Universal Journal of Agricultural Research 11(2): 417-424, 2023 http://www.hrpub.org
DOI: 10.13189/ujar.2023.110218

The Application of Black Powdered Colorant from Black Glutinous Carbonized Merang to the Traditional Product Ireng-Ireng

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Received February 2, 2023; Revised March 6, 2023; Accepted April 21, 2023

Cite This Paper in the Following Citation Styles

(a): *[1] Erni Sofia Murtini, Dina Wahidah Islamiyah , "The Application of Black Powdered Colorant from Black Glutinous Carbonized Merang to the Traditional Product Ireng-Ireng," Universal Journal of Agricultural Research, Vol. 11, No. 2, pp. 417 - 424, 2023. DOI: 10.13189/ujar.2023.110218.*

(b): *Erni Sofia Murtini, Dina Wahidah Islamiyah (2023). The Application of Black Powdered Colorant from Black Glutinous Carbonized Merang to the Traditional Product Ireng-Ireng. Universal Journal of Agricultural Research, 11(2), 417 - 424. DOI: 10.13189/ujar.2023.10218.*

Abstract Black powdered colorant from carbonized merang can be used as a ready-to-use colorant in making traditional product ireng-ireng. The aim of this study was to determine the effect of various black powdered colorant concentrations as well as to obtain the optimum concentration of the colorant on the physical properties of ireng-ireng product, such as lightness (L*), redness (a*), yellowness (b*) and texture profile (hardness, springiness, cohesiveness, gumminess, chewiness) The research used one factor completely randomized design (CRD). The factor used was colorant concentration (1%, 3%, 5%, 7% (w/v)). Each treatment level was repeated three times to obtain 12 experimental units. The data were analyzed using ANOVA with a 95% confidence interval and continued by Tukey's HSD test of 5%. Ireng-ireng from the optimum concentration (addition of 7% colorant) based on Multiple Attribute Zeleny had lightness (L*) 23.02 ± 0.61, redness (a*) -0.97 ± 0.06, yellowness (b*) 5.05 ± 0.18, hardness 43.6 ± 7.19, cohesiveness 0.85 ± 0.07, springiness 8.9 ± 0.31, gumminess 36.70 ± 3.96, and chewiness 327.86 ± 40.97.

Keywords Carbon, Dark, Flour, Texture

1. Introduction

Based on [13], Indonesia is the third largest rice-producing country in the world, right after China and India. Still, the utilization of rice merang as a by-product of harvesting has yet to optimize. Merang is the top part of rice straw to panicle (without leaves), representing 30–50% of the total weight of rice straw. When merang is burned at a high temperature, it turns black, called carbonized merang. The black color is caused by the carbon content. According to [25], black glutinous carbonized merang contains 44.7% carbon, so it can be used as a natural black colorant. In Indonesia, carbonized merang has been used as a black colorant in traditional products, including cenil, jongkong cake, and dawet [15]. However, its use is inefficient because it takes quite a long time to obtain the colorant. Carbonized merang must be immersed in water first, then filtered to obtain black water to be added to product making. Thus, using a spray dryer to make powdered colorant by immersing water in carbonized merang can overcome the problem. The spray drying method can produce ready-to-use colorant.

The application of carbonized merang colorant to food products has been carried out in the study of [24] with various liquid colorant concentrations (0%, 0.5%, 1%, 1.5%) in the making of sago noodles. The optimum concentration was obtained at the addition of 1.5% colorant concentration with physical properties elongation 54.45 ± 0.35%, cooking loss 2.72 ± 0.08%, cooking time 153.8 ± 0.15 s, lightness (L*) 29.7 ± 0.08, redness (a*) -2.1 ± 0.10, and yellowness (b*) 3.2 ± 0.03. In addition, the application of carbonized merang to dawet has been done by [23] with various colorant concentrations (1.5%, 2%, 2.5%, and 3%). The result showed that the addition of colorant concentration decreases the lightness value and increases the texture of dawet. According to those studies, carbonized merang has the potential to be used as a natural black colorant for food products. Further studies need to be done to utilize the abundance of merang itself. The application of carbonized merang can be used in traditional product ireng-ireng making.

