafi 2014, Retnowati et al. 2019). Meanwhile, moisture content was regarded as an important factor in determining the quality of flour. According to SNI standards, wheat flour should not exceed a maximum moisture content of 14.5%, and ash content showed the mineral composition of a material. In lesser yam flour soaked in 20% and 25% NaCl solutions, the ash content was 1.21 ± 0.03 and 2.25 ± 0.01%, respectively, higher than the results reported by (Saskiawan and Nafi 2014). The increase in ash content was related to higher NaCl concentrations, which contributed to the mineral content of flour. Therefore, the greater NaCl concentrations used for soaking, the higher the ash content.

Fat Content

The fat content of the two flour treatments showed a significant difference, with higher NaCl concentrations correlating to lower fat content. This phenomenon was attributed to fat oxidation, which was triggered by the presence of increased water content. An increase in water content led to higher concentrations of radicals necessary for the initiation stage (Sainnoin et al. 2019).

Protein Content

Regarding protein content, both flour treatments showed increased total protein levels with higher NaCl concentrations during soaking. This increase was likely due to microbial activity, which produced protease enzymes during soaking (Zarnila, 2021). The total protein content in this research fell within a similar range as reported by (Retnowati et al. 2019), approximately ± 3%. Specifically, the protein content in lesser yam tubers flour surpassed that of edible canna (*Canna edulis*) and

Table 1. Chemical content of lesser yam flour in soaking treatment with different NaCl concentrations

Chemical parameters	Lesser yam flour A	Lesser yam flour B
Moisture (%)	6.54± 0.02a	7.33± 0.01b
Ash (% w.b.)	1.21± 0.03a	2.25± 0.01b
Fat (% w.b.)	0.18± 0.02b	0.10± 0.01a
Total protein (% w.b.)	3.18± 0.02a	3.83± 0.01b
Fiber (% w.b.)	1.25± 0.03a	1.42± 0.01a
Carbohydrate by difference (% w.b.)	88.89± 0.03a	86.49± 0.00a
Calorie (cal)	344.84± 0.01b	336.43± 4.86a
Reduced sugar (% w.b.)	10.00± 0.03a	10.73± 0.03b
Total sugar (% w.b.)	11.83± 0.03a	12.59± 0.02b
Glucomannan (% db)	12.5± 0.11b	8.61± 0.08a

*Values are expressed as mean ± standard deviation; numbers followed by the same letter in a row show no difference at the 95% significance level (*p*<0.05) using a t-test.

taro (*Colocassia esculenta*) flour, reported at 1.665 and 2.375%, respectively (Herawati and Kamsiati 2021).

Crude Fiber Content

Crude fiber represented the part of dietary fiber resistant to acid or base hydrolysis, primarily consisting of cellulose (60-80%) and lignin (4-6%), alongside some mineral content. This type of fiber was associated with various health benefits, including the prevention of constipation, diverticulosis, coronary heart disease, and certain cancers (Madhu et al. 2017). Although the crude fiber content was lower than the content reported by Omohimi et al. (2018), ranging from 1.3-2%, no significant difference was observed between the two treatments. Similar results were observed in the carbohydrate content calculated by difference.

Carbohydrate Content (by difference), Reduced Sugar, Total Sugar, and Glucomannan

In this research, the carbohydrate content was higher compared to the results by (Omohimi et al. 2018). Specifically, reducing sugar and total sugar levels significantly increased with higher NaCl concentrations during soaking. The analyzed lesser yam flour had glucomannan levels ranging from 8.61 ± 0.08 to 12.5 ± 0.11%. However, the levels were lower than those found in *porang* tubers (*Amorphophalus muelleri*), which were reported to reach about 57% (Witoyo et al. 2020). Glucomannan, a natural heteropolysaccharide macromolecule extracted from tubers comprised D-glucose and D-mannose molecules linked by α-1,4-glycosidic bonds. It had good textural properties such as water binding, thickening, film forming, and gelling (Zhang et al. 2020). Interestingly, higher NaCl concentrations during soaking resulted in lower glucomannan content. Given the need for hydrocolloids in gluten-free noodles to maintain a compact texture, good consistency, and better mouthfeel (Padalino et al. 2016), flour treated with 20% NaCl immersion was selected for noodles production.

