**Eksakta** : Berkala Ilmiah Bidang MIPA
VOLUME 25 NO 02 2024, pp 201-218
ISSN : Print 1411-3724 — Online 2549-7464
DOI : https://doi.org/10.24036/eksakta/vol25-iss02/507

Eksakta
Berkala Ilmiah Bidang MIPA
http://www.eksakta.ppj.unp.ac.id/index.php/eksakta

*Article*

# Effect of Adding Beet Puree (*Beta vulgaris* L) on the Characteristics of Dry Noodles Made from Wheat Flour with Substitution of Sorghum (*Sorghum bicolor* (L) Moench) Flour

**Diana Sylvi[1], Purnama Dini Hari[1], Fadhillawati Fri Asma[1]**

[1]Faculty of Agricultural Technology, Universitas Andalas, Padang, Indonesia

**Article Info**

***Article history :***

Received May 03, 2024
Revised May 23, 2024
Accepted May 27,2024
Published June 30, 2024

***Keywords*** :
Beet tuber puree, characteristics, dry noodles, sorghum flour

**Abstract.** This study aims to determine the effect of adding beet tuber puree on the characteristics of dry noodles made from wheat flour with sorghum flour substitution. This research design used Complete Randomized Design (CRD) with 5 treatments and 3 repeats. The treatments carried out in this study were A (Control), B (Addition of beet tuber puree 3%), C (Addition of beet tuber puree 6%, D (Addition of beet tuber puree 9%), and E (Addition of beet tuber puree 12%). The data obtained in the study were carried out statistical analysis by ANOVA then continued with the analysis of Duncan's New Multiple Range Test (DNMRT) at the level of 5% effect on water content, ash content, protein content, fat content, carbohydrate content, antioxidant activity, color, and elasticity The best treatment based on physical, chemical, and organoleptic properties is treatment E (addition of puree 12%) with moisture content. of 8.89%, ash content of 2.83%, protein content of 13.58%, fat content of 2.80%, carbohydrate content of 71.89%, elasticity of 57.27%, value of 78.57 ◦hue (yellow-red) and total plate count of 0.79 x 105 CFU/ml, organoleptic analysis color 4.65 (likes), aroma 4.15 (likes), texture 4.30 (likes), and taste 3.90 (regular).



***Corresponding Author :***
Diana Sylvi
Faculty of Agricultural Technology, Universitas Andalas. Padang, Indonesia
Email : dianasylvi1@gmail.com

## 1. Introduction

Noodles are a food product that is popular and popular among the public because they have a delicious taste and have an easy and practical way of serving them [1-2]. Noodles are very popular in Southeast Asia, especially Indonesia, Japan, Thailand, China and so on Malaysia [2-3]. For some people, noodles have become an alternative food that can be stored for a long time. Based on data from the World Instant Noodles Association (WINA) in 2021, Indonesian instant noodle consumption increased 4.98% to 13.27 billion packs compared to 2020 with instant noodle consumption of 12.6 billion packs [2-5]. This number places Indonesia's consumption as the second largest in the world after China in terms of level consumption of 43.99 billion packs [6-7].

The basic ingredient in making noodles is wheat flour which comes from wheat. Based on data from the Central Statistics Agency (2022), Indonesia's imports of wheat flour reached 31.34 thousand tonnes or a value of 11.81 million US dollars throughout 2021. Wheat flour has a high glycemic index, namely 85. A high glycemic index value can increase sugar levels. blood quickly [8]. One effort to reduce the use of wheat is by developing flour based on local food ingredients. One local food ingredient that can be used as a substitute for wheat flour is sorghum [9].

Sorghum (Sorghum bicolor L. Moench) as a food ingredient has quite high nutritional content compared to other cereals. Sorghum can be used as a carbohydrate substitute. Sorghum seeds have a carbohydrate content of 80.42%, protein 10.11%, fat 3.65%, fiber 2.74%, and ash 2.24% [10]. Sorghum can have a positive effect on health because it contains dietary fiber that the body needs (dietary fiber) [11]. Based on data from the Central Statistics Agency (2020), total sorghum production is around 4,000-6,000 tonnes per year and is spread across five provinces, namely West Java, Central Java, East Java, Yogyakarta Special Region and East Nusa Tenggara. The use of sorghum production is not yet optimal because the potential existence of sorghum is generally not well known by the public. Additionally, sorghum's health benefits include its potential to improve gut microbiota and reduce anthropometric markers in overweight individuals, and its positive impact on cardiovascular health and glucose metabolism [12].

Color is one of the quality attributes used by consumers in assessing a food product. Based on research [13] regarding the comparison of the composition of sorghum flour with wheat flour on the characteristics of instant noodles, the organoleptic properties of the sorghum noodles produced were less liked by the panelists because the more sorghum flour added, the browner the noodles would be, so ingredients were needed that could improve the color of sorghum noodle products. One ingredient that can be used as a source of natural dye is beetroot [14].

Beetroot is a food that has benefits for the body. Beetroot contains main nutrients in the form of fiber, vitamins, minerals and contains antioxidants. Antioxidants will inhibit chain reactions that can cause oxidative stress from the formation of free radicals [15]. The red color in beetroot contains betacyanin pigment which has antiradical effects and high antioxidant activity [16]. Additionally, the bioactive compounds in beetroot, such as betacyanins and phenolic acids, show significant antioxidant activity and can protect cells from oxidative stress [17].

Beetroot (Beta vulgaris L.) contains betalain pigments of 1,000mg/100g dry weight or 120 mg/100g wet weight. In beet tubers, there are two groups of betalain pigments, namely red violet pigments betacyanin and the yellow pigment betaxanthin [18]. Based on previous research, using red dragon fruit slurry in sorghum noodles can increase antioxidant activity. The ratio of wheat flour and sorghum flour used is 70: 30. The higher the use of red dragon fruit slurry, the antioxidant activity of the dried noodles will increase and the resulting color will be darker red [19-21].

In the pre-research that has been carried out, namely making dry noodles with a mixture of 70% wheat flour and 30% sorghum flour to produce noodles with the best texture with the nature of noodles that do not break easily. This research uses beet root puree to see how it affects the characteristics of the dry noodles produced and can increase the functional value of dry noodles.

## 2. Method

### 2.1 Materials and Tools

The tools used in this research were a noodle maker, analytical scales, blender, steamer, pan and food dehydrator. The tools used in the analysis are oven, electric furnace, soxhlet, aluminum crucible, porcelain crucible, Kjeldahl flask, analytical balance, desiccator, spatula, gegep (iron tongs), erlenmeyer, measuring cup and measuring flask [22-24]. The ingredients used in making dry noodles are wheat flour, sweet sorghum flour of the Bioguma variety produced by Sorghum Bersama, beetroot obtained from a supermarket in Padang City, water, salt and eggs. The chemicals used for nutrient analysis are concentrated sulfuric acid, hexane, selenium mix, 50% NaOH, 0.02 N HCl, methanol, DPPH and H2SO4 [13][25-26].

### 2.2 Research Design

The research design used in this study was a Completely Randomized Design (CRD) with 5 treatments and 3 replications. The observation results were analyzed statistically using the Analysis of Varience (ANOVA) test and if the observation results were significantly different, it was continued with Duncan's New Multiple Range Test. (DNMRT) at a significance level of 5% [27,28,29].

The treatments used in this research were differences in the addition of beet root puree in making dry noodles. The treatment is as follows:
A = Addition of 0% beetroot puree
B = Addition of 3% beetroot puree
C = Addition of 6% beetroot puree
D = Addition of 9% beetroot puree
E = Addition of 12% beet root puree
Description: add beetroot puree based on the total flour ingredients.

