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EFFECT OF SOYBEAN FLOUR ADDITION ON THE PHYSICOCHEMICAL AND ORGANOLEPTIC PROPERTIES OF BENENG TARO DRIED NOODLES

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Abstrak

Ketergantungan Indonesia pada impor gandum telah mendorong minat pada alternatif tepung lokal, meskipun formulasi sebelumnya menggunakan tepung talas beneng dan MOCAF menghadapi tantangan dalam mencapai kandungan protein 10% yang disyaratkan oleh Standar Nasional Indonesia (SNI). Untuk mengatasi hal ini, tepung kedelai Anjasmoro, yang dikenal dengan kandungan proteinnya yang tinggi, dimasukkan pada tingkat (0, 5, 10, 15, dan 20%). Penelitian ini bertujuan untuk mengetahui pengaruh penambahan tepung kedelai Anjasmoro terhadap karakteristik fisikokimia dan organoleptik mi kering yang dibuat. Penelitian ini disusun dengan menggunakan rancangan acak lengkap (RAL) dengan satu faktor. Hasil menunjukkan bahwa mi dengan penambahan 15% tepung kedelai mencapai tingkat protein optimal, memenuhi standar SNI, sekaligus meningkatkan kecerahan warna berkat pigmen karotenoid alami pada kedelai. Namun, peningkatan kadar tepung kedelai juga meningkatkan kehilangan saat memasak dan memperpanjang waktu memasak akibat interaksi pati-protein yang berubah, sehingga diperlukan formulasi seimbang untuk menjaga tekstur dan kualitas. Penelitian ini menegaskan potensi penggunaan tepung lokal dalam mi kering, menawarkan produk yang lebih bergizi sambil mendukung sektor pertanian Indonesia dan mengurangi ketergantungan pada impor gandum.

Kata Kunci: Kedelai Anjasmoro; Mi kering; Protein; Talas beneng; Tepung komposit

Abstract

Indonesia's reliance on wheat imports has spurred interest in local flour alternatives. However, prior formulations using beneng taro and MOCAF faced challenges in reaching the 10% protein content required by the Indonesian National Standard (SNI). To address this, Anjasmoro soybean flour, known for its high protein content, was incorporated at levels of (0, 5, 10, 15. and 20%). This study aims to determine the effect of Anjasmoro soybean flour on the physicochemical and organoleptic characteristics of dried noodles. This research was arranged using a completely randomized design (CRD) with one factor. Results showed that noodles with a 15% addition of soybean flour achieved optimal protein levels, meeting SNI standards while enhancing color vibrancy through the natural carotenoid pigments in soy. However, increasing soybean flour levels raised cooking losses and prolonged cooking times due to altered starch-protein interactions, underscoring the need for a balanced formulation to maintain texture and quality. This research underscores the potential of using local flours in dried noodles, offering a nutritionally improved product while supporting Indonesia's agricultural sector and reducing dependence on wheat imports.

Keywords*: Anjasmoro soybean; Beneng taro; Composit flour; Dried noodles; Protein*

1. INTRODUCTION

Noodles are a popular food product in Indonesia, ranking second globally in noodle consumption in 2018, consuming 12.54 billion packs (Sukamto et al., 2019). Among various noodle types, dried noodles are commonly consumed and are primarily made from wheat flour, as per the Indonesian National Standard (SNI) 8217-2015. However, Indonesia's noodle production heavily depends on imported wheat, with 11.48 million tons imported in 2017 (Widiawati et al., 2022). This dependency has prompted research into alternatives, focusing on local flours to reduce wheat imports.

Efforts to substitute wheat flour with locally sourced flours, such as beneng taro and modified cassava flour (mocaf), have gained momentum. The two composite flour raw materials are selected because mocaf and beneng taro flour can produce final product characteristics similar to wheat flour. The making of dried noodles using composite flour from beneng taro and mocaf has been carried out in the research of Wulandari and Putri (2022). The results are in accordance with SNI 8217-2015 standards on dried noodles for moisture, fat, and carbohydrate content. Beneng taro has shown potential in replacing wheat flour in various food products (Kusumasari et al., 2019). Similarly, mocaf, produced through cassava fermentation, can substitute up to 20% of wheat flour in noodle production (Nursasminto, 2012). These alternatives address the challenges of wheat import dependence while promoting local agriculture.

