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Karakteristik Fisik Kimia dan Organoleptik Permen Jelly Kopi Robusta dengan Variasi Rasio Ekstrak Lemon dan Air

Physical, Chemical, and Organoleptic Characteristics of Robusta Coffee Jelly Candy with Variations in the Ratio of Lemon Extract and Water

*Yesiva Tulaini, Bosman Sidebang, Ulfah Anis**

Department of Agricultural Technology, Faculty of Agriculture, University of Bengkulu, Indonesia

*E-mail Korespondensi: ulfahanis@unib.ac.id

ABSTRAK

Permen jeli kopi Robusta berpotensi dikembangkan sebagai produk kembang gula fungsional melalui penambahan bahan-bahan alami. Penelitian ini bertujuan untuk mengevaluasi pengaruh berbagai rasio ekstrak lemon dan air terhadap karakteristik fisik, kimia, dan organoleptik permen jeli kopi Robusta. Rancangan acak lengkap dengan lima perlakuan diterapkan dalam penelitian ini. Sampel dianalisis meliputi warna, profil tekstur, pH, kadar kafein, aktivitas antioksidan, dan sifat sensoris menggunakan metode analisis serta statistik yang sesuai. Hasil penelitian menunjukkan bahwa ekstrak lemon berpengaruh signifikan terhadap beberapa karakteristik fisikokimia (kadar air, tekstur, kadar kafein, pH, dan aktivitas antioksidan) dan sensoris. Proporsi ekstrak lemon yang tepat mampu meningkatkan kualitas produk sekaligus mempertahankan tingkat preferensi konsumen yang dapat diterima, sehingga menunjukkan potensi penerapannya dalam pengembangan permen jeli fungsional.

Kata kunci:
kopi robusta, lemon, permen jelly

ABSTRACT

Robusta coffee jelly candy has the potential to be developed as a functional confectionery product through the incorporation of natural ingredients. This study aimed to evaluate the effects of different ratios of lemon extract and water on the physical, chemical, and organoleptic characteristics of robusta coffee jelly candy. A completely randomized design with five treatments was applied. The samples were analyzed for color, texture profile, pH, caffeine content, antioxidant activity, and sensory properties using appropriate analytical and statistical methods. The results demonstrated that lemon extract significantly influenced several physicochemical (water content, texture, caffeine content, pH, and antioxidant activity) and sensory characteristics. An appropriate proportion of lemon extract improved product quality while maintaining acceptable consumer preference, indicating its potential application in functional jelly candy development.

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1. INTRODUCTION

Robusta coffee (*Coffea canephora*) is one of the most important plantation commodities in Indonesia due to its distinctive flavor, high caffeine content, and abundant bioactive compounds with antioxidant potential (chfiroh, 2024; Pinkan *et al*., 2021). The increasing demand for functional foods has encouraged the development of coffee into value-added products, including jelly candy, which offers an alternative form of coffee consumption with improved consumer appeal.

Jelly candy quality is primarily determined by its physicochemical and sensory characteristics, including color, texture, taste, aroma, and overall acceptability. The incorporation of hydrocolloids such as gelatin contributes to the formation of an elastic gel structure, while formulation changes may significantly influence product quality (Chrisella *et al*., 2015; Handayani *et al*., 2021).

Lemon (*Citrus limon*) extract is a natural ingredient rich in vitamin C, organic acids, and phenolic compounds, which may enhance antioxidant activity while affecting pH, texture, and sensory characteristics of jelly candy (Bahri *et al*., 2020; Cahyaning *et al*., 2024). Previous studies have demonstrated that citrus addition can modify the physicochemical properties and consumer acceptance of confectionery products (Setiawati & Sari, 2020).

Several studies have investigated coffee-based jelly candy formulations Pakpahan *et al*., 2022; Brilliantina *et al*., 2023). However, information regarding the effect of different ratios of lemon extract and water on the chemical, physical, and organoleptic characteristics of robusta coffee jelly candy remains limited. Therefore, this study aimed to evaluate the influence of lemon extract addition on the physicochemical and sensory characteristics of robusta coffee jelly candy to determine an appropriate formulation with desirable quality and consumer acceptance.