### 2.3 Research Implementation

#### 2.3.1 Determination of Formulation

The determination of the formula used in this research was based on the formula that had been carried out in previous pre-research. The dry noodle formulation can be seen in Table 1.

**Table 1.** The dry noodle formulation

| Material | Treatment | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| Wheat flour (g) | 175 | 175 | 175 | 175 | 175 |
| Sorghum flour (g) | 75 | 75 | 75 | 75 | 75 |
| *Puree*beetroot (g) | 0 | 7.5 | 15 | 22.5 | 30 |
| Salt (g) | 5 | 5 | 5 | 5 | 5 |
| Egg (g) | 30 | 30 | 30 | 30 | 30 |
| Water (g) | 50 | 50 | 50 | 50 | 50 |

#### 2.3.2 Making Beetroot Puree

Making puree starts from thinly peeling the beet tubers so as not to remove too much of the beet tuber flesh. Next, cut into cubes measuring ± 4 cm to speed up the ripening process during steaming, the steaming process is carried out for ± 20 minute. The steamed beets are then mashed using a blender for a grinding time of ± 1 minute [30-32].

#### 2.3.3 Making Dry Noodles

Wheat flour is mixed with sorghum flour and beetroot puree according to the specified formulation, then additional ingredients are added in the form of table salt, eggs and water. The mixture of ingredients is put into the noodle maker until twisted noodles are formed. The noodles are steamed for ± 10 minutes, then cooled at room temperature for 10 minutes. The steamed noodles are dried in a food dehydrator at 50 ºC for 4 hours to produce dry noodles [13][33-34].

## 3. Results and Discussion

### 3.1 Raw Material Analysis

The analysis carried out on the raw material used in this research was beetroot puree. The results of the analysis can be seen in Table 2.

**Table 2.** Raw material analysis

| Parameter Analysis | *Puree* Beetroot ± SD |
|---|---|
| Water content (%) | 91.60 ± 0.08 |
| Antioxidants (%)* | 31.62 ± 0.47 |

Information: SD = Standard Deviation; * = concentration 1000 ppm

Based on Indonesian Food Composition Data (2018), beets contain 87.6% water. The analysis shows that beetroot puree contains 91.60% water. This is in line with research which found that beetroot paste contains 93.08% water [35]. The increase in water content may be due to the added water during processing. The water content in a food item must be controlled because higher water content increases spoilage and reduces shelf life [36-38]

Analysis shows that beetroot puree has an antioxidant value of 31.62%. The antioxidant content in beetroot juice is 32.81% [39]. Beetroot puree contains antioxidants due to the presence of flavonoids, betacyanin, ascorbic acid, and carotenoids [40-41]. The processing will induce changes in the physical and chemical composition of a food item. Steaming can reduce the nutritional value of food, depending on the steaming method and food type [16]. The processing can reduce phytochemicals and antioxidants in vegetables compared to fresh vegetables [38].

### 3.2 Chemical Analysis of Dried Noodles

#### 3.2.1 Water Content

Water content refers to the amount of water in a material, expressed as a percentage. Water content can affect the texture, taste, and shelf life of a food product [42]. The average water content in dried noodles made from wheat flour substituted with sorghum flour and beetroot puree is shown in Table 3 [13][34].

**Table 3.** Water content analysis of dried noodles

| Treatment | Water Content (%) ± SD |
|---|---|
| A (Without Beetroot Puree Addition) | 7.22 ± 0.51 a |
| B (Beetroot Puree Addition 3%) | 8.00 ± 0.33 b |
| C (Beetroot Puree Addition 6%) | 8.56 ± 0.19 c |
| D (Beetroot Puree Addition 9%) | 8.56 ± 0.19 c |
| E (Beetroot Puree Addition 12%) | 8.89 ± 0.19 c |
| KK: 3.76% | |

Note: PUB = Beetroot Puree. The numbers in the same column followed by the same letters are not significantly different at the 5% level using Duncan's New Multiple Range Test (DNMRT).

Based on the research, as more beetroot puree is added, the water content of the dried noodles increases. The water content of the dried noodles was below 13%. The water content for dried noodles per SNI 8217:2015 is a maximum of 13% during drying, indicating that the water content of the dried noodles with beetroot puree addition meets the SNI category [43]. The increase in water content is likely due to the steaming and boiling of the beetroot, consistent with Nurjana et al.'s (2018) findings [44]. They stated that increased water content might be due to foods containing fiber that can absorb water during cooking. During the gelatinization process, hydrogen bonds between molecules weaken, allowing starch to absorb more water and release less water [45-46]. The water content of a material can affect its absorption [47]. Lower water content makes the material easier to absorb water [48-49].

### 3.2.2 Ash Content

The ash content of a food material indicates the inorganic mineral content. The variance analysis showed that dried noodles made from wheat flour with sorghum substitution and beetroot puree addition have a significant effect at the α = 5% level. The average ash content can be seen in Table 4.

**Table 4.** Ash content analysis of dried noodles

| Treatment | Ash Content (%) ± SD |
|---|---|
| A (Without Beetroot Puree Addition) | 1.67 ± 0.14 a |
| B (Beetroot Puree Addition 3%) | 1.92 ± 0.14 a |
| C (Beetroot Puree Addition 6%) | 2.42 ± 0.14 b |
| D (Beetroot Puree Addition 9%) | 2.67 ± 0.14 b c |
| E (Beetroot Puree Addition 12%) | 2.83 ± 0.14 c |
| KK: 6.28% | |

Note: PUB = Beetroot Puree. The numbers in the same column followed by the same letters are not significantly different at the 5% level using Duncan's New Multiple Range Test (DNMRT).

The statistical analysis with ANOVA at the 5% level shows a significant difference between the dried noodle samples. This indicates that adding beetroot puree affects the ash content of the dried noodles produced. The ash content of the dried noodles was below 3%. The maximum ash content for dried noodles per SNI 01-2979-1992 is 3%, so the ash content of the dried noodles with beetroot puree meets the SNI category. The ash content represents the organic residue from burning organic matter. As more beetroot puree is added, the ash content increases because beets have high mineral content [49-51].

Beetroot pasta has an ash content of 0.65% [35]. Beetroot contains minerals such as calcium, iron, magnesium, phosphorus, potassium, sodium, and zinc, with the highest mineral being potassium at 404.9 mg. Therefore, the addition of beetroot puree increases the ash content of the dried noodles [52-55].

### 3.2.3 Protein Content

Protein is an essential nutrient for the body and serves as a building block. Protein is a macronutrient made up of amino acids containing carbon, hydrogen, oxygen, and nitrogen [49,50,56]. The average protein content in the dried noodles produced is shown in Table 5.

**Table 5.** The average protein content in the dried noodles produced

| Treatment | Protein Content (%) ± SD |
|---|---|
| A (Without Beetroot Puree Addition) | 13.20 ± 0.09 a |
| B (Beetroot Puree Addition 3%) | 13.21 ± 0.15 a |
| C (Beetroot Puree Addition 6%) | 13.33 ± 0.11 a |
| D (Beetroot Puree Addition 9%) | 13.39 ± 0.16 a b |
| E (Beetroot Puree Addition 12%) | 13.58 ± 0.04 b |
| KK: 0.88% | |

Note: PUB = Beetroot Puree. The numbers in the same column followed by the same letters are not significantly different at the 5% level using Duncan's New Multiple Range Test (DNMRT).

The research shows that the average protein content of dried noodles ranges from 13.20 to 13.58%. Based on the Indonesian food composition data, beetroot contains 1.6 grams of protein per 100 grams. The higher the concentration of beetroot puree added, the higher the protein content produced [49-51][57].

The addition of red dragon fruit slurry to the characteristics of dried noodles substituted with sorghum flour has a protein content of 11-13% [19][58]. According to SNI 8217:2015, dried noodles must have a minimum protein content of 10% for drying and 8% for frying [13][43]. In this study, the protein content meets the quality standards for dried noodles [34][59].