While beneng taro and mocaf offer promising alternatives to wheat flour, a critical issue arises with the protein content of dried noodles made from these flours. Studies have shown that dried noodles made from a beneng taro and mocaf composite contain only 5.92–8.47% protein, falling short of the 10% minimum required by SNI standards (Wulandari & Nia, 2022). This poses a significant challenge in producing nutritionally adequate noodles with these flours.

Plant-based protein sources, particularly soybeans, have been explored to address protein deficiency. Soybeans are well-known for their high protein content, with varieties like Anjasmoro boasting 41.8–42.1% protein (BALITKABI, 2005). The addition of soybean flour has been shown to enhance the protein content of various noodle products, making it a viable solution for improving the nutritional profile of dried noodles.

Research on legume-based flours in noodle production has consistently demonstrated improvements in protein content. Using bean flour can increase protein content by up to 14% to meet SNI 8217-2015 standards. Among them are research by Violalita et al. (2020) on wet noodles with the addition of soybean flour, dried noodles with the addition of mung bean flour (Aji & Fithri, 2014); and Retnaningsih (2007), as cited by Noorlayla (2015), found that using 15% soybean flour in instant noodles made from sweet potato flour resulted in a product most preferred by consumers.

This study aims to enhance the protein content of dried noodles made from a composite of beneng taro and mocaf by incorporating Anjasmoro soybean flour in concentrations ranging from 0 to 20%. The research will evaluate the physicochemical and organoleptic properties of the resulting noodles to determine the optimal formulation that meets both nutritional and organoleptic quality standards.

2. MATERIALS AND METHOD

The materials used are the soybeans Anjasmoro variety (Kandang Tentrem Lestari brand) obtained from Pati Regency, Central Java Province, taro beneng flour obtained from the (Unni Gudang Talas Beneng workshop), and mocaf flour (KWT Mawar brand), wheat flour (Bogasari), cooking oil (Bimoli), CMC (carboxymethyl cellulose), STPP (sodium tripolyphosphate), salt (Dolpin), eggs, water, H_2SO_4, NaOH, distilled water and 0.02 N HCl solution, and mineral water.

This research was arranged using the completely randomized design (CRD) with one factor: the addition of concentrated soybean flour with five levels (0, 5, 10, 15, and 20%) with three replications. Soybean flour was prepared by pretreatment, namely soaking for 24 hours in 2.5% $NaHCO_3$ solution and boiling (T: 100°C and t: 10 minutes) in 2.5% $NaHCO_3$ solution. In this study, dried noodles were made by weighing the formulations according to the measurements. Beneng taro flour, mocaf, and wheat flour were mixed with the soybean flour and other ingredients to form the dough, which was kneaded, then printed, cut, and dried to produce dried noodles. The flowchart of dried noodles making is presented in Figure 1.

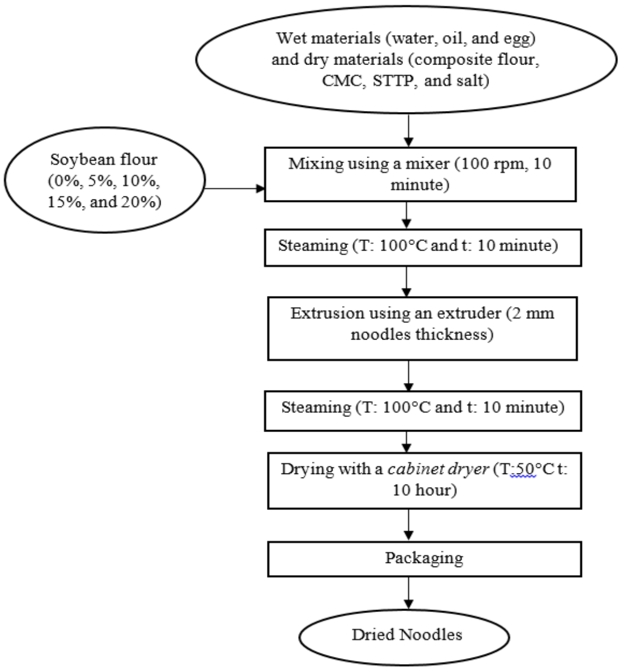

Figure 1. Flowchart of dried noodles

The following parameters of proximate analysis (moisture content, protein, and fat) were determined by AOAC methods. Carbohydrate by difference, fiber and ash through gravimetric methods. Cooking properties, including cooking time and cooking loss, were determined according to Noviasari et al. (2013) and AACC (2000). Physical properties, L* (lightness), and tensile strength. The organoleptic evaluation was performed using a 7-point hedonic test, where somewhat trained panelists rated color, texture, taste, aroma, and overall acceptability. The data obtained were analyzed statistically ANOVA; if it had a significant effect, it was followed by Duncan's multiple range test (DMRT) at a 5% significance level.