2. MATERIALS AND METHODS

2.1 Tools and Materials

The tools used in this study include a gas stove, pan, knife, spatula, fruit squeezer, 60 mesh sieve, 50 mesh stainless steel sieve, and candy molds measuring 11 cm X 19.5 cm and a digital thermometer. The laboratory equipment used are an oven, SP-CLR30 colorimeter, Texture Profile Analysis (TPA) TX-700, beaker, measuring cylinder, measuring flask, porcelain cup, analytical balance, stirring rod, volumetric pipette, test tube, pH meter, separating funnel, cuvette, UV-Vis spectrophotometer, hot plate, mortar and pestle.

The materials used in this study were Robusta coffee powder, lemon, water, sucrose, CMC, and gelatin.

2.2 Experimental Design

The experimental design implemented in this study was a Completely Randomized Design (CRD) with a single factor, namely the concentration of lemon extract, which included 5 treatment levels and 3 replications with the use of lemon extract concentrations of 0% (without the addition of lemon extract), 1.03%, 2.068%, 3.10%, and 4.13%. The experiment comprised a total of 15 treatment units.

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2.3 Research Procedures

2.3.1 How to Make a Robusta Coffee Brew

The preparation of Robusta coffee brew refers to the research of (Handayani *et al*., 2021). A total of 300 g of Robusta coffee grounds were mixed with 1,500 mL of hot water at a 1:5 ratio. The water was first heated over medium heat and monitored until it reached 95°C using a digital thermometer. The coffee and water mixture was stirred until homogeneous, then filtered through a 50-mesh stainless steel sieve to remove the coffee grounds. This process produced a Robusta coffee brew, which was then used as an essential ingredient in the production of Robusta coffee jelly candy.

2.3.2 How to Make Lemon Extract

The steps for making lemon extract refer to the research of (Cahyaning *et al*., 2024). First, the lemons were washed with running water until clean, then cut in half. The lemons were squeezed using a fruit squeezer to obtain lemon extract. The lemon extract was filtered through a 60-mesh sieve to produce a clear lemon extract without pulp. The filtered lemon extract was taken according to the needs of each treatment, namely at concentrations of 0% (without the addition of lemon extract) 1.03%, 2.068%, 3.10%, and 4.13%.

2.3.3 How to Make Jelly Candy

The preparation of robusta coffee jelly candy refers to a modified study by Brilliantina *et al* . (2023). 202 g of brewed robusta coffee mixed with 150 g of granulated sugar was mixed into a pan, then heated over medium heat until it reached a temperature of 90°C while stirring for 3 minutes. Temperature monitoring was carried out from the beginning of heating using a digital thermometer. After the temperature was reached, the heat was reduced and 10 g of CMC was added and the temperature was measured again until it reached 80°C, then stirred until the mixture became thick. Next, 24 g of bovine gelatin was added and the temperature was measured again until it reached 65°C and stirred until homogeneous. Water and lemon extract were then added to the mixture according to the treatment concentration, namely 0% (without the addition of lemon extract), as well as 1.03%, 2.068%, 3.10%, and 4.13%. The mixture was reheated over low heat until it reached a temperature of 60°C for 3 minutes and bubbles appeared in the mixture. The hot mixture was then poured into silicone molds measuring 11 cm high and 19.5 cm thick, cooled at room temperature for 10 minutes, and then refrigerated for 24 hours. After the cooling process was complete, the jelly candies were removed from the molds one by one, measuring 1.3 cm × 1.2 cm per jelly candy. Next, the jelly candies were tested for physical, chemical, and organoleptic characteristics.