The protein quality of a food depends on the essential amino acids and its composition, based on the needs of the body. The digestibility of protein is also important [60-61]. The protein content of a food can be influenced by processing, the presence of antinutrients, and reactions with other compounds [60,62].

### 3.2.4 Fat Content

Fats and oils are a group of lipids that are organic compounds with hydrophobic characteristics, meaning they do not dissolve in water but dissolve in organic solvents such as ether, benzene, chloroform, etc. [49,50,63]. The average fat content of dried noodles is shown in Table 6.

**Table 6.** The average fat content of dried

| Treatment | Fat Content (%) ± SD |
|---|---|
| A (Without Beetroot Puree Addition) | 2.08 ± 0.01 a |
| B (Beetroot Puree Addition 3%) | 2.46 ± 0.01 b |
| C (Beetroot Puree Addition 6%) | 2.48 ± 0.01 b |
| D (Beetroot Puree Addition 9%) | 2.63 ± 0.02 c |
| E (Beetroot Puree Addition 12%) | 2.80 ± 0.02 d |
| KK: 0.56% | |

Note: PUB = Beetroot Puree. The numbers in the same column followed by the same letters are not significantly different at the 5% level using Duncan's New Multiple Range Test (DNMRT).

The research shows that the addition of beetroot puree has a significant effect at the 5% level on the fat content of the dried noodles produced. The average fat content ranged from 2.08 to 2.80%. The highest average fat content was in treatment E (12% beetroot puree addition) at 2.80%. The addition of beetroot puree in making crackers resulted in a fat content of 1.58%. The addition of beetroot puree to fish sausage resulted in a very low fat content because the fat content in fruit is also very low, at 0.17% [16][50][64-65].

### 3.2.5 Carbohydrate Content

The analysis shows that the carbohydrate content of dried noodles made from wheat flour substituted with sorghum flour and beetroot puree has a significant effect at the α = 5% level.

**Table 7.** Carbohydrate content analysis of dried noodles

| Treatment | Carbohydrate Content (%) ± SD |
|---|---|
| E (Beetroot Puree Addition 12%) | 71.89 ± 0.10 a |
| D (Beetroot Puree Addition 9%) | 72.76 ± 0.34 b |
| C (Beetroot Puree Addition 6%) | 73.22 ± 0.27 b |
| B (Beetroot Puree Addition 3%) | 74.42 ± 0.53 c |
| A (Without Beetroot Puree Addition) | 75.84 ± 0.67 d |
| KK: 0.5% | |

Note: PUB = Beetroot Puree. The numbers in the same column followed by the same letters are not significantly different at the 5% level using Duncan's New Multiple Range Test (DNMRT).

Based on the research, it can be seen that the addition of beetroot puree has a significant effect at the 5% level on the carbohydrate content of the dried noodles. The average carbohydrate content ranged from 71.89% to 75.84%. The highest average carbohydrate content was found in treatment A (without beetroot puree addition) at 75.84%, while the lowest average carbohydrate content was found in treatment E (12% beetroot puree addition) at 71.89% [25][49-50].

The addition of beetroot puree in making crackers resulted in a carbohydrate content of 89.05%. The carbohydrate content is calculated by difference and is influenced by other nutrients such as water, ash, protein, and fat. Fatkurrahman et al. (2012) stated that carbohydrates calculated by difference are affected by other nutritional components. The lower the other components, the higher the carbohydrate content, and vice versa. The higher the other nutritional components, the lower the carbohydrate content [66-68].

### 3.2.6 Antioxidant Activity

The analysis of variance results showed that the antioxidant activity of dried noodles, based on wheat flour substitution with sorghum flour, and the addition of beetroot puree, had a significant effect at the 5% significance level. The average antioxidant activities of the dried noodles produced can be seen in Table 8.

**Table 8.** Results of antioxidant activity analysis in dried noodles

| Treatment | Antioxidant Level (%) ± SD |
|---|---|
| A (No Addition of PUB) | 12.41 ± 0.94a |
| B (Addition of PUB 3%) | 16.39 ± 1.17b |
| C (Addition of PUB 6%) | 16.83 ± 3.04b |
| D (Addition of PUB 9%) | 19.44 ± 2.11c |
| E (Addition of PUB 12%) | 22.60 ± 4.70c |

Note: PUB = Beetroot Puree. The numerical data in the same column followed by different small letters indicate a significant difference based on the 5% Duncan's New Multiple Range Test (DNMRT). The coefficient of variation (CV) is 12.31%.

Based on the research results, the highest average antioxidant activity was found in treatment E (Beetroot Puree 12%) with an antioxidant activity of 22.60%, followed by treatments D, C, and B, with antioxidant activities of 19.44%, 16.83%, and 16.39%, respectively. The lowest average antioxidant activity was found in treatment A (without the addition of beetroot puree) at 12.41% [16][59][70].

These findings align with research conducted by Pertiwi et al. (2017) mentioned that the more beetroot extract added to dried noodles substituted with red bean flour, the higher the antioxidant activity produced [71]. Beets contain antioxidant components such as betalains, betaxanthins, phenols, carotenoids, and flavonoids [59][72]. This is consistent with Zitnanova et al. (2006), who stated that beets are rich in antioxidant components such as betalains and other phenolic groups. The betalains in beetroot exhibit better antioxidant capacity compared to anthocyanins, which are commonly found in red cabbage [53]. This is also in line with Roy et al. (2004), who stated that betalain compounds exhibit greater stability to temperature and pH compared to anthocyanin compounds, making them suitable for use in food additives that require heating processes [16][73][74].

### 3.3 Physical Analysis of Dried Noodles

#### 3.3.2 Color Analysis

The analysis of variance results showed that the addition of beetroot puree had a significant effect at the 5% significance level on the color of the dried noodles produced. The results of the color analysis of the dried noodles can be seen in Table 9.

**Table 9.** Results of color analysis in dried noodles

| Treatment | L ± SD | HUE ± SD | Letter |
|---|---|---|---|
| A (No Addition of PUB) | 55.34 ± 1.34 | 82.04 ± 0.41 a | (Yellow-Red) |
| B (Addition of PUB 3%) | 47.66 ± 4.48 | 79.93 ± 0.17 b | (Yellow-Red) |
| C (Addition of PUB 6%) | 47.06 ± 4.44 | 78.20 ± 0.16 c | (Yellow-Red) |
| D (Addition of PUB 9%) | 44.57 ± 2.88 | 76.57 ± 0.26 c | (Yellow-Red) |
| E (Addition of PUB 12%) | 42.17 ± 1.05 | 75.10 ± 0.20 c | (Yellow-Red) |

Note: PUB = Beetroot Puree. The numerical data in the same column followed by different small letters indicate a significant difference based on the 5% Duncan's New Multiple Range Test (DNMRT). The coefficient of variation (CV) is 0.51%.

Andarwulan et al. (2011) stated that the L* notation shows the panel that produces white, gray, ash, or black colors [75]. The a* notation represents a positive value (red) and a negative value (green). The b* notation represents a positive value (yellow) and a negative value (blue). The results of the color analysis in Table 9 show that the color of the dried noodles ranges from 75.10 – 82.04. Based on the observations made, the color of the dried noodles produced can be grouped into yellow-red hues. The research results indicated that the higher the concentration of beetroot puree added, the more red the resulting dried noodles became [38][64][76].

The color of the dried noodles comes from beets. The addition of beetroot affects the color of the product. The more beetroot puree added, the darker the red color of the noodles. The red color in beets comes from the betacyanin pigment. The betacyanin pigment is a type of betalain, which is red-violet in color [64][77-79].