3. RESULTS AND DISCUSSION

3.1 Moisture and Ash Content

The moisture content is an important parameter in determining the quality of dried noodles because it is related to their shelf life. Figure 2 presents the results of the moisture content analysis on dried noodles with the addition of soybean flour.

Figure 2 shows the moisture content across different treatments (F1 to F5). As the percentage of Anjasmoro soybean flour increases from 0% to 20%, the moisture content also increases, ranging from 7.98% in F1 (0%) to 9.96% in F5 (20%). Compared with SNI 8217:2015 standards on dried noodles, the maximum moisture content of dried noodles is 13%. Based on this, dried noodles with soybean flour have fulfilled the SNI requirements for dried noodles.

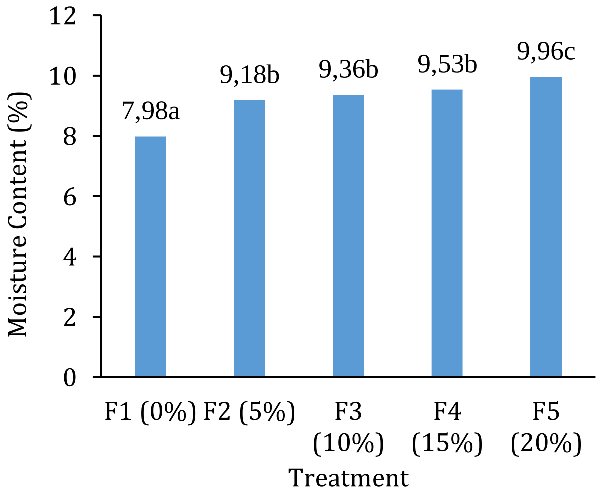

Figure 2. The moisture content of dried noodles with the addition of soybean flour. *Numbers followed by the same letter show no significant difference in the DMRT test at a significant level of 5%

The results indicate a significant increase in moisture content with increasing soybean flour concentration. This increase is primarily due to the hydrophilic nature of soybean protein, which has a high capacity to bind and retain water molecules. Iskandar (2003) revealed that the absorption of water by proteins is related to the presence of polar side chain groups such as carbonyl, hydroxyl, amino, carboxyl, and sulfhydryl, which causes proteins to be hydrophilic so they can form hydrogen bonds with water. The increase in moisture content observed in this study aligns with previous research findings. Violalita et al. (2020) demonstrated that higher soybean flour concentrations result in enhanced water retention, owing to the protein content of soybeans. This enhancement in moisture is attributed to the hydrophilic amino acids found in soybean protein, which allow better water absorption than wheat proteins alone (Olawuyi & Oyetola, 2020).

Furthermore, the local Anjasmoro soybean variety used in this study has been shown to possess higher moisture content than imported varieties. Based on research conducted by Handayani et al. (2023) shows that the difference in water content between local soybeans of the Anjasmoro variety and imported soybeans is that the highest water content is found in local soybeans of the Anjasmoro variety, namely 12.07%, while imported soybeans have a water content of 10.84%.

3.2 Ash Content

Analysis of ash content in noodles aims to determine the total minerals contained (Nurhidayah, 2019). The higher the ash content of a material, the higher its mineral content. From the analysis, adding soybean flour to manufacture dried noodles significantly affects the ash content produced. The results of the ash content analysis on dried noodles with the addition of soybean flour are presented in Figure 3.