Ireng-ireng or ireng cake is a traditional food from Tulungagung, East Java which is made of tapioca flour by steaming process. It is called ireng-ireng because of its black appearance, whereas ireng means black in Javanese. Ireng-ireng has a sweet taste, and chewy texture, cut into a square shape and served with grated coconut. The product is usually found in the traditional market [17]. Ireng-ireng is classified as a traditional wet cake because it contains high moisture content [27]. The product can be consumed at any time by various groups and is made of high-carbohydrate ingredients so that it can delay hunger [14].

According to [17], the black appearance in ireng-ireng is caused by the addition of natural colorant obtained from banana leaves using the conventional method. Banana leaves are burned and immersed in water, then filtered to separate the water and undissolved solid. After that, the black water is added to the ireng-ireng batter. However, the method is inefficient because it takes overnight (24 hours) to obtain the liquid black colorant. The application of black powdered colorant was done in this study with various colorant concentrations (1%, 3%, 5%, 7% (w/v)). The study aimed to obtain an ireng-ireng product with the best physical properties, including lightness (L*), redness (a*), yellowness (b*) and texture profile analysis (hardness, springiness, cohesiveness, gumminess, chewiness). The addition of powdered carbonized merang can also be a black colorant alternative which is ready to use in ireng-ireng making.

2. Materials and Methods

2.1. Material

The materials used to make powdered colorant were black glutinous merang from farmers in Trawas, which burned into carbonized merang, maltodextrin from CV Pratama Mandiri, aquades (Hydrobatt), and Whatman filter paper no 42. Materials used in the making of ireng-ireng were powdered carbonized merang colorant, tapioca flour (Cap Gunung Agung), medium-protein flour (Segitiga Biru), granulated sugar (Gulaku), table salt (Cap Kapal), coconut milk (Sasa), cooking oil (Filma), water from PDAM Malang, while the material used for analysis was plastic (polypropylene).

2.2. Tool

The tools used in the making of powdered colorant were a ball mill (Vertake), sieves (250 and 350 mesh), digital balance (Kenko), hot plate stirrer (Cimarex), centrifuge (Hermle Z 32 HK), and spray dryer (Buchi). Tools used in the making of ireng-ireng were a large bowl, balloon whisk stainless steel, steamer, measuring cup, filter, thermometer, stove, knife, digital balance (Kenko), and 20 x 8 cm steam pan, while the tools used for analysis were texture profile analyzer (Brookfield) and color reader (Konica Minolta CR-10).

2.3. Experimental Design

This study used one factor completely randomized design (CRD). The factor was colorant concentrations (1%, 3%, 5%, 7% (w/v)). Each treatment level was repeated three times to obtain 12 experimental units. The data obtained were analyzed using ANOVA (Analysis of Variance) with a 95% confidence interval and continued by Tukey's HSD test (Tukey's Honesty Significant Difference Test) 5% in Minitab Software 2017. The optimum concentration of colorant was obtained using Multiple Attribute Zeleny in Microsoft Excel 2016.

2.4. Research Stage

The making of powdered colorant was done by grinding the carbonized merang using a ball mill at 116 – 118 rpm for 120 minutes, then sieved in 350 mesh. Carbonized merang that passed through 350 mesh was immersed in water with a ratio of 1:4 (solid: water) for 24 hours using a hot plate stirrer at 500 rpm. Carbonized merang suspension was then centrifuged at 3500 rpm for 10 minutes. After that, 5% maltodextrin was added into 100 ml carbonized merang supernatant using a hot plate stirrer at 500 rpm for 10 minutes. The mixture was dried using a spray dryer at 105OC (inlet temperature) and 70 – 75OC (outlet temperature).