#### 3.3.2 Elasticity

The analysis of variance results showed that the addition of beetroot puree had a significant effect at the 5% significance level on the elasticity of the dried noodles produced. The results of the elasticity analysis of dried noodles can be seen in Table 10.

**Table 10.** Average elasticity values of dried noodles

| Treatment | Elasticity (%) ± SD |
|---|---|
| A (No Addition of PUB) | 24.29 ± 4.29 a |
| B (Addition of PUB 3%) | 36.22 ± 5.45 b |
| C (Addition of PUB 6%) | 48.08 ± 5.77 c |
| D (Addition of PUB 9%) | 51.92 ± 1.92 c |
| E (Addition of PUB 12%) | 57.27 ± 2.72 d |

Note: PUB = Beetroot Puree. The numerical data in the same column followed by different small letters indicate a significant difference based on the 5% Duncan's New Multiple Range Test (DNMRT). The coefficient of variation (CV) is 9.87%.

The average elasticity analysis ranges from 24.29% to 57.27%. The highest average elasticity was found in treatment E (12% beetroot puree addition), which was 57.27%, while the lowest average elasticity was found in treatment A (without beetroot puree addition), which was 24.29%.

Based on the research by Winarti et al. (2017), dried noodles made from wheat flour have an elasticity of 37.33% [80]. The elastic properties of the dough cause the noodles to not break during the printing and cooking process [25]. Water is an important component in noodle formation. Water can act as a flavor enhancer during mixing and also helps reduce the stickiness of the dough while increasing its elasticity. Thus, the water content in the noodles, along with their elasticity and chewiness, decreases over time [81].

### 3.4 Microbiological Test

### 3.4.1 Total Plate Count

Microbial analysis on dried noodles is conducted to determine the number of microorganisms that can grow on the dried noodles produced. The total plate count analysis of the dried sorghum flour noodles substituted with beetroot puree can be seen in Table 11.

**Table 11.** Total plate count analysis of dried noodles

| Treatment | Average (CFU/g) |
|---|---|
| A (Without Beetroot Puree Addition) | 1.43 x 10^5 |
| B (Beetroot Puree Addition 3%) | 1.32 x 10^5 |
| C (Beetroot Puree Addition 6%) | 1.12 x 10^5 |
| D (Beetroot Puree Addition 9%) | 1.09 x 10^5 |
| E (Beetroot Puree Addition 12%) | 0.79 x 10^5 |

Note: PUB = Beetroot Puree

Based on the data obtained, the lowest microbial growth was found in treatment E, which was 0.79 x 10^5 CFU/g. The addition of beetroot puree during the preparation of dried sorghum flour noodles affects the microbial count in the dried noodles.

If the water content is high, it will facilitate the growth of bacteria, molds, and yeast, allowing them to thrive, which can lead to changes in the food [81-82]. The addition of beetroot puree during the preparation of the product impacts the microbial count because the beetroot is antibacterial, which can inhibit microbial growth [78][83]. Compounds that can inhibit bacterial growth in beets include phenols, flavonoids, betalains, and betacyanins.

According to the research results on dried sorghum flour noodles with the addition of beetroot puree, the noodles met the SNI (Indonesian National Standard). Based on SNI 8217:2015, the maximum total plate count for dried noodles is 1x10^6 CFU/g [43]. The total plate count in the dried noodles produced ranged from 0.6x10^5 to 1.35x10^5 CFU/g. Therefore, it can be concluded that dried sorghum flour noodles with beetroot puree addition are suitable for consumption [53][84].

### 3.5 Organoleptic Test

#### 3.5.1 Color

Color is the main factor that consumers look at when choosing a food item. The average result of the organoleptic analysis of the color of dried sorghum flour noodles with beetroot puree can be seen in Table 12.

**Table 12.** Organoleptic analysis of color in dried noodles

| Treatment | Average ± SD |
|---|---|
| A (Without Beetroot Puree Addition) | 3.55 ± 0.83 a |
| B (Beetroot Puree Addition 3%) | 3.65 ± 0.67 a |
| C (Beetroot Puree Addition 6%) | 3.85 ± 0.37 a b |
| D (Beetroot Puree Addition 9%) | 4.15 ± 0.49 b |
| E (Beetroot Puree Addition 12%) | 4.65 ± 0.59 c |
| KK: 15.32% | |

Note: Score 1 = strongly dislike, 2 = dislike, 3 = neutral, 4 = like, 5 = strongly like. Numbers followed by the same letter are not significantly different according to the 5% DNMRT test.

The results of the organoleptic analysis of color showed that the average panelist acceptance of dried noodles with beetroot puree was 3.55-4.65. The highest rating for color was found in treatment E with a score of 4.65, categorized as "liked," for the red-colored noodles produced. The lowest score was in treatment A with a score of 3.55, categorized as "neutral." Based on the color analysis, the dried noodles in treatment E were red, with a hue value of 52.19.

Color is a critical parameter for food, and it is the first thing consumers see [13]. The color of beetroot comes from betalain pigments, which have a vibrant red hue. The betalain pigment includes betacyanin and betaxanthin [85]. The betalain pigment is water-soluble and can improve the appearance of food. Beetroot can also provide red color and nutrients, making the food more visually appealing and healthier [64].

#### 3.5.2 Aroma

Aroma is the sensation caused by chemical stimulation. Volatile compounds produce aroma as food enters the mouth [86] (Waqiah et al., 2019). The average results of the organoleptic analysis of the aroma of dried sorghum flour noodles with beetroot puree can be seen in Table 13.

**Table 13.** Organoleptic analysis of aroma in dried noodles

| Treatment | Average ± SD |
|---|---|
| A (Without Beetroot Puree Addition) | 3.55 ± 0.76 a |
| B (Beetroot Puree Addition 3%) | 3.60 ± 0.68 a |
| C (Beetroot Puree Addition 6%) | 3.70 ± 0.47 a |
| D (Beetroot Puree Addition 9%) | 4.05 ± 0.49 a b |
| E (Beetroot Puree Addition 12%) | 4.15 ± 0.75 b |
| KK: 17.01% | |

Note: Score 1 = strongly dislike, 2 = dislike, 3 = neutral, 4 = like, 5 = strongly like. Numbers followed by the same letter are not significantly different according to the 5% DNMRT test.

The average aroma scores ranged from 3.55 to 4.15. The highest average aroma score was in treatment E (12% beetroot puree addition), at 4.15, classified as "like," while the lowest average aroma score was in treatment A (without beetroot puree addition), at 3.55, classified as "neutral."

Beetroot contains geosmin, produced by gram-positive bacteria Streptomyces. These bacteria create the characteristic "earthy" aroma in beetroot, giving it its distinct flavor (earth taste). According to Asgar and Musaddad (2006), several processes can reduce the earthy aroma in beetroot, such as boiling, blanching, and seasoning [87]. During noodle production, geosmin and other earthy aromas are reduced through enzymatic processes, including the oxidation of catalase and peroxidase enzymes, which results in the earthy aroma [41][64][88-89].

### 3.5.3 Texture

Texture is one of the quality criteria that contribute to the characteristic of noodles. Texture relates to the sensation of chewing the noodles. Parameters such as chewy, firm, soft, sticky, or smooth can be perceived in noodles [90]. The average results of the organoleptic analysis of the texture of dried sorghum flour noodles with beetroot puree can be seen in Table 14.

**Table 14.** Organoleptic analysis of texture in dried noodles

| Treatment | Average ± SD |
|---|---|
| B (Beetroot Puree Addition 3%) | 3.55 ± 0.70 a |
| A (Without Beetroot Puree Addition) | 3.80 ± 0.61 a b |
| C (Beetroot Puree Addition 6%) | 3.95 ± 0.51 b c |
| D (Beetroot Puree Addition 9%) | 4.30 ± 0.49 c |
| E (Beetroot Puree Addition 12%) | 4.30 ± 0.47 c |
| KK: 14.33% | |

Note: Score 1 = strongly dislike, 2 = dislike, 3 = neutral, 4 = like, 5 = strongly like. Numbers followed by the same letter are not significantly different according to the 5% DNMRT test.