2.4 Observation Parameters

2.4.1 Physical Characteristics of Jelly Candy

2.4.1.1 Water Content

Water content measurement is done by heating the cup in an oven at 105°C for 30 minutes and cooling it in a desiccator for 15 minutes, the cup is weighed using an analytical balance. After that, 2 g of jelly candy is put into a porcelain cup, then the cup containing the jelly candy is reheated in an oven at 105°C for 4 hours. After that, cool the cup again for 15 minutes in a desiccator and weigh it again (Wijana *et al*., 2014). The calculation of water content uses the following formula:

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$$\text{Water Content (\%)} : \frac{w1-w2}{w1-w0}\ x\ 100$$

Description:
w0 = weight of empty cup (g)
w1 = weight of cup and sample before drying (g)
w2 = weight of cup and sample after drying (g)

2.4.1.2 Color

Color testing for jelly candies was conducted using an SP-CLR30 colorimeter. Three parameters are used in color testing: L, which indicates brightness; a, which describes the green/red chromaticity; and b, which indicates the blue/yellow chromaticity. Prior to testing, the SP-CLR30 colorimeter was calibrated using a standard white color. The results of this test include values for L, a, b, hue angle, and chroma. After obtaining the L, a, and b values, color analysis was performed using the following equation:
L* = Brightness (ranges from 0 (black) to 100 (white)
a* = Chromatic color (ranges from +100 (red) to -80 (green)
b* = Color intensity (ranges from +70 (blue) to -70 (yellow)
(Setiawati & Sari, 2020).

2.4.1.3 Texture

Jelly candy texture measurements were carried out following the method used by Yusof *et al*. (2019) using the Texture Profile Analysis (TPA) TX-700. The Texture Profile Analysis mechanism is that the jelly candy sample is placed horizontally under the probe or sensor, then its position is adjusted. The probe speed is set at 5 mm/s and the sample is pressed until it reaches 30% of its initial height. The type of probe used in jelly candy texture measurements is the Bloom Probe (130046). After that, the required TPA parameters are selected and the analysis data is saved. Parameters measured by this tool include hardness, cohesiveness, springiness, gumminess, chewiness, and resilience.

2.4.2 Chemical Characteristics of Jelly Candy

2.4.2.1 Caffeine Levels

The caffeine content test can be explained through an experiment conducted by Suwiyarsa *et al*. (2018) The stock solution preparation involved pouring 20 mg of standard caffeine into a 100 mL volumetric flask, dissolving it in distilled water to the mark, and shaking until a homogeneous solution was formed to obtain a concentration of 200 ppm. Determining the maximum absorbance wavelength involved taking 10 mL of the standard caffeine solution and adding it to the stock solution in a 100 mL volumetric flask, dissolving it in distilled water to the mark to obtain a 20 ppm stock solution. The absorbance of the solution was then determined at 270 nm–300 nm to determine the maximum absorbance wavelength. Determining the calibration curve involved preparing caffeine standards with concentrations of 0, 10, 20, 30, and 40 ppm, as well as preparing solutions by adding 0, 5, 10, 15, and 20 mL of the 200 ppm stock solution to the 100 mL volumetric flask and adding distilled water to the

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mark. In addition, the absorbance of each solution was measured at its maximum wavelength using distilled water as a blank. Sample preparation involved weighing 5 g of jelly candy, dissolving it in 100 mL of hot distilled water, and filtering it. The filtrate was then heated to half with 2 g of Na_2CO_3. When the temperature decreased, the solution was transferred to a separatory funnel and extraction was performed by adding 25 mL of chloroform in four iterations. The chloroform phase was collected in an Erlenmeyer flask followed by evaporation to obtain the caffeine extract. The caffeine extract was dissolved and transferred to a 100 mL volumetric flask to the mark. Then, dilution was performed by transferring 2 mL of the solution to a 50 mL volumetric flask and adding distilled water to the mark. Finally, the absorbance was determined at its maximum wavelength (±285 nm) using a UV-Vis spectrophotometer. The caffeine concentration in the sample was obtained from the regression equation on the calibration curve while its content was calculated using the formula below:

$$caffeine\ content\ (ppm) = \frac{M\ x\ V\ x\ Fp}{m}$$

Description:

M : Concentration ppm
V : Final volume of solution
Fp: Dilution factor
m : Sample weight (g)

2.4.2.2 pH

The pH of robusta coffee jelly candy was measured by standardizing the pH meter electrode with distilled water. Afterward, the electrode was cleaned with distilled water and dried. A 5 g sample was mixed with 100 mL of distilled water until evenly distributed. The pH meter was calibrated using distilled water. After calibration, the electrode was cleaned with distilled water and dried. The electrode was inserted into the sample until a consistent reading was obtained (Pakpahan *et al*., 2022).