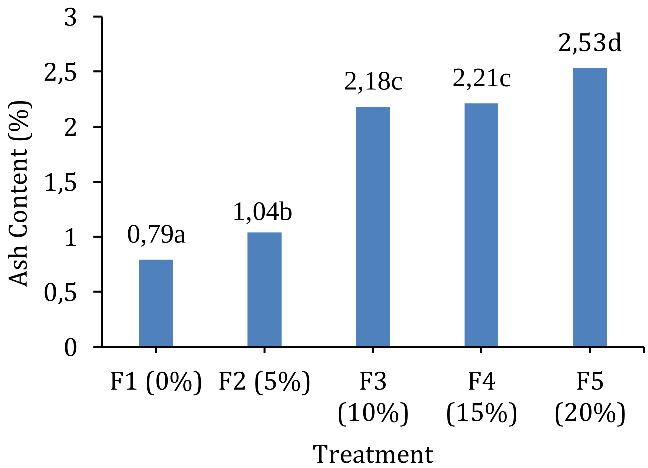

Figure 3. Ash content of dried noodles with the addition of soybean flour. *Numbers followed by the same letter show no significant difference in the DMRT test at a significant level of 5%

The results shown in Figure 3 demonstrate a positive relationship between soybean flour concentration and the ash content in dried noodles. The ash content ranged from 0.79% in F1 (0%) to 2.53% in F5 (20%). As the percentage of soybean flour increases, the ash content of the noodles rises accordingly. This outcome is expected, as soybean flour contains higher levels of minerals. According to USDA (2014), the mineral content contained in wheat flour per 100g consists of 33 mg calcium, 323 mg phosphorus, and 3.71 mg iron, while the mineral content per 100g of soybean flour includes 8 mg iron, 195 mg calcium, and phosphorus 554 mg, while other minerals are found in tiny amounts (less than 0.003%), namely boron, magnesium, beryllium, and zinc (Eni et al., 2017).

The same result stated by Violalita et al. (2020) showed an increase in ash content in wet noodles substituted for soybean flour with a concentration of (10%-30%) resulting in ash content of 0.58% to 0.62%. Similar findings were reported in studies where composite flours using legume ingredients resulted in elevated ash content, as legumes are generally richer in minerals than cereals like wheat (Sibian & Riar, 2020).

Despite the increased ash content, it is important to note that the final products still meet the SNI 01-2974-1992 standards for dried noodles, which require the ash content to be no higher than 3%. The results of this study confirm that the inclusion of soybean flour, even at higher concentrations, remains within acceptable regulatory limits, ensuring both nutritional enhancement and compliance with quality standards.

3.3 Fat Content

The fat content of dried noodles determines their durability. High fat content in food can cause rancidity (Gumelar, 2019). From the analysis, adding soybean flour in the manufacture of dried noodles has a significantly different effect on the fat content produced. Fat Content of Dried Noodles with the Addition of Soybean Flour are presented in Figure 4.

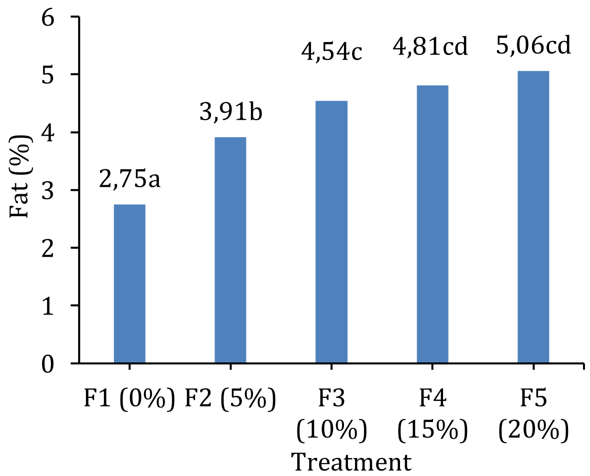

Figure 4. Fat content of dried noodles with the addition of soybean flour. *Numbers followed by the same letter show no significant difference in the DMRT test at a significant level of 5%

The results shown in Figure 4 demonstrate a positive relationship between soybean flour concentration and the fat content in dried noodles. The fat content ranges from 2.75% in F1 (0%) to 5.06% in F5 (20%). The fat content of dried noodles increases in proportion to the concentration of soybean flour used in the formulations. Soybean flour, which contains significantly more fat than beneng taro flour and MOCAF, contributes to this rise in fat levels. According to Indrati and Gardjito (2014), the fat percentage in 100 grams of soybean flour is 27.1%. Namely, in taro beneng flour, the fat content is 0.28% (Ariska, 2017), and in mocaf flour it is 0.8% (Faza, 2007). Violalita et al. (2020) also expressed that adding soybean flour with a concentration of 10-30% can increase the fat content in wet noodles by 4.53% to 6.36%. Mahendrayana et al. (2023) reported a similar thing, namely an increase in instant noodles with the addition of soybean protein isolate with a concentration of 20-30% by 2.56% to 3.40%.