The average texture scores ranged from 3.55 to 4.30. The highest average texture score was in treatment E (12% beetroot puree addition) at 4.30, classified as "like," while the lowest average texture score was in treatment B (3% beetroot puree addition) at 3.55, classified as "neutral." This indicates that all treatments are still within acceptable standards by the panelists in terms of texture. The texture of the food is mostly determined by the water content in the product. The higher the water content, the softer the resulting product will be [32].

The steaming process increases the chewiness of the noodles produced. This condition shows that longer steaming results in higher gelatinization and increases the chewiness of the noodles produced [91-92]. The gelatinization process causes the amylose and amylopectin bonds to strengthen, which affects the texture of the noodles produced [45].

### 3.5.4 Taste

Taste is an essential sensory component because consumers tend to like food with a pleasant taste. The average results of the organoleptic analysis of the taste of dried sorghum flour noodles with beetroot puree can be seen in Table 15.

**Table 15.** Organoleptic analysis of taste in dried noodles

| Treatment | Average ± SD |
|---|---|
| A (Without Beetroot Puree Addition) | 3.30 ± 0.66 a |
| B (Beetroot Puree Addition 3%) | 3.35 ± 0.67 a |
| D (Beetroot Puree Addition 9%) | 3.60 ± 0.63 a b |
| C (Beetroot Puree Addition 6%) | 3.70 ± 0.73 a b |
| E (Beetroot Puree Addition 12%) | 3.90 ± 0.85 b |
| KK: 19.82% | |

Note: Score 1 = strongly dislike, 2 = dislike, 3 = neutral, 4 = like, 5 = strongly like. Numbers followed by the same letter are not significantly different according to the 5% DNMRT test.

The average taste scores ranged from 3.30 to 3.90. The highest average taste score was in treatment E (12% beetroot puree addition) at 3.90, while the lowest average taste score was in treatment A (3% beetroot puree addition) at 3.30. This indicates that all treatments were within the acceptable standards according to the panelists in terms of taste. According to Ambarwati et al. (2020), beetroot is commonly used as a sweetener in products [41]. This is because beetroot contains a significant amount of sucrose, approximately 6%. Sucrose serves to impart a distinctive sweet taste to products [64][81][88].

### 3.5.5 Recapitulation of Organoleptic Values

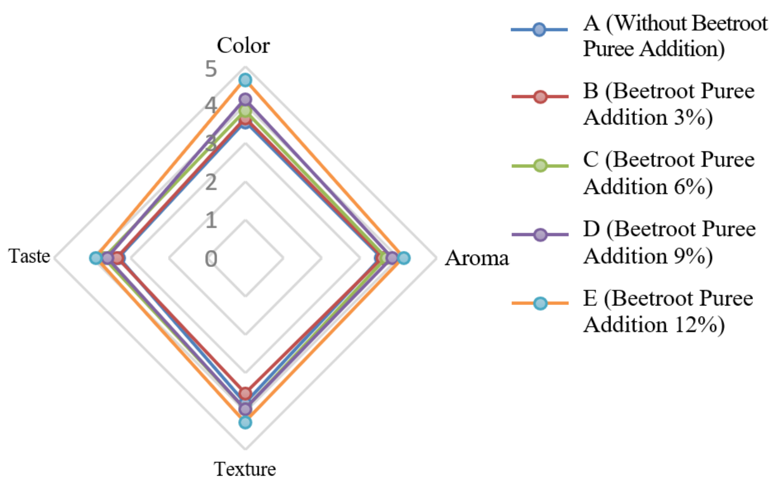


**Figure 1.** Organoleptic Recapitulation

Based on Figure 1, the highest panelist acceptance of dried noodles in terms of color, aroma, taste, and texture was found in treatment E, which involved the addition of 12% beetroot puree, with scores for color 4.65 (like), aroma 4.15 (like), taste 3.9 (like), and texture 4.3 (like).

## 4. Conclusion

Based on the results of the research conducted, it can be concluded that the addition of beetroot puree to the basic wheat flour noodle recipe substituted with sorghum flour significantly affects the water content, ash content, protein content, fat content, carbohydrate content, antioxidant activity, elasticity, color organoleptic, aroma, texture, and taste. The best formula for making dried noodles from wheat flour substituted with sorghum flour includes the addition of 12% beetroot puree (treatment E), with organoleptic scores of 4.65 (like) for color, 4.15 (like) for aroma, 3.9 (like) for taste, and 4.3 (like) for texture. The physicochemical results are water content (8.89%), ash content (2.83%), protein content (13.58%), fat content (2.80%), carbohydrate content (71.89%), elasticity (57.27%), and ALT (0.79 x 10^5 CFU/g). Based on the conducted research, it is recommended that future researchers carry out further studies by increasing the amount of beetroot to enhance the antioxidant properties.

**References**

[1] Kraithong, S., & Rawdkuen, S. (2021). Quality attributes and cooking properties of commercial Thai rice noodles. *PeerJ*, *9*, e11113.

[2] Chailek, C., Thitichai, P., Praekunatham, H., Taweewigyakarn, P., & Chantian, T. (2023). Peer Reviewed: Availability and Price of Low-Sodium Condiments and Instant Noodles in the Bangkok Metropolitan Region. *Preventing Chronic Disease*, *20*.

[3] Kingwell, R., & Carter, C. (2020). Application of Choice Modeling for Understanding Wheat User Preferences in Southeast Asia1. *Cereal Foods World*, *65*(5).

[4] Adejuwon, O. H., Jideani, A. I., & Falade, K. O. (2020). Quality and public health concerns of instant noodles as influenced by raw materials and processing technology. *Food Reviews International*, *36*(3), 276-317.

[5] Sah, G. K. (2023). Consumers' Noodle Consumption: Experiences and Practices in Nepal. *Tribhuvan University Journal*, *38*(2), 142-158.

[6] Park, S., & Liu, M. (2023). A Positive Causal Relationship between Noodle Intake and Metabolic Syndrome: A Two-Sample Mendelian Randomization Study. *Nutrients*, *15*(9), 2091.

[7] Quan, Y. H., & Im, J. B. (2023). Exposure or pandemic effect: Export boom in instant noodles from South Korea during COVID-19. *Food Science & Nutrition*, *11*(12), 8043-8059.

[8] Rahmawati, T. Y. H., Hermawan, B., Witara, I. M., Yuliyanto, G., & Nugroho, S. P. (2023). Innovation of Red Bean Flour as A Substitution for Wheat Flour in Making Noodle. *Gastronary*, *2*(2), 55-64.

[9] Wahjuningsih, S. B., Azkia, M. N., & Kusumaningtyas, R. W. (2022). Physicochemical, functional and sensory properties of wheat noodles substituted by sorghum and mung bean flours. *Food Research*, *6*(5), 84-90.

[10] Pontieri, P., Troisi, J., Calcagnile, M., Bean, S. R., Tilley, M., Aramouni, F., ... & Del Giudice, L. (2022). Chemical composition, fatty acid and mineral content of food-grade white, red and black sorghum varieties grown in the mediterranean environment. *Foods*, *11*(3), 436.

[11] Widowati, S., & Luna, P. (2022, May). Nutritional and functional properties of sorghum (Sorghum bicolor (L.) Moench)-based products and potential valorisation of Sorghum Bran. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1024, No. 1, p. 012031). IOP Publishing.