2.4.2.3 Antioxidant Activity

Preparation of DPPH (1,1-diphenyl-2-picrylhydrazyl) stock solution: 10 mg of DPPH powder was measured by weighing, then dissolved in 96% ethanol to the mark using a 100 ml volumetric flask, and stored in a beaker covered with aluminum foil. Preparation of DPPH blank solution: 50 ml of DPPH stock solution was measured and placed in a 100 ml volumetric flask, then mixed with 96% ethanol until homogeneous, left for 30 minutes, and then the absorbance was measured using a UV-Vis spectrophotometer at a wavelength of 517 nm. Antioxidant activity test: 10 mg of the jelly candy sample was taken and then dissolved in 10 ml of 96% ethanol, then filled to the mark. The solution was divided into samples and then into 20 ppm, 40 ppm, 60 ppm, 80 ppm, and 100 ppm solutions. Each solution was taken using a pipette and then dissolved using 96% ethanol in a 10 ml volumetric flask, up to the mark. A 2 ml sample solution was taken using a pipette and poured into a test tube containing 2 ml of a solution with a wavelength of 517 nm. Next, the measurement results are entered into a regression equation with the extract concentration as the X-axis (abscissa) and the % inhibition value as the Y-axis (ordinate). Using a linear equation, the IC_{50} value is calculated using the following formula:

$$IC_{50} = \frac{50-a}{b}$$

Description:

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y = % inhibition (50)
a = Intercept (line cut on the y-axis)
b = Slope
x = concentration

(Handayani *et al*., 2020).

2.4.3 Organoleptic

Organoleptic testing was conducted to determine which treatment was preferred by the panelists. Organoleptic testing was conducted on robusta coffee jelly candy with the addition of lemon extract, covering color, aroma, texture, taste, and overall based on the level of preference with a hedonic test using 25 untrained panelists (Marsigit *et al*., 2019).

2.5 Data Analysis

The data obtained were analyzed using SPSS software with a significance level of 5% ($\alpha<0.05$), with the analysis carried out using the Analysis of Variance (ANOVA) test, and if there were significant results from the ANOVA test, it was continued with the Duncan Multiple Range Test (DMRT) to find differences in treatment. Organoleptic data using an ordinal scale were analyzed using the Friedman test, while if there were significant differences, they were then further analyzed using the Wilcoxon Signed-Rank test.

3. RESULTS AND DISCUSSION

3.1 Water Content

Water content is a crucial component in assessing and evaluating the quality of food products because it maintains product quality and ensures long-term safety for consumption (Purwaningtyas & Mursyid, 2022). The water content values obtained from jelly candies can be seen in Figure 1.