Effect of Lesser Yam Flour Proportion Treatment on Texture Parameters of Dry Noodles

Hardness

In the preparation of dry noodles, lesser yam flour and mocaf flour were combined in a certain proportion and analyzed for texture profile. The hardness parameter, which described the peak force during the first bite, was evaluated (El-Sohaimy et al. 2020). The results showed that increasing the proportion of lesser yam flour led to increased noodles hardness. As shown in Table 3, noodles with 40% and 30% lesser yam flour had softer characteristics compared to those with 100% mocaf flour. The results were in line with previous reviews (Winarti et al. 2017), suggesting that adding lesser yam flour enhanced noodles hardness. The hardness of noodles was affected by the starch development ability of flour used. Flour or starch that lacked development would result in harder and more elastic noodles. Additionally, texture characteristics, such as noodles hardness, could be affected by cooking losses and the starch gelatinization process during the preparation of the staple food. The moisture content of dry noodles for each treatment was presented in Table 2. The addition of lesser yam flour led to an increase in the moisture content of dry noodles produced. Moreover, higher proportions of lesser yam flour (up to 80%) corresponded to increased moisture levels. This phenomenon was attributed to the higher glucomannan content, which enhanced water-binding capacity. Therefore, an increased water content in the production of dry noodles contributed to their reduced hardness.

Table 2. Moisture content of dry noodles in each treatment

Treatment	Moisture content (%)
TG0	9.15a
TG1	11.13c
TG2	12.44e
TG3	12.08d
TG4	12.23de
TG5	10.58b

*Numbers followed by the same letter in one column show no difference at the 95% significance level (p<0.05).

Notes:

TG0 (lesser yam flour:mocaf flour = 0:100), TG1 (lesser yam flour:mocaf flour = 50:50), TG2 (lesser yam flour:mocaf flour = 60:40), TG3 (leser yam flour:mocaf flour = 70:30), TG4 (lesser yam flour:mocaf flour = 80:20), TG5 (lesser yam flour:mocaf flour = 90:10).

Springiness

The springiness or elasticity parameter (cm) measured the recovery time between the end of the first bite and the beginning of the second bite. It was calculated as the ratio of T2 to T1, where T1 represented the distance between the beginning and the highest point of the first bite, and T2 represented the distance between the beginning and the highest point of the second bite (El-Sohaimy et al. 2020). The texture parameter springiness showed an increasing trend in noodles elasticity as the percentage of lesser yam flour added increased from 0.65 to 0.88, significantly

Table 3. Texture parameter values of each noodles treatment

Texture parameter	Hardness (gf)	Springiness	Cohesiveness	Chewiness
TG0	2153.33ab	0.63a	0.77c	1873.18c
TG1	1724.52a	0.65a	0.67b	605.13a
TG2	1881.07a	0.77b	0.62a	707.72ab
TG3	2217.63ab	0.87cd	0.66b	1142.28b
TG4	2672.8b	0.88d	0.59a	2059.14c
TG5	1931.41a	0.79bc	0.58a	608.17a

*Numbers followed by the same letter in one column show no difference at the 95% significance level ($p<0.05$).
Notes:
TG0 (lesser yam flour:mocaf flour = 0:100), TG1 (lesser yam flour:mocaf flour = 50:50), TG2 (lesser yam flour:mocaf flour = 60:40), TG3 (lesser yam flour:mocaf flour = 70:30), TG4 (lesser yam flour:mocaf flour = 80:20), TG5 (lesser yam flour:mocaf flour = 90:10).

surpassing noodles made from 100% mocaf flour. Previous research by (Winarti et al. 2017) also reported a reduction in the elasticity level of the staple food with the use of lesser yam flour. The optimal treatment was observed with noodles containing 15% lesser yam flour. The elasticity of the staple food was affected by the starch and glucomannan content present in lesser yam flour. In this case, low amylose starch content contributed to a chewier and more elastic texture. Mocaf flour, which had a lower protein content, resulted in noodles with a less elastic texture. Therefore, the addition of starch and glucomannan content from lesser yam flour improved the elasticity of noodles, and the springiness value was presented in Table 3.

Cohesiveness

Cohesiveness was measured as the ratio of the area under the pressure peak during the second compression divided by the area under pressure during the first compression (El-Sohaimy et al. 2020). Additionally, it could be measured as the degree to which the material was mechanically crushed. The results showed that the addition of lesser yam flour significantly reduced the cohesiveness of noodles, decreasing the score from 0.77 to 0.58, and detailed cohesiveness values were presented in Table 3.

Chewiness

Chewiness, which was the most challenging texture parameter measurement, stimulated the oral chewing process covering multiple simultaneous actions such as compressing, shearing, piercing, grinding, tearing, and cutting, facilitated by saliva lubrication at body temperature (Indiarto, R. et al. 2012). The results showed that increasing the amount of lesser yam flour raised the chewiness of noodles, though it decreased when surpassing 80% lesser yam flour content. The chewiness value of dry noodles was presented in Figure 4.