3.4 Protein Content

The addition of soybean flour aims to increase the protein content in dried noodles to meet SNI 8217:2015 requirements for dried noodles. From the analysis, the addition of soybean flour in the manufacture of dried noodles has a significantly different effect on the protein content produced. The Protein Content of Dried Noodles with the Addition of Soybean Flour is presented in Figure 5.

The results shown in Figure 5 demonstrate a positive relationship between soybean flour concentration and the protein content in dried noodles. The protein content ranges from 7.63% in F1 (0%) to 12.15% in F5 (20%). Incorporating soybean flour into the noodle formulations significantly enhanced the protein content, reaching levels aligning with the Indonesian National Standard (SNI) 8217:2015 on dried noodles requirement of at least 10% protein. Using 15% soybean flour resulted in the optimal protein enrichment, achieving the desired nutritional standard. This increase is primarily due to the high protein content of soybean flour, which contains approximately 40% protein, significantly higher than wheat, beneng taro, or mocaf (Rani et al., 2013).

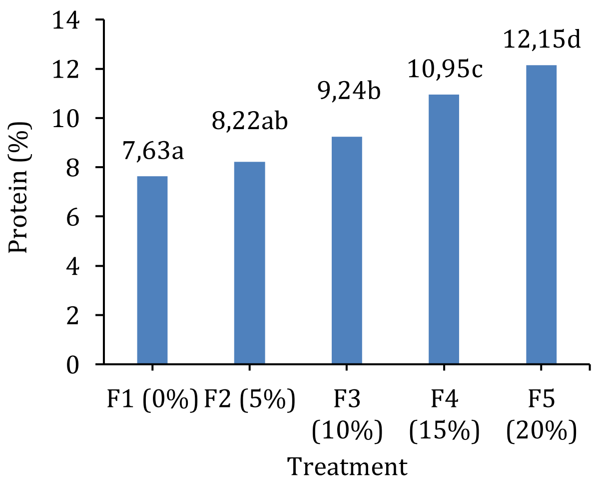

Figure 5. protein content of dried noodles with the addition of soybean flour. *Numbers followed by the same letter show no significant difference in the DMRT test at a significant level of 5%

The enhancement in protein content observed in this study is consistent with findings from previous research. Legume-based flours, such as soybean flour, have effectively increased protein levels in noodle formulations. Levent and Yeşil (2019) reported similar increases in protein content when soybean flour was incorporated into noodle recipes, with protein levels exceeding 15%. Furthermore, using Anjasmoro soybeans, which contain a higher protein concentration than other local varieties (41.8–42.1%), further underscores the protein enrichment potential observed in this study (BALITKABI, 2005). Legume-enriched noodles provide a plant-based alternative that supports overall nutritional health (Singh & Liu, 2021).

3.5 Carbohydrate and Crude Fiber Content

The addition of Anjasmoro soybean flour in composite flour-based dried noodles has a significant impact on carbohydrates. As illustrated in Figure 6, the carbohydrate content decreases from 80.84% in F1 (0% soybean flour) to 70.29% in F5 (20% soybean flour).

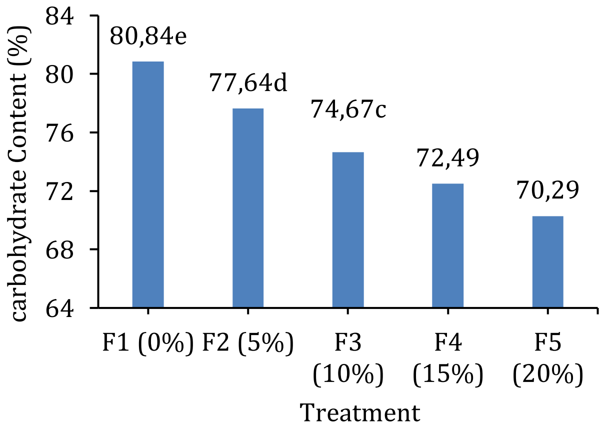

Figure 6. Carbohydrate content of dried noodles with the addition of soybean flour. *Numbers followed by the same letter show no significant difference in the DMRT test at a significant level of 5%

The addition of soybean flour in the dried noodles formulations resulted in a noticeable decrease in carbohydrate content. As soybean flour was introduced, the protein and fat content increased, which inversely affected the carbohydrate levels, as confirmed through the "by difference" calculation method. This reduction reflects the shift in macronutrient distribution, where higher protein and fat concentrations in the formulation naturally lead to a lower proportion of carbohydrates. The research results of Violalita et al. (2020) also showed a decrease in wet noodles with the addition of soybean flour with a concentration of 10-30%, amounting to 27.68-16.51%.