The making of ireng-ireng was done by mixing dry ingredients, including 25 grams of medium-protein flour, 25 grams of tapioca flour, 25 grams of granulated sugar, and 1 gram of table salt. Powdered colorant with various concentrations (1%, 3%, 5%, 7% (w/v)) was dissolved in 100 ml coconut milk, then added to the dry mixture and mixed until the batter turned grey or black completely. The batter was filtered to separate lumps, and then cooking oil was applied to the steam pan so that the ireng-ireng product didn't stick to it. The steam pan was heated in a steamer for 10 minutes. After that, the batter was poured into the pan and steamed at 80OC for 45 minutes. Then, ireng-ireng was cooled at room temperature for 15 minutes, removed from the pan, and cut into 5x3 cm each. The physical properties of the product were analyzed including lightness (L*), redness (a*), yellowness (b*), and texture profile analysis (hardness, cohesiveness, springiness, gumminess, chewiness).

2.5. Analysis Procedure

2.5.1. Color [21].

Ireng-ireng was cut into 5x3 cm each and put into polypropylene plastic, then the color reader was turned on, and the display was set to L*, a*, b*. After that, the color reader was directed to the plastic surface, and the target button was pressed until the L*, a*, and b* values appeared r on the color reader display.

2.5.2. Texture Profile Analysis [2]

The texture profile of ireng-ireng was obtained using a texture profile analyzer with settings as follows.

1. Test date: Compression
2. Target: 10 mm
3. Hold time: 0 s
4. Trigger load: 6.8 g
5. Test speed: 1 mm/s
6. Return speed: 1 mm/s
7. # of cycles: 2
8. Recovery time: 0 s
9. Same trigger: False
10. Pretest speed: 2 mm/s
11. Data rate: 50 points/sec
12. Probe: TA44
13. Fixture: TA-BT-KI
14. Load cell: 1000 g
15. Sample size: 3x3x10 cm

3. Result and Discussion

3.1. Lightness (L*)

The analysis of variance showed that the addition of various colorant concentrations had a significant effect ($\alpha = 0.05$) on the lightness value (L*) of ireng-ireng. The average lightness value of ireng-ireng due to various concentrations of colorant can be seen in Table 1. It shows that the addition of colorant decreases the lightness value of ireng-ireng. The product is getting black as the concentration of colorant increases. According to [9] , the lower the lightness value, the darker the product is. This is due to the carbon content in the powdered colorant, which can increase dark intensity in ireng-ireng. Therefore, the higher the addition of the colorant, the higher the carbon content in the product itself.

According to [25], the more carbon a product contains, the darker the product. Carbon content can be formed during the incomplete combustion process of organic matter, in this case, rice straw, at high temperatures [19]. Carbonized merang is considered vegetable carbon that can be used as a black colorant in the food product. [20] stated that vegetable carbon could produce spectrums from grey to black, whereas black in food can be seen if the colorant is added at a high concentration. The result of this study is in accordance with the study conducted by [24], who made sago noodles with various concentrations of liquid carbonized merang colorant (0%, 0.5%, 1%, 1.5%). The result showed that the higher the colorant concentration, the lower the lightness value of sago noodles.

Table 1. The Average Lightness Value of Ireng-Ireng Due to Various Concentrations of Colorant

Colorant Concentration (%)	Lightness (L*) Value
1	31.21 $\pm$ 0.90 ^{a}
3	26.64 $\pm$ 0.69 ^{b}
5	$\pm$ 0.52 ^{bc}
7	23.02 $\pm$ 0.61 ^{c}

1. The data is an average of 3 repetitions with the number after $\pm$ as the standard error

2. Numbers with different notations show significant differences ($\alpha = 0.05$)

3.2. Redness (a*)

The result of the analysis of variance showed that the addition of various colorant concentrations had a significant effect ($\alpha = 0.05$) on the redness value (a*) of ireng-ireng. The average redness value of ireng-ireng due to various concentrations of colorant can be seen in Table 2.