[12] Mohamed, H. I., Fawzi, E. M., Basit, A., Lone, R., & Sofy, M. R. (2022). Sorghum: nutritional factors, bioactive compounds, pharmaceutical and application in food systems: a review. *Phyton*, *91*(7), 1303.

[13] NF, A. N. R., Hartati, F. K., & Hariyani, N. (2023). Chemical and Organoleptic Quality of Free-Gluten Dry Noodles from Sorghum (Sorghum bicolor) and Modified Cassava Flour with Different Drying Temperature. *SAGA: Journal of Technology and Information System*, *1*(3), 64-71.

[14] Patty, M. D., Murtini, E. S., & Putri, W. D. R. (2023). Physicochemical characteristics of starch noodles based on sorghum flour (Sorghum bicolor L. Moench) and sago flour (Metroxylon Sp). *Jurnal Pangan dan Agroindustri*, *11*(3), 147-157.

[15] Varshney, K., & Mishra, K. (2022). An analysis of health benefits of beetroot. *International Journal of Innovative Research in Engineering & Management*, *9*(1), 207-210.

[16] Niroula, S., & Adhikari, B. (2022). Effect of Processing Methods on Bioactive Components and Antioxidant Activity of Beetroot (Beta vulgaris L.). *Tribhuvan University Journal of Food Science and Technology*, 46-56.

[17] Thiruvengadam, M., Chung, I. M., Samynathan, R., Chandar, S. H., Venkidasamy, B., Sarkar, T., ... & Simal-Gandara, J. (2024). A comprehensive review of beetroot (Beta vulgaris L.) bioactive components in the food and pharmaceutical industries. *Critical Reviews in Food Science and Nutrition*, *64*(3), 708-739.

[18] Koldaev, V. Oh, um. (2023). Dynamics of changes in the content of betelain pigments in the roots of red beet in the process of vehetation and storage. *Vegetables in Russia*, (3), 10-15.

[19] Dwimargiyanti, E. (2017). *Subtitusi tepung sorgum (Sorghum bicolor L.) dalam pembuatan mie kering dengan penambahan slurry buah naga merah (Hylocereus polyrhizus) yang mengandung antioksidan* (Doctoral dissertation, UAJY).

[20] Ali, R. T. M., & Jameel, Q. Y. (2023). Red beetroot betalains as a novel source of colorent in ice-cream as compared with Red Dye 40 (E129). *Functional Foods in Health and Disease*, *13*(4), 225-239.

[21] Huỳnh, T. Đ., Nguyễn, H. T., Nguyễn, T. K. N., Đặng, T. N. Á., Lê, T. T., Dương, T. N. D., & Phan, T. H. (2023). Optimization of ultrasound-assisted enzymatic extraction of betalains from red beetroot (Beta vulgaris L.). *Tạp chí Nông nghiệp và Phát triển*, *22*(6), 65-77.

[22] Farhan, M. H., & Suendri, S. (2023). Instant Noodle Production Information System Using The Method Supply Chain Management To Overcome Targets Not Achieved. *Journal of Computer Networks, Architecture and High Performance Computing*, *5*(2), 537-543.

[23] Mîndru, R. C. H., Kiss, A. A., Velciov, A. B., Orboi, D. M., & Mîndru, G. H. (2023). Manufacture, Physicochemical And Sensory Evaluation Of Artisanal Noodles Enriched With Broth And Spinach. *International Multidisciplinary Scientific GeoConference: SGEM*, *23*(6.1), 181-186.

[24] Jakkielska, D., Frankowski, M., Kurzyca, I., & Ziołafrankowska, A. (2023). Risk Profiling of Exposures to Potentially Toxic Metals PTM (S) Through Noodles Consumption. A Case Study of Human Health Risk Assessment. *Acta Universitatis Cibiniensis. Series E: Food Technology*, *27*(1), 91-102.

[25] Prayitno, S. A., Utami, D. R., Ningrum, S., Patria, D. G., Putri, S. N. A., Puspita, R. A., & Niam, M. K. (2023). Pengaruh penambahan tepung kulit ari kedelai dan tepung wortel terhadap sifat fisikokimia dan sensori mie kering [Effect of the soybean husk and carrot flour addition on the physicochemical and sensory properties of dry noodles]. *Jurnal Teknologi & Industri Hasil Pertanian*, *28*(2), 76-89.

[26] 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.

[27] Yenrina, R., Anggraini, T., & Effendi, M. A. B. (2023, June). The characteristics of rosella flower (Hibiscus sabdariffa) functional drink addition with red ginger (Zingiber officinale) extract. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1182, No. 1, p. 012060). IOP Publishing.

[28] Daroyani, D. I., Yusasrini, N. L. A., & Sugitha, I. M. (2022). Pengaruh Perbandingan Ikan Tuna (Thunnus sp.) Dengan Puree Jantung Pisang (Musa Paradisiaca sp.) Terhadap Karakteristik Nugget. *Jurnal Ilmu dan Teknologi Pangan*, *11*(2).

[29] Sayuti, K., Mutiara, E. P., & Silvy, D. (2023). The Effect of the Addition of Citrus Fruits Juice on The Physical and Chemical Characteristics of Sapodilla (Manikara zapota) Sliced Jam. *AJARCDE (Asian Journal of Applied Research for Community Development and Empowerment)*, 8-15.

[30] Holovko, T., Bordunova, O., Bolhova, N., Vasylenko, O., Nazarenko, Y., & Prymenko, V. (2023). Sponge cake enriched with beetroot powder and chard puree: nutritional and sensory qualities.
[31] Mudgal, D., Singh, S., Singh, B. R., Kumar, P., & Sisodia, K. (2023). Effect of Different Pre-Treatments and Temperatures on Drying Characteristics of Beetroot Slices. *Current Journal of Applied Science and Technology*, *42*(28), 1-10.
[32] Bhattarai, S., & Kusma, R. (2022). Preparation and quality evaluation of sugar and honey based beetroot candies.
[33] Sadek, N. F., & Hamidah, R. S. (2023, April). The stability of total phenolic and antioxidant activity during processing and cooking of sorghum-moringa substituted tapioca noodle. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1169, No. 1, p. 012096). IOP Publishing.
[34] Halim, Y., Angelina, B., Hardoko, H., & Handayani, R. (2023, June). Characteristics of dried noodle analogue made from sorghum flour and rice flour added with konjac glucomannan. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1200, No. 1, p. 012032). IOP Publishing.
[35] Mahrita, L., Wahjuningsih, S. B., & Haryati, S. (2020). Pengaruh Penambahan Pasta Umbi Bit Sebagai Pewarna Alami Terhadap Karakteristik Fisikokimia Dan Sensori Getuk Lindri. *Repository Universitas Semarang*, 1-14.
[36] Ekka, S. I., Mishra, S., Bahadur, V., Topno, S. E., & Kapadnis, V. (2023). Effect of Different Concentration of Strawberry and Beetroot Juice on Quality and Storage of Strawberry Beetroot Candy. *International Journal of Environment and Climate Change*, *13*(9), 1158-1164.
[37] Azmin, S. N. H. M., Jaine, N. I. M., & Nor, M. S. M. (2020). Physicochemical and sensory evaluations of moisturising lip balm using natural pigment from Beta vulgaris. *Cogent Engineering*, *7*(1), 1788297.
[38] Liu, Y., Sabadash, S., Duan, Z., & Deng, C. (2022). The Influence Of Different Drying Methods On The Quality Attributes Of Beetroots. *Eastern-European Journal of Enterprise Technologies*, *117*(11).
[39] Dini, K. (2020). *Pengaruh Penambahan Sari Umbi Bit (Beta Vulgaris, L) Terhadap Karakteristik Margarin Dari Vco (Virgin Coconut Oil) Dan Stearin Kelapa Sawit* (Doctoral dissertation, Universitas Andalas).
[40] Jakubczyk, K., Melkis, K., Janda-Milczarek, K., & Skonieczna-Żydecka, K. (2023). Phenolic Compounds and Antioxidant Properties of Fermented Beetroot Juices Enriched with Different Additives. *Foods*, *13*(1), 102.
[41] Ambarwati, F., Mulyani, S., & Setiani, B. E. (2020). Karakteristik sponge cake dengan perlakuan penambahan pasta bit (Beta Vulgaris L.). *Jurnal Agrotek Ummat*, *7*(1), 43-49.
[42] Widiawati, D., Giovani, S., & Liana, S. P. (2022). Formulasi dan Karakterisasi Mi Kering Substitusi Tepung Kacang Merah Tinggi Serat. *Jurnal Al-Azhar Indonesia Seri Sains Dan Teknologi*, *7*(2).
[43] Badan Standardisasi Nasional [BSN]. SNI Mi Kering (SNI 8217:2015). Jakarta, 2015.
[44] Nurjanah, N., Jacoeb, A. M., Nugraha, R., Permatasari, M., & Sejati, T. K. A. (2014). Perubahan komposisi kimia, aktivitas antioksidan, vitamin C dan mineral tanaman genjer (Limnocharis flava) akibat pengukusan. *AJIE (Asian Journal of Innovation and Entrepreneurship)*, *3*(03), 185-195.
[45] Hasni, D., Nilda, C., & Amalia, J. R. (2022). Kajian pembuatan mie basah tinggi serat dengan substitusi tepung porang dan pewarna alami [Study of making high fibre-wet noodles with porang flour substitution and natural dyes]. *Jurnal Teknologi & Industri Hasil Pertanian*, *27*(1), 31-41.