3.6 Crude Fiber Content

Adding Anjasmoro soybean flour in composite flour-based dried noodles did not have a significantly different effect on crude fiber content. The crude fiber Content of dried noodles with the addition of Soybean Flour is presented in Figure 7.

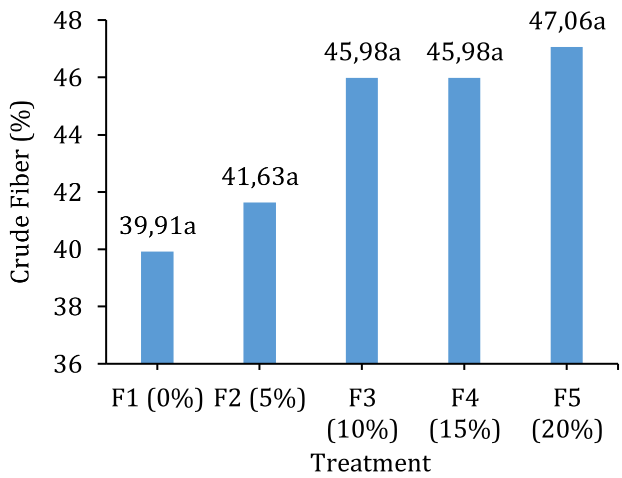

Figure 7. Crude fiber content of dried noodles with the addition of soybean flour. *Numbers followed by the same letter show no significant difference in the DMRT test at a significant level of 5%

The crude fiber content comes from the ingredients used to make dry noodles: soybean flour, beneng taro flour, and mocaf flour. The use of composite flour in making dry noodles consists of 40 g of taro beneng flour, 40 g of mocaf flour, 20 g of wheat flour, and 5 g, 10 g, 15 g, and 20 g of soybean flour. Soybean flour contains crude fiber of 10.55g/100g (Dwi et al., 2014), taro beneng flour has a fiber content of 9.52%/100g (Ariani et al., 2021), mocaf flour is 3.4%/ 100g (Salim, 2011), and the fiber content in wheat flour is 0.4%/100g (Tarigan et al., 2015).

3.7 Cooking Time and Cooking Loss

The addition of soybean flour in dried noodles significantly affects the cooking time and cooking loss produced. The cooking time of noodles with soybean flour addition and the cooking loss of noodles with soybean flour addition are presented in Figures 8 and 9.

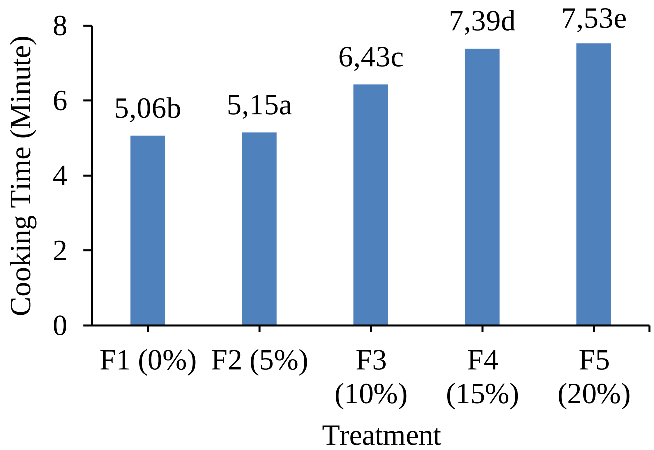

Figure 8. The average cooking time of dried noodles with the addition of soybean flour. *Numbers followed by the same letter show no significant difference in the DMRT test at a significant level of 5%