Table 2. The Average Redness Value of Ireng-Ireng Due to Various Concentrations of Colorant

Colorant Concentration (%)	Redness (a*) Value
1	-1.44 $\pm$ 0.08 ^{ab}
3	-1.47 $\pm$ 0.04 ^{a}
5	-1.17 $\pm$ 0.02 ^{bc}
7	-0.97 $\pm$ 0.06 ^{c}

1. The data is an average of 3 repetitions with the number after $\pm$ as the standard error

2. Numbers with different notations show significant differences ($\alpha = 0.05$)

The result indicates that the higher the addition of colorant concentration, the higher the redness value of ireng-ireng. The redness value obtained was negative (-), so the color of ireng-ireng tends to be greenish. According to [7], a negative redness value indicates a color that tends to be greenish, while reddish is indicated by a positive value. Based on the result, with the higher concentration of colorant, a* value of ireng-ireng tends to be closer to a* value of the carbonized merang (0.66 $\pm$ 0.06). The main ingredients in ireng-ireng making are medium-protein flour and tapioca flour, which look yellowish-white. Therefore, the ireng-ireng color will tend to follow the color of colorant, including the redness value. According to the literature, the redness value of food products can be affected by additives and processing [5, 13].

3.3. Yellowness (b*)

The result of the analysis of variance shows that the addition of various colorant concentrations had a significant effect (α = 0.05) on the yellowness (b*) of ireng-ireng. The average yellowness value of ireng-ireng due to various concentrations of colorant can be seen in Table 3.

Table 3. The Average Yellowness Value of Ireng-Ireng Due to Various Concentrations of Colorant

Colorant Concentration (%)	Yellowness (b*) Value
1	6.63 ±0.28 [a]
3	5.76 ±0.18 [ab]
5	4.79 ±0.20 [b]
7	5.05 ±0.18 [b]

1. The data is an average of 3 repetitions with the number after ± as the standard error

2. Numbers with different notations show significant differences (α = 0.05).

The result shows that the yellowness value of ireng-ireng decreases with the increase in colorant concentration. The yellowness value obtained was positive (+), so the ireng-ireng color tends to be yellowish. According to [7], a negative b* value indicates a bluish color, while yellowish is indicated by a positive value. Before the colorant is added, the ireng-ireng batter looks yellowish-white. Thus, the higher the colorant concentration, the darker ireng-ireng and causes decreasing yellowness value of the product. The yellowish white of ireng-ireng batter is caused by the main ingredients, tapioca and medium-protein flour. According to [10], flour is yellowish-white because of the xanthophyll content from wheat. The result of this study is in accordance with the study conducted by [24], who made sago noodles with the addition of 0%, 0.5%, 1%, and 1.5% liquid carbonized merang colorant. The result showed that the higher concentration of colorant, the lower the yellowness value of sago noodles. Ireng-ireng with various concentrations of colorant can be seen in Figure 1.