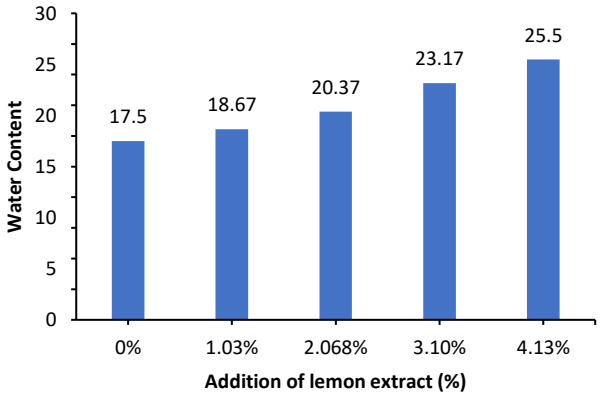

Figure1. Water Content of Coffee Jelly Candy

ANOVA results showed that the addition of lemon extract had no significant effect on the water content of jelly candy with a significance level of 5% (0.287>0.05). Figure 4 shows that the water content value in robusta coffee jelly candy is in the range of 17.50-25.50. The lowest water content level was obtained in the 0% treatment, while the highest water content was obtained in the 4.13% treatment. The increase in water content with increasing lemon extract addition may be attributed to the moisture introduced by the extract. However, the differences among treatmnets were not statistically significant, indicating that lemon extract addition did not substantially affect the water content of teh product. SNI 3547.2-2008 states that the maximum water content permitted in jelly candy products is a maximum of 20%

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(Diandra *et al*., 2022). Treatments with concentrations of 0%, 1.03%, and 2.068% still meet the quality standards for jelly candy, while treatments of 3.10%, and 4.13% have exceeded the limits set by SNI.

3.2 Color

Color plays a role in the visual elements of a product, which is an important aspect in determining consumer appeal objectively. This can be seen using a colorimeter that detects light reflected from the sample surface (Rohmah *et al*., 2023). The results of the color measurement can be seen in Table 1.

Table 1. Coffee Jelly Candy Color

Color	Treatment				
	0%	**1,03%**	**2,068%**	**3,10%**	**4,13%**
L*	26,55[a]	25,06[a]	27,72[a]	26,93[a]	25,84[a]
a*	-1,15[a]	0,90[a]	-1,19[a]	0,70[a]	0,72[a]
b*	45,35[a]	43,73[a]	47,25[a]	46,63[a]	44,56[a]
Chroma	45,38[a]	43,75[a]	46,09[a]	46,44[a]	44,59[a]
Hue Angle	91,84[b]	91,43[a]	91,71[b]	91,38[b]	44,59[b]

Description: Numbers followed in the same column indicate no significant difference.

Lightness (L*) indicates a bright color with a range between 0-100, where values closer to 0 indicate a dark color, while values closer to 100 indicate increased brightness (Sinaga, 2019). Based on the ANOVA analysis, lemon extract addition had no significant effect on the L value of jelly candy (0.822>0.05). Table 1 shows that the L* value of jelly candy is in the range of 25.06-27.72. The highest value was obtained in the 2.068% treatment while the lowest value was obtained in the 1.03% treatment. The dark color is dominated by natural pigments from coffee and the browning reaction that occurs during the processing. The addition of lemon extract does not provide a bright change because it does not change the basic black color of coffee jelly candy to a light color.

The a* value represents the range between red and green, where positive values indicate red and negative values indicate green (Sinaga, 2019). The ANOVA results show that the addition of lemon extract has no significant effect on the a* value of jelly candy with a significant level (0.952>0.05). Table 1 shows the a* value of jelly candy in the range of -1.15-0.90. The a* value in jelly candy indicates that the addition of lemon extract is thought to be unable to produce a strong red or green color, because lemon does not have dominant red and green pigments which only provide a slight color shift. Lemons are dominated by carotenoids that provide a yellow-orange color, color differences are due to varying carotenoid concentrations (Habibi *et al*., 2023).

The b* value indicates the color direction between yellow-blue, positive values indicating yellow and negative values indicating blue (Sinaga, 2019). The ANOVA results indicated that the addition of lemon extract did not significantly affect the b value of the jelly candy (0.821>0.05). Table 1 shows that all treatments have positive and high b* values, ranging from 43.73-47.25. The relatively high and stable values show that variations in the concentration of lemon extract addition do not provide significant changes in the b* value parameter, even though the jelly candy looks dark due to the presence of natural carotenoid pigments.

Chroma describes the degree of saturation or strength of a color, where a higher number reflects a brighter and stronger color (Pathare & Al-Dairi, 2022). The chroma value

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of the jelly candy was not significantly affected by the addition of lemon extract, as indicated by the ANOVA results (0.837>0.05). Table 1 shows the chroma value of jelly candy in the range of 43.75-46.44. The highest value was obtained in the 3.10% treatment and the lowest value was obtained in the 1.03% treatment. The chroma value did not change significantly, presumably because the lemon plays a role in shifting the color position.