Dry noodles made from wheat flour had a hardness value of 8840±2.7, springiness of 0.73±0.07, and chewiness of 4444.52±1766.14 (Agusman et al. 2020). In contrast, gluten-free noodles had a lower hardness value, similar springiness, and reduced chewiness compared to their wheat counterparts. Therefore, gluten-free noodles showed limitations, being more prone to crumbling and less chewy than wheat noodles. The optimal treatment identified through the effectiveness index method (Afifah and Ratnawati 2017) was treatment TG4, featuring a ratio of 80:20 for lesser yam flour to mocaf flour. This treatment had superior values for hardness, springiness, chewiness, and cohesiveness, indicating its higher productivity relative to other treatments.

CONCLUSION

In conclusion, soaking in different NaCl solutions (20 and 25%) significantly affected chemical composition of lesser yam flour, including moisture, ash, fat, total protein, reducing sugar, total sugar, glucomannan, and caloric value. However, there was no significant impact on crude fiber and carbohydrate content. Noodles prepared with different ratios of lesser yam flour and mocaf flour had distinct characteristics across treatments in terms of hardness, springiness, cohesiveness, and chewiness. A higher proportion of lesser yam flour to mocaf flour resulted in increased hardness, springiness, and chewiness of dry noodles. The optimal treatment composition was found to be a ratio of lesser yam flour to mocaf flour of 80:20. With lesser yam flour capable of constituting up to 80% of gluten-free noodles, there was potential for its use in the production of noodles.

ACKNOWLEDGMENTS

The authors thank the Directorate of Research, Technology and Community Service, The Indonesian Ministry of Education, Culture, Research, and Technology for funding support through the Beginner Lecturer Research scheme for the fiscal year 2022. Additionally, texture analysis was supported by research facilities at the Appropriate Technology Research Laboratory - BRIN, Subang.

CONFLICT OF INTEREST

The authors declare no conflicts of interest with any parties in this research.

REFERENCES

[AOAC]. Association of Official Analytical Chemistry International. 2005. Official Methods of Analysis of AOAC INTERNATIONAL.

Afifah, N. and L. Ratnawati. (2017). Quality assessment of dry noodles made from a blend of mocaf flour, rice flour, and corn flour. IOP Conference Series: Earth and Environmental Science 101.

Agusman, Murdinah, & T. Wahyuni. (2020). The nutritional quality and preference of wheat noodles incorporated with Caulerpa sp. seaweed. *International Food Research Journal*, *27*, 445–453.

Caio, G., U. Volta, A. Sapone, D. A. Leffler, R. De Giorgio, C. Catassi, & A. Fasano. (2019). Celiac disease: A comprehensive current review. *BMC Medicine*, *17*, 1–20.

El-Sohaimy, S. A., M. Brennan, A. M. G. Darwish, & C. Brennan. (2020). Physicochemical, texture and sensorial evaluation of pasta enriched with chickpea flour and protein isolate. Annals of Agricultural Sciences 65:28–34.

Herawati, H., and E. Kamsiati. (2021). Characteristics of various flour and gluten free noodles from Indonesian local food. *IOP Conference Series: Earth and Environmental Science 803.*

Indiarto, R., N. B, and S. E. (2012). Kajian Karakteristik tekstur dan organoleptik daging ayam asap berbasis teknologi asap cair tempurung kelapa. *Jurnal Teknologi Hasil Pertanian 5,* 106–116.

Lebwohl, B. and A. Rubio-Tapia. (2021). Epidemiology, presentation, and diagnosis of celiac disease. *Gastroenterology*, *160*, 63–75.

Madhu, C., K. M. Krishna, K. R. Reddy, P. J. Lakshmi, and E. Kumar Kelari. (2017). Estimation of crude fibre content from natural food stuffs and its laxative activity induced in rats. International *Journal of Pharma Research and Health Sciences, 5*, 1703–1706.

Omohimi, C. I., C. Piccirillo, M. Roriz, V. Ferraro, M. W. Vasconcelos, L. O. Sanni, K. Tomlins, M. M. Pintado, and L. A. Abayomi. (2018). Study of the proximate and mineral composition of different Nigerian yam chips, flakes and flours. *Journal of Food Science and Technology, 55*, 42–51.