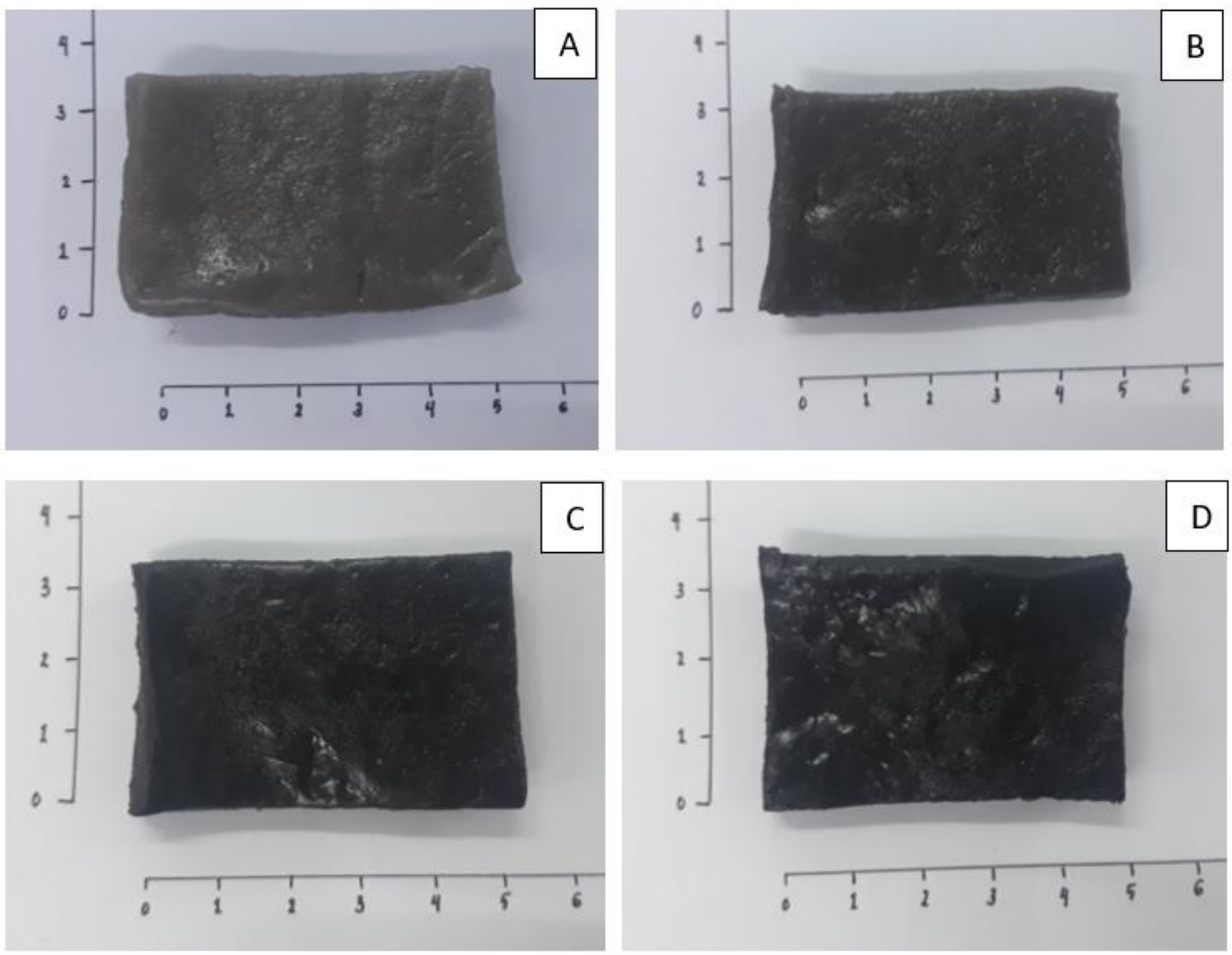

Figure 1. Ireng-Ireng Product with Various Colorant Concentrations (A) 1% (B) 3% (C) 5% (D) 7%