The hue angle value is a measure that shows the type or direction of a color in a range between 0 and 360°, with qualitative characteristics that determine the color category, such as reddish, greenish, bluish, yellowish, etc (Melanie & Christy, 2020). ANOVA results showed that the addition of lemon extract significantly affected the hue angle value of jelly candy with a significance level (0.003<0.05). The DMRT analysis demonstrated that the 4,13% treatment was not significantly different from the 1,03% and 2,068% treatments. Meanwhile, the 0% and 3,10% treatments showed significantly different results from the 1,03% and 4,13% treatments. This indicates that hue angle is more sensitive to changes in product composition and chemical conditions. The hue angle parameter is sensitive to product chemical composition (Bahri *et al*., 2020).

3.3 Texture

Texture is a crucial characteristic of food that influences how consumers perceive it. Texture impacts a product through aspects of softness, tenderness, and hardness, which are measured using a Texture Analyzer TX-700 (Beni *et al*., 2020). Values for hardness, cohesiveness, springiness, gumminess, chewiness, and resilience are shown in Table 2.

Table 2. Coffee Jelly Candy Texture

	Treatment				
	0%	**1,03%**	**2,068%**	**3,10%**	**4,13%**
Hardness	2,439^{d}	1,973^{c}	1,668^{b}	1,434^{a}	1,280^{a}
Cohesiveness	0,985^{d}	0,984^{c}	0,980^{b}	0,977^{ab}	0,976^{a}
Springiness	0,938^{e}	0,896^{d}	0,875^{c}	0,850^{b}	0,827^{a}
Gumminess	2,404^{e}	1,942^{d}	1,635^{c}	1,401^{a}	1,249^{a}
Chewiness	2,256^{e}	1,740^{d}	1,431^{c}	1,192^{b}	1,034^{a}
Resilience	1,052^{a}	1,018^{a}	0,982^{a}	0,980^{a}	0,960^{a}

Description: Numbers followed in the same column indicate no significant difference.

Hardness is a force applied to an object undergoing a change in shape or deformation. To change the shape, a large force is usually required to compress the object (Chrisella *et al*. 2015). ANOVA results indicate that the addition of lemon extract significantly affected the hardness value of jelly candies at a significance level (0.001 <0.005). The DMRT test results showed that the 0% treatment showed significantly different results from each other and significantly different from the 3,10% and 4,13% treatments. Table 2 shows hardness values with a range of values 1.280-2.439. The highest hardness value was obtained in the 0% treatment and the lowest was obtained in the 4,13% treatment. This results in a weakening of the three-dimensional structure of the gelatin hydrocolloid that binds water, thus impacting the physical strength or hardness of the product (Chrisella *et al*., 2015).

Cohesiveness is the level of compactness and internal resistance of the structure of a food material so that it remains united and does not separate after being exposed to pressure with initial deformation (Salehi & Kashaninejad, 2021). ANOVA results showed that the addition of lemon extract significantly affected the cohesiveness value of jelly candy with a significance level (0.001 <0.05). The DMRT indicated that the 1,03% and 0% treatments showed significantly different results from the other treatments. Table 5 shows that the

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highest cohesiveness value was obtained in the 0% treatment and the lowest cohesiveness value was obtained in the 4,13% treatment. Table 2 shows the cohesiveness value with a value of 0.976-0.985 with the highest cohesiveness value obtained in the 0% treatment, while the lowest cohesiveness value was obtained in the 4,13% treatment. The use of hydrocolloids provides high cohesiveness, but the presence of acid can inhibit the formation of a solid three-dimensional gel network (Chrisella *et al*., 2015).