Padalino, L., A. Conte, and M. A. Del Nobile. 2016. Overview of the general approaches to improve gluten-free pasta and bread. *Foods, 5*, 1–18.

Philia, J., Widayat, Hadiyanto, M. Suzery, and I. A. Budianto. (2020). Diversifikasi tepung mocaf menjadi produk mie sehat di PT. Tepung Mocaf Solusindo. *Indonesia Journal of Halal 2*, 40–45.

Prabowo, A. Y., E. Teti, and P. Indria. (2014). Gembili (Dioscorea esculenta L.) as food contain bioactive compounds: a review. *Jurnal Pangan dan Agroindustri 2*, 129–135.

Rahman, M. H. R., R. P. Ariani, and L. Masdarini. (2021). Substitusi penggunaan tepung mocaf (modified cassava flour) pada butter cookies kelapa. *Jurnal Kuliner 1*, 89–97.

Rastiyati, N. L. D., A. Hartiati, and B. Admadi. (2016). Pengaruh konsentrasi Nacl dan rasio air dengan bahan terhadap karakteristik mutu pati ubi gadung (*Dioscorea hispida* Dennst). *J. Rekayasa dan Manajemen Agroindustri, 4*, 116–125.

Retnowati, D. S., R. Ratnawati, and A. C. Kumoro. (2019). Nutritional characteristics and potential applications of flour prepared from Indonesian wild white yam (*Dioscorea esculenta* L.). *Reaktor 19*, 43–48.

Sabbatini, S. B. (2014). Design of a premix for making gluten free noodles. *International Journal of Nutrition and Food Sciences*, *3*, 488.

Sainnoin, R. A., R. S. Mauboy, and V. M. Ati. (2019). Pengaruh kadar NaCl terhadap kadar lemak beberapa jenis ikan asin yang dijual di pasar oeba dan pasar oesapa kota kupang. *Jurnal Biotropikal Sains 16*, 78–92.

Saskiawan, I., and M. Nafi. (2014). Sifat fisikokimia tepung gembili (*Dioscorea esculenta* (Lour.) Burk.) hasil fermentasi dengan penambahan inokulum bakteri selulolitik dan bakteri asam laktat. *Jurnal Biologi Indonesia*, *10*, 101–108.

Seftiono, H., E. Djiuardi, and S. Pricila. (2019). Analisis proksimat dan total serat pangan pada crackers fortifikasi tepung tempe dan koleseom (Talinumtiangulare). *Agritech 39,* 160.

Suharti, S., Y. Sulastri, and A. Alamsyah. (2019). Pengaruh lama perendaman dalam larutan NaCl dan lama pengeringan terhadap mutu tepung talas belitung (*Xanthosoma sagittifolium*). *Pro Food, 5*, 402–413.

Ulfa, D. A. N., and R. Nafi'ah. (2018). Pengaruh perendaman NaCl terhadap kadar glukomanan dan kalsium oksalat tepung iles-iles (*Amorphophallus variabilis* Bi). *Cendekia Journal of Pharmacy, 2*, 124–133.

Violalita, F., Evawati, S. Syahrul, H. F. Yanti, and K. Fahmy. (2020). Characteristics of gluten-free wet noodles substituted with soy flour. IOP Conference Series: Earth and Environmental Science 515.

Wangtueai, S., Y. Phimolsiripol, C. Vichasilp, J. M. Regenstein, and R. Schöenlechner. (2020). Optimization of gluten-free functional noodles formulation enriched with fish gelatin hydrolysates. LWT 133.

Winarti, S., E. K. B. Susiloningsih, and F. Y. Z. Fasroh. (2017). Karakteristik mie kering dengan substitusi tepung gembili dan penambahan plastiziser gms (gliserol mono stearat). *Agrointek 11*, 53.

Witoyo, J. E., E. Ni'Maturohmah, B. D. Argo, S. S. Yuwono, and S. B. Widjanarko. (2020). Polishing effect on the physicochemical properties of porang flour using centrifugal grinder. IOP Conference Series: Earth and Environmental Science 475.

Zarnila, Ansharullah, & Hermanto. (2021). Pengaruh lama perendaman terhadap karakteristik proksimat dan fisikokimia tepung umbi gadung (*Dioscorea hispida* Dennst) *J. Sains dan Teknologi Pangan*, *6*(5), 4436–4449.

Zhang, L., L. Zeng, X. Wang, J. He, and Q. Wang. (2020). The influence of Konjac glucomannan on the functional and structural properties of wheat starch. *Food Science and Nutrition, 8*, 2959–2967.