[46] Costa, W. Y., & Manihuruk, F. M. (2021). Karakteristik Kimia Dan Organoleptik Kerupuk Daging Dengan Penambahan Tepung Tapioka Dan Waktu Pengukusan Berbeda. *Jurnal AgroSainTa: Widyaiswara Mandiri Membangun Bangsa*, *5*(1), 9-14.

[47] Mahmudah, N. A., Amanto, B. S., & Widowati, E. (2017). Karakteristik fisik, kimia dan sensoris flakes pisang kepok Samarinda (Musa Paradisiaca Balbisiana) dengan substitusi pati Garut. *Jurnal Teknologi Hasil Pertanian*, *10*(1), 32-40.

[48] Muharja, M., Fadilah, S. N., Khamil, A. I., Darmayanti, R. F., Putri, D. K. Y., Rizkiana, M. F., ... & Azhar, B. (2023). Effect of Immersion Concentration in Salt Solution, Drying Time and Air Velocity on Drying Wet Noodles Using a Tray Dryer and Solar Assistance. *Jurnal Teknik Kimia dan Lingkungan*, *7*(1), 9-16.

[49] Christwardana, M., Handayani, A. S., Febriyanti, E., Hadiyanto, H., & Nefasa, A. N. (2023). Proximate Analysis and Hedonic Test on Dried Noodle with The Addition of Spirulina platensis Microalgae as A High Protein Food. *Journal of Bioresources and Environmental Sciences*, *2*(1), 31-38.

[50] Devi, M., Soekopitojo, S., Putri, A., Pratikto, H., Wibawa, A. P., & Hamid, M. A. (2022, December). The addition of dried broccoli (Brassica oleacea L.) leaves can improve the nutrition of noodles. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1116, No. 1, p. 012024). IOP Publishing.

[51] Yaver, E. (2023). Dephytinized flaxseed flours by phytase enzyme and fermentation: functional ingredients to enhance the nutritional quality of noodles. *Journal of the Science of Food and Agriculture*, *103*(4), 1946-1953.

[52] Lazăr, S., Constantin, O. E., Horincar, G., Andronoiu, D. G., Stănciuc, N., Muresan, C., & Râpeanu, G. (2022). Beetroot by-product as a functional ingredient for obtaining value-added mayonnaise. *Processes*, *10*(2), 227.

[53] Trindade, L. R. D., Baião, D. D. S., da Silva, D. V. T., Almeida, C. C., Pauli, F. P., Ferreira, V. F., ... & Paschoalin, V. M. F. (2023). Microencapsulated and Ready-to-Eat Beetroot Soup: A Stable and Attractive Formulation Enriched in Nitrate, Betalains and Minerals. *Foods*, *12*(7), 1497.

[54] Yahya, F., Xiang, Y. K., Zainol, M. K., & Hasmadi, M. (2022). Effect of different ratios of wheat flour to black bean (Phaseolus vulgaris L.) flour on physicochemical properties and sensory acceptability of cooked noodle. *Food Research*, *6*(2), 457-464.

[55] Gebregziabher, B. S., Gebremeskel, H., Debesa, B., Ayalneh, D., Mitiku, T., Wendwessen, T., ... & Getachew, T. (2023). Journal of Agriculture and Food Research. *Journal of Agriculture and Food Research*, *14*, 100834.

[56] Yani, I. E., Handayani, M., & Husna, H. (2022). Kadar Protein dan Daya Terima Mi Padat Gizi Berbasis Pangan Lokal Sebagai Alternatif Pangan Darurat. *Jurnal Sehat Mandiri*, *17*(2), 1-9.

[57] Liang, J. N., Nargotra, P., Li, X. Y., Sharma, V., Hsieh, S. L., Tsai, Y. H., ... & Kuo, C. H. (2023). Evaluation of Wheat Noodles Supplemented with Soy Protein Isolate for Nutritional, Textural, Cooking Attributes and Glycemic Index. *Applied Sciences*, *13*(13), 7772.

[58] Anggraweni, I., Sari, D. M., Herpandi, H., & Yuliarti, Y. (2022). Uji Organoleptik Dan Analisis Kandungan Kimia Pada Mi Kering Dari Tepung Kulit Buah Naga Merah Dan Tepung Kacang Merah. *Journal of Food Technology and Agroindustry*, *4*(2), 59-66.

[59] Yenrina, R., Ismed, I., Hildayani, W., & Rahma, J. (2023). Antioxidant Activity and Physicochemical Characteristics of Dry Noodles with a Mixture of Wheat Flour and Kidney Bean Flour With the Addition of Butterfly Pea (Clitoria Ternatea L.) Extract. *Andalasian International Journal of Agriculture and Natural Sciences (AIJANS)*, *4*(02), 130-139.

[60] Purwanti, I., Kamsiah, K., & Wahyu, T. (2020). Mutu Protein dan Kandungan Zat Gizi Formula Makanan Cair dengan Penambahan Tepung Labu Kuning. *Jurnal Penelitian Terapan Kesehatan*, *7*(1), 1-4.

[61] Ohanenye, I. C., Ekezie, F. G. C., Sarteshnizi, R. A., Boachie, R. T., Emenike, C. U., Sun, X., ... & Udenigwe, C. C. (2022). Legume seed protein digestibility as influenced by traditional and emerging physical processing technologies. *Foods*, *11*(15), 2299.

[62] Ashkar, F., & Wu, J. (2023). Effects of food factors and processing on protein digestibility and gut microbiota. *Journal of Agricultural and Food Chemistry*, *71*(23), 8685-8698.

[63] Obadi, M., Li, Y., & Xu, B. (2022). Identifying key factors and strategies for reducing oil content in fried instant noodles. *Journal of Food Science*, *87*(10), 4329-4347.

[64] Herawati, E. R. N., Ariani, D., Miftakhussolikhah, M., Ningrum, V. A., & Pranoto, Y. (2022, April). Physical and sensory characteristic of arenga-arrowroot starch noodle with beetroot extract addition. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1012, No. 1, p. 012075). IOP Publishing.