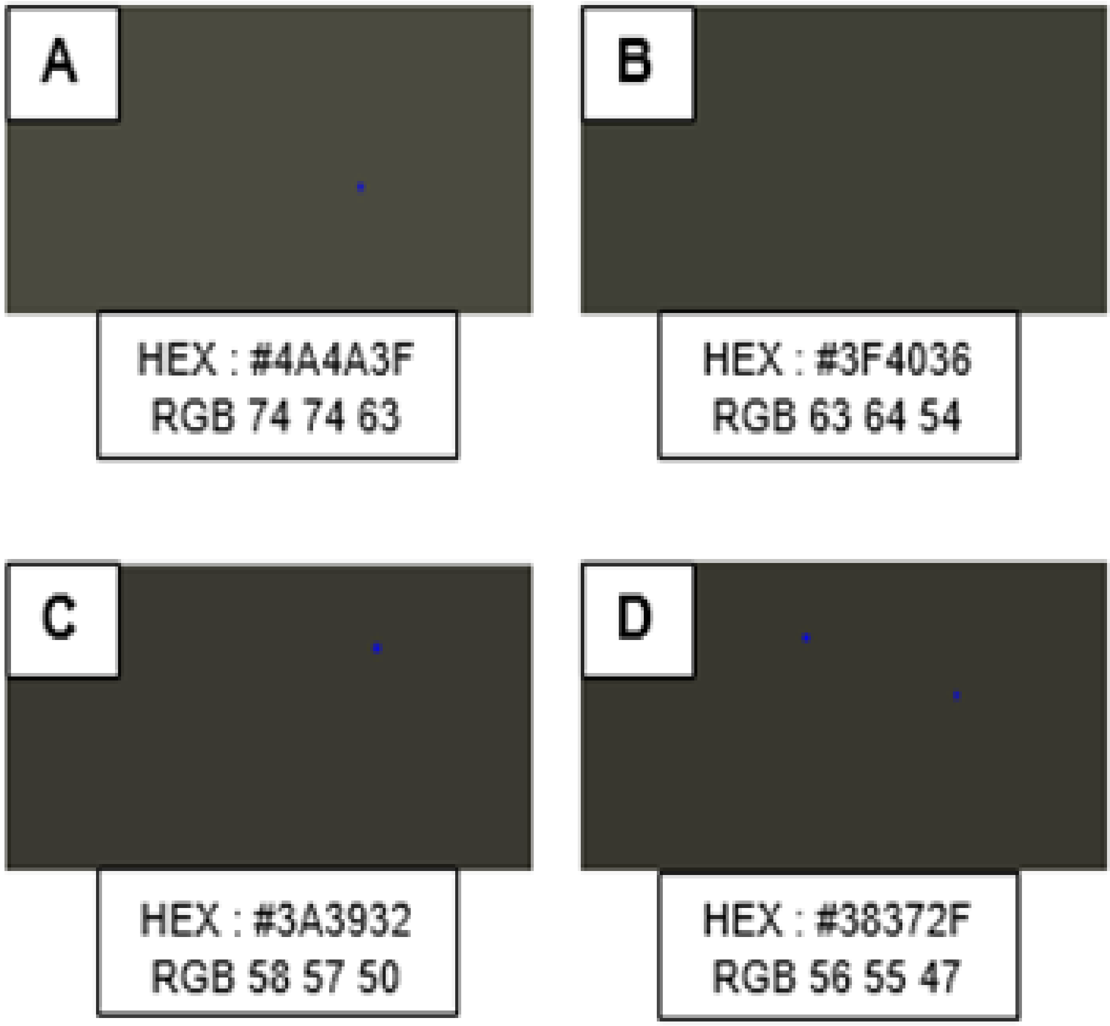

Figure 2. Color Spectrum of Ireng-Ireng with Various Colorant Concentrations (A) 1% (B) 3% (C) 5% (D) 7%

Based on the physical analysis results, those values of L, a*, and b* were converted to RGB units so that the #HEX code is obtained to determine the color spectrum representing the product's colour. The color interpretation can be seen in Figure 2.

3.4. Texture Profile Analysis

The result of the analysis of variance showed that the addition of various colorant concentrations has no significant effect (α = 0.05) on all parameters of texture profile analysis. The average texture profile analysis of ireng-ireng due to various concentrations of colorant can be seen in Table 4

According to [3] hardness is the amount of force required to destroy a material. The harder the material, the greater the force required. One of the factors that affect hardness value is moisture content in the material itself. The higher the moisture content, the lower the hardness value [12]. The moisture content in ireng-ireng comes from the addition of coconut milk. The coconut milk added to each concentration was the same (100 ml) so that there was no difference in the moisture content of ireng-ireng. In addition, the cooking temperature affects the hardness value. [28] stated that higher cooking temperature causes water to easily evaporate so that the water availability to bind to polar components in food ingredients is getting less. Therefore, the higher the steaming temperature, the higher the hardness value. However, the temperature for making ireng-ireng was the same in each concentration (80 ℃) so that the water availability to bind to amylose, amylopectin, and protein contained in the ireng-ireng batter was no different.

According to [8], springiness can be referred to as elasticity. The higher the springiness value of a product, the more elastic the product is. The springiness level of a material can be affected by the ratio of amylose and amylopectin contained in the material [26] . The higher the amylopectin content, the higher the springiness value of a material. This is because amylopectin is able to produce products with non-rigid gel properties (Fadhallah et al., 2021). The ratio of amylopectin and amylose depends on the type of flour used. In ireng-ireng making, the same brand of flour was used in each concentration. Therefore, the ratio of amylose and amylopectin contained in ireng-ireng batter in each concentration was also the same, so that the springiness values obtained were no different. [6] stated that tapioca flour has 83% amylopectin and 17% amylose, while wheat flour has 74% amylopectin and 26% amylose.