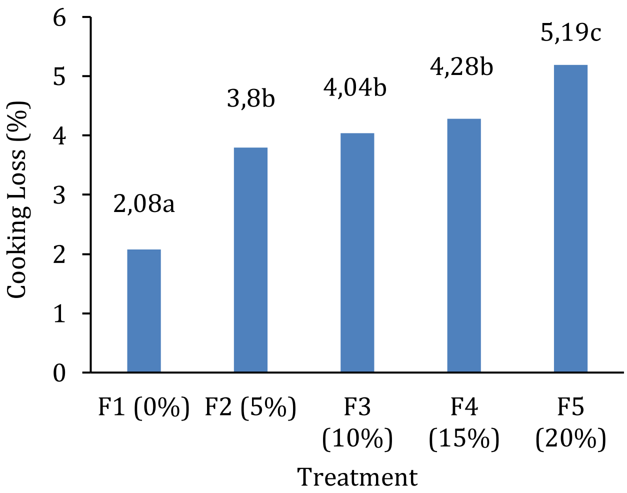

Figure 9. The average cooking loss of dried noodles with the addition of soybean flour. *Numbers followed by the same letter show no significant difference in the DMRT test at a significant level of 5%

The incorporation of soybean flour into dried noodle formulations led to an increase in cooking time. Cooking time ranged from 5.06 minutes in F1 (0%) to 7.53 minutes in F5 (20%). This result can be attributed to the higher protein content in soybean flour, which raises the gelatinization temperature of the starch, thereby extending the cooking process (Tethool & Dewi, 2018). The same result was stated by Akubor and Fayashe (2018), who showed that the cooking time for instant fried noodles continued to increase as the concentration of soybean flour increased from 10-50% in the noodles, the cooking time ranged from 7.19 to 9.45 minutes. According to Trisnawati and Nisa (2015), this phenomenon occurs because starch and protein compete to bind water. Protein will prevent water from entering the starch granule, so it takes a long time because of this competition.

Cooking loss ranges from 2.08% in F1 (0%) to 5.19% in F5 (20%). Furthermore, cooking loss increased as influenced by soybean flour's low amylose starch content. Soybean flour has amylopectin of 11.7-13.4% and amylose of 12.16% (Stevenson et al., 2006). A fairly high amylose content is expected in making noodles because it has a stronger binding force, so the cooking loss value is low (Kim et al., 1996). The rise in cooking loss also aligns with previous research, where noodles made with legume flours released more solids into the cooking water, reflecting weaker structural integrity and reduced starch network strength (Liang et al., 2023). Apart from that, the increase in cooking loss in dry noodles can be influenced by the small amount of wheat flour used, where wheat flour contains gluten protein, which is unavailable in soybean flour.

3.8 Lightness and Tensile Strength

The addition of soybean flour in dried noodles significantly affects the L* (lightness) value and tensile strength produced. L* (lightness) value of noodles with soybean flour addition and tensile strength of noodles with soybean flour addition are presented in Table 1.

Table 1. The average physical properties of dried noodles with the addition of soybean flour

Physic Properties	F1	F2	F3	F4	F5
L* (%)	50,81[a]	58,25[b]	59,72[c]	62,21[d]	65,41[e]
TS (MPa)	0,73[d]	0,64[c]	0,53[b]	0,44[a]	0,39[a]

Notes: L* (Lightness); TS (Tensile strength). *Numbers followed by the same letter in the treatment chart show no significant difference in the DMRT test at a significant level of 5%.

The color lightness test aims to determine the brightness of the dried noodles. The L* value indicates the change in brightness or lightness with a range of values from 0 (black) to (100) white. Commercial dried noodles circulating in the community have an L* of 67.31% (Rahayu et al., 2019). The L* value of the dried noodles in this study is lower than that of commercial dried noodles. The incorporation of soybean flour into dried noodle formulations led to an increase in L* value. L* value ranging from 50.81% in F1 (0%) to 65,41% in F5 (20%). The results showed that the higher the concentration of soybean flour, the higher the Lightness (L*) value, so the color of the dry noodles will be brighter. The increase in L* value is due to the pigments in soybeans, especially carotenoids such as β-carotene and lutein. (De Sá et al., 2013). Similar findings were reported by Sundaresan (2023), who noted that carotenoid-rich flours lead to more vibrant, yellowish products compared to wheat-based formulations, which typically have neutral or pale colors.