[65] Artiningsih, N. K. (2021). Penambahan Puree Bit (Beta Vulgari L.) Terhadap Kandungan Gizi Makro Dan Kadar Serat Sosis Ikan Kembung (Rastrelliger kanagurt L.). *Jurnal Gizi Dan Pangan Soedirman*, *5*(1), 92-104.

[66] Raczyk, M., Kruszewski, B., & Zachariasz, E. (2022). Effect of tomato, beetroot and carrot juice addition on physicochemical, antioxidant and texture properties of wheat bread. *Antioxidants*, *11*(11), 2178.

[67] Mitrevski, J., Pantelić, N. Đ., Dodevska, M. S., Kojić, J. S., Vulić, J. J., Zlatanović, S., ... & Antić, V. V. (2023). Effect of beetroot powder incorporation on functional properties and shelf life of biscuits. *Foods*, *12*(2), 322.

[68] Wei, N. S., & Sulaiman, R. (2022). Effect of Maltodextrin, Arabic Gum, and Beetroot Juice Concentration on the Powder Properties of Spray-Dried Beetroot-Skim Milk Mixtures. *Acta Universitatis Cibiniensis. Series E: Food Technology*, *26*(2), 209-224.

[69] Ashraf, S., Sayeed, S. A., Ali, R., Vohra, F., Ahmed, N., & Alam, M. K. (2022). Assessment of potential benefits of functional food characteristics of beetroot energy drink and flavored milk. *BioMed Research International*, *2022*.

[70] Liu, Y., Duan, Z., Sabadash, S., & Shang, F. (2022). Study on the effect of intermittent microwave drying conditions on the bioactive compounds and antioxidant capacity of beetroots. *Technology audit and production reserves*, *1*(3), 63.

[71] Pertiwi, A. D., Widanti, Y. A., & Mustofa, A. (2017). Substitusi tepung kacang merah (Phaseolus vulgaris L.) pada mie kering dengan penambahan ekstrak bit (Beta vilgaris L.). *JITIPARI (Jurnal Ilmiah Teknologi dan Industri Pangan UNISRI)*, *2*(1).

[72] Setiaji, W. P., Rizqiati, H., & Nurwantoro, N. (2019). Aktivitas Antioksidan, Nilai pH, Kemuluran dan Uji Hedonik Keju Mozzarella dengan Penambahan Jus Umbi Bit (Beta vulgaris L). *Jurnal Teknologi Pangan*, *3*(1), 9-19.

[73] Muguruma, M., Ahhmed, A. M., Katayama, K., Kawahara, S., Maruyama, M., & Nakamura, T. (2009). Identification of pro-drug type ACE inhibitory peptide sourced from porcine myosin B: Evaluation of its antihypertensive effects in vivo. *Food Chemistry*, *114*(2), 516-522.

[74] El-Beltagi, H. S., El-Mogy, M. M., Parmar, A., Mansour, A. T., Shalaby, T. A., & Ali, M. R. (2022). Phytochemical characterization and utilization of dried red beetroot (Beta vulgaris) peel extract in maintaining the quality of Nile Tilapia Fish Fillet. *Antioxidants*, *11*(5), 906.

[75] Kusnandar, F., Andarwulan, N., & Herawati, D. (2011). Analisis Pangan. *Jakarta: Dian Rakyat*.

[76] Shiau, S. Y., Yu, Y., Li, J., Huang, W., & Feng, H. (2023). Phytochemical-rich colored noodles fortified with an aqueous extract of Clitoria ternatea flowers. *Foods*, *12*(8), 1686.

[77] ASRA, R., Yetti, R. D., Ratnasari, D., & Nessa, N. (2020). Studi fisikokimia betasianin dan aktivitas antioksidan dari umbi bit merah (Beta vulgaris L.). *Journal of Pharmaceutical and Sciences*, *3*(1), 14-21.

[78] Muramatsu, D., Uchiyama, H., Higashi, H., Kida, H., & Iwai, A. (2023). Effects of heat degradation of betanin in red beetroot (Beta vulgaris L.) on biological activity and antioxidant capacity. *Plos one*, *18*(5), e0286255.

[79] Bahriye, G., Dadashi, S., Dehghannya, J., & Ghaffari, H. (2023). Influence of processing temperature on production of red beetroot powder as a natural red colorant using foam-mat drying: Experimental and modeling study. *Food Science & Nutrition*, *11*(11), 6955-6973.

[80] Winarti, S., Susiloningsih, E. K. B., & Fasroh, F. Y. Z. (2017). Karakteristik mie kering dengan substitusi tepung gembili dan penambahan plastiziser GMS (gliserol mono stearat). *Agrointek: Jurnal Teknologi Industri Pertanian*, *11*(2), 53-62.

[81] Kavitha, K., & Gowthami, S. (2022). Standardization, Sensory Evaluation and Physico Chemical Analysis of Grape Seed Powder Incorporated Home Made Noodles. *FoodSci: Indian Journal of Research in Food Science and Nutrition*, 58-65.

[82] Fikriyah, Y. U., & Nasution, R. S. (2021). Analisis kadar air dan kadar abu pada teh hitam yang dijual di pasaran dengan menggunakan metode gravimetri. *Amina*, *3*(2), 50-54.

[83] Miftahul, J. (2019). *Pengaruh Penambahan Sari Umbi Bit Merah (Beta Vulgaris L.) Pada Pembuatan Fruit Leather Dari Buah Sirsak (Annona Murricata L.) Dan Kolang-Kaling (Arenga Pinnata, M.)* (Doctoral dissertation, Universitas Andalas).

[84] Nguyen, G. T. H. (2023). Effects of pasteurization on the physicochemical, sensory properties and microbiological quality of beetroot (Beta vulgaris L.) wine during storage. *Science and Technology Development Journal*, *26*(3), 2950-2958.

[85] Pandeirot, B. N. K., & Handoko, Y. A. (2022). Physical, chemical, and organoleptic characterization of beetroot leather (Beta vulgaris L.) with additional CMC and Carrageenan.

[86] Waqiah, A. N., Damat, D., & Putri, D. N. (2019). Karakteristik Sifat Fisiko-Kimia Mi Basah Subtitusi Tepung Sorgum (Sorghum bicolor L. Moench) Diperkaya Serat Rumput Laut (Gracilaria sp.). *Food Technology and Halal Science Journal*, *2*(2), 174-182.

[87] Asgar, A., & Musaddad, D. (2006). Optimalisasi cara, suhu, dan lama blansing sebelum pengeringan kubis. *Jurnal Hortikultura*, *16*(4).

[88] Suriawati, J., & Rachmawati, S. R. (2023). Garlic extract (Allium sativum) improves the taste of dried moringa noodle products (Moringa oleifera). *AcTion: Aceh Nutrition Journal*, *8*(3), 407-415.

[89] Lin, Q., Ren, A., Liu, R., Xing, Y., Yu, X., & Jiang, H. (2022). Flavor properties of Chinese noodles processed by dielectric drying. *Frontiers in Nutrition*, *9*, 1007997.

[90] Ahmad, H., Mustarin, A., & Fadilah, R. (2020). Analisis Kualitas Mie Basah dengan Penambahan Daun Ubi Jalar Ungu (Ipomoea batatas). *J. Pendidik. Teknol. Pertan*, *6*(1), 87-100.

[91] Kamsiati, E., Rahayu, E., & Herawati, H. (2021). Pengaruh konsentrasi binder dan lama waktu pengukusan terhadap karakteristik mi sorgum bebas gluten. *Agrointek: Jurnal Teknologi Industri Pertanian*, *15*(1), 92-105.

[92] Xiao, W., Ding, Y., Cheng, Y., Xu, S., & Lin, L. (2022). Understanding the changes in quality of semi-dried rice noodles during storage at room temperature. *Foods*, *11*(14), 2130.