According to [18], cohesiveness can be referred to as wholeness. The higher the cohesiveness value of a material, the higher the integrity of the material. One of the components that affect cohesiveness is gluten. [16] stated that if a material containing gluten is processed using thermal, it will form a compact (cohesive) product because it can create networks that bind each other. According to [29], the cohesiveness of a material is affected by the glutenin component contained in gluten structure. Tapioca flour in ireng-ireng making also affects cohesiveness value of the product due to the amylopectin content. [12] stated that the higher amylopectin content, the higher cohesiveness value of a product. However, in this study, tapioca flour was added in the same amount (25 grams). Thus, the amylopectin content in the batter in each colorant concentration was also no different, so that it didn’t make any difference to cohesiveness value of ireng-ireng.

Gumminess value is obtained by multiplying hardness and cohesiveness values [4]. Gumminess is affected by steaming temperature, amylopectin content, and gluten. According to Fadhallah et al. (2021), amylopectin has high adhesion and can form non-rigid gels. Gluten content also affects gumminess, [30]) stated that gluten can form viscoelastic networks around starch granules. In ireng-ireng making, the steaming temperature in each colorant concentration was 80^{O}C and the amount of tapioca flour and medium-protein flour added was 25 grams each. The only difference was the addition of colorant concentrations (1%, 3%, 5%, 7%). Therefore, the gumminess value of ireng-ireng was not different among various colorant concentrations.

Chewiness is obtained by multiplying gumminess and springiness value [22] so that its value is affected by hardness, cohesiveness, and springiness. Chewiness in a product is affected by moisture content, steaming temperature, amylose:amylopectin ratio, and gluten. According to [11], starch contains 2 main components, amylose and amylopectin. Gluten also affects chewiness of ireng-ireng, [1] stated that gluten can form networks that bind to each other during heating process. In this study, there was no difference in the making process of ireng-ireng in each colorant concentration, except the colorant concentration itself (1%, 3%, 5%, 7%). Thus, the chewiness value of ireng-ireng was not different among various colorant concentrations.

3.5. The Optimum Concentration of Colorant

The determination was done using Multiple Attribute Zeleny [31] that based on lightness, redness, yellowness, hardness, springiness, cohesiveness, gumminess, and chewiness. In this study, the optimum concentration was obtained with the addition of 7% colorant. The physical properties of the product are presented in Table 5.

Table 4. The Average Texture Profile Analysis Value of Ireng-Ireng Due to Various Concentrations of Colorant

Colorant Concentration (%)	Hardness Value	Springiness Value	Cohesiveness Value	Gumminess Value	Chewiness Value
1	44.86 ±2.47	10.44 ±0.60	1.06 ±0.04	47.76 ±3.19	501.81 ±58.03
3	42.86 ±3.21	10.45 ±0.66	0.94 ±0.08	40.60 ±4.67	430.09 ±70.95
5	58.40 ±10.66	9.23 ±0.49	0.90 ±0.05	53.22 ±11.58	497.18 ±124.94
7	43.60 ±7.19	8.90 ±0.31	0.85 ±0.07	36.70 ±3.96	327.86 ±40.97

Numbers with different notations show significant differences (α = 0.05)

Table 5. Physical Properties of The Best Ireng-Ireng

Parameter	Value
Lightness (L*)	23.02 ±0.61
Redness (a*)	-0.97 ±0.06
Yellowness (b*)	5.05 ±0.18
Hardness	43.60 ±7.19
Springiness	8.90 ±0.31
Cohesiveness	0.85 ±0.07
Gumminess	36.70 ±3.96
Chewiness	40.97

The data is an average of 3 repetitions with the number after ±as the standard error

4. Conclusion

The addition of various colorant concentrations has significant effects (α = 0.05) on lightness (L*), redness (a*), and yellowness (b*), but has no significant effect on all parameters of texture profile analysis (hardness, springiness, cohesiveness, gumminess, chewiness) of ireng-ireng. The best ireng-ireng was obtained at the addition of 7% colorant with physical properties lightness 23.02 ±0.61, redness -0.97 ±0.06, yellowness 5.05 ±0.18, hardness 43.60 ± 7.19, springiness 8.90 ± 0.31, cohesiveness 0.85 ± 0.07, gumminess 36.70 ± 3.96, and chewiness 327.86 ±40.97.

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