Tensile strength is the force required to break a strand of noodles, so it is suitable for use as a strength parameter of noodles (Chansri et al., 2005). As illustrated in Table 1, the tensile strength decreases from 0,73 MPa in F1 (0% soybean flour) to 0,39 MPa in F5 (20% soybean flour). This can be influenced by the decrease in elasticity of the noodles due to denaturation of the protein in soya flour, resulting in structural changes in the protein, which makes the texture of the noodles hard. So, in this case, the force required to break the noodles is higher. Denaturation of proteins causes clumping of proteins, which opens up opportunities for protein molecules to interact (Intan, 2009).

3.9 Organoleptic Properties

Organoleptic analysis is an important step in understanding consumer acceptance of a product. The organoleptic analysis in this study used the hedonic method (preference test). The organoleptic analysis of the dried noodles samples included color, aroma, taste, texture, and overall preference. Each panelist rated each sample based on individual preferences using the numerical scores for each parameter. The average organoleptic responses for dried noodles with the addition of soybean flour are presented in Figure 10.

Adding soybean flour to composite flour-based food products, such as dried noodles, significantly affects organoleptic properties and color and did not significantly affect aroma, taste, texture, and overall in hedonic tests.

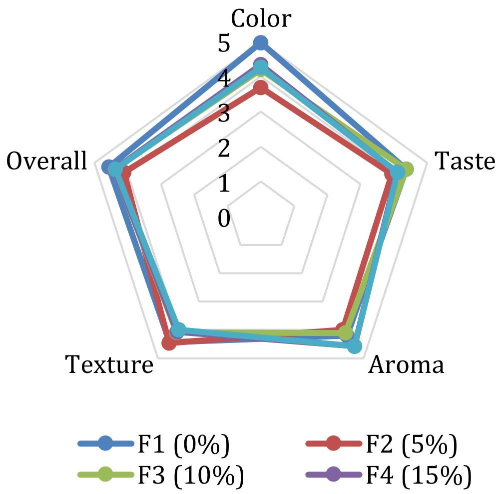

Figure 10. Organoleptic properties

The organoleptic test results for the color of dried noodles ranged from 3.69 to 4.97. The color value scale for each ranges from 3.69 (slightly dislike) to 4.97 (neutral). The results showed that the higher the concentration of soybean flour, the lower the organoleptic value of dry color. This can be influenced by soybean flour, which causes the dry color to become pale (brown in intensity) because the color of soybean flour is yellowish-white. Thus reducing the panelists' preferences. The sample aroma value scale ranges from 4.00 (neutral) to 4.57 (neutral), which shows the level of panelists' liking for the aroma of the dry noodles produced. The resulting aroma of dry noodles with the addition of soybean flour does not have a distinctive aroma, so it is acceptable to the panelists. The taste rating scale for each ranges from 3.94 (slightly dislike) to 4.37 (neutral). The use of soybean flour in dry noodles has a distinctive taste, which many panelists rarely feel, so the panelists do not like noodles with the increasing use of soybean flour. Efforts to increase the value of the taste preference test can be made by boiling the soybean seeds first. The boiling process aims to remove the bitterness and chalky taste caused by glycoside compounds in soybean seeds (Jaya, 2016). The value scale for each texture sample ranges from 4.00 to 4.46, which indicates the level of panelists' liking for the texture of the dry noodles produced, namely neutral. The texture of the resulting noodles tends to decrease, and the resulting noodles become inelastic and break easily. The overall scale score for each sample ranges from 4.11 (neutral) to 4.57 (neutral), which shows the level of panelists' liking for the dry noodles produced, namely neutral, so that the panelists can accept it. Overall, adding soybean flour to composite flour-based dried noodles affects organoleptic properties, particularly color. While soybean flour enhances the nutritional profile by increasing protein content, it is crucial to carefully consider the proportion to maintain desirable organoleptic qualities for consumers.

4. CONCLUSION

Adding Anjasmoro soybean flour to beneng taro and mocaf-based noodles effectively enhanced the protein content, achieving levels compliant with Indonesian National Standards (SNI) while improving the nutritional profile of the noodles. At an optimal 15% soybean flour concentration, the noodles displayed significant improvements in protein, fat, and ash content, along with color attributes. However, this formulation also increased cooking time and loss, reflecting the impact of soybean flour's high protein content on starch-gelatinization dynamics. This research highlights the potential of composite flours using locally sourced ingredients, particularly in reducing dependency on imported wheat and supporting local agriculture. Future research should focus on refining formulations to balance these nutritional and organoleptic benefits, maximizing consumer appeal and nutritional value in local noodle products.

5. ACKNOWLEDGMENT

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