Springiness or degree of elasticity is the extent to which something can return itself to its original shape when subjected to pressure (Herdiana *et al*., 2023). The ANOVA results showed that the addition of lemon extract significantly affected the springiness value of jelly candy with a significance level (0.001<0.05). Further analysis using DMRT revealed that all treatments were significantly different from each other. Table 2 shows the springiness value with a range of values 0.827-0.938. Using a pH that is too low greatly affects the gel structure to return to its original position which is influenced by the acidic environment itself, causing the gel to become less than ideal (Chrisella *et al*., 2015).

Gumminess is a property related to the transformation of the material's shape due to the coherence force applied to break down the sample to reach a condition ready for swallowing (Kalkan, 2025). ANOVA results exhibited that the addition of lemon extract significantly affected the gumminess value of jelly candy with a significance level (0.001<0.05). The DMRT test results showed that the treatments of 0%, 1,03%, and 2,068% were significantly different from each other. Table 2 shows the gumminess values with a range of values 1.249-2.402. The highest gumminess value was obtained in the 0% treatment and the lowest was obtained in the 4.13% treatment. Gumminess increased in line with the increase in hardness because it is related to the strength of the gel matrix which triggers a significant difference (Yusof *et al*., 2019).

Chewiness describes the amount of effort required to bite and chew a food to achieve a soft texture (Mahat *et al*., 2020). ANOVA results presented that the addition of lemon extract significantly affected the chewiness value of jelly candy with a significance level (0.001<0.005). The DMRT test results showed that all treatments were significantly different from each other. Table 2 shows the chewiness values with a range of values 1.034-2.194. The highest chewiness value was obtained in the 0% treatment and the lowest was obtained in the 4,13% treatment. Chewiness will increase as hardness increases, indicating a significant change in gel strength from treatment (Yusof *et al*., 2019).

Resilience can be considered as a parameter to measure the rate of return to the initial position when the load is pulled (Kalkan, 2025). The ANOVA results showed that the addition of lemon extract had no significant effect on the resilience value of jelly candy at a significant level (0.059>0.05). The main factor that determines the texture of jelly candy is the gel-forming ingredient, namely gelatin, which functions as a gelling agent (Melanie & Christy, 2020).

3.4 Caffeine Levels

Caffeine is a xanthine alkaloid compound in the form of crystals and has a bitter taste which provides benefits when consumed within reasonable limits which can provide positive things and does not cause dependence on caffeine individually, unlike other things if consumed too much it is not good for the health of the body (Pinkan *et al*., 2021). The results of the caffeine content values obtained can be seen in Figure 2.

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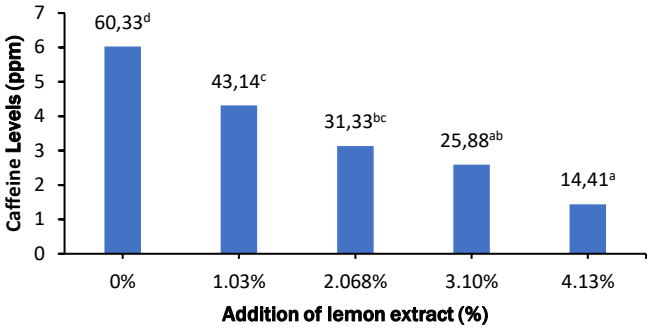

Figure 2. Caffeine Content of Coffee Jelly Candy

ANOVA results showed that the addition of lemon extract significantly affected the caffeine content of jelly candy with a significance level (0.001<0.05). The DMRT test results showed that 0% was significantly different across all treatments. Figure 2 shows that caffeine levels ranged from 14.41-60.33 ppm. The highest caffeine content was obtained in the 0% treatment and the lowest caffeine content was obtained in the 4,13% treatment. Caffeine also has a significant impact which is relatively stable in mild acidic conditions and is widely used in the form of caffeine citrate which remains stable in mild acidic conditions in aqueous solutions with acidic pH (Fitri, 2025).

3.5 pH

The pH value acts as a marker to evaluate the level of acidity or alkalinity of a product because the pH value describes the level of acidity (Simarmata *et al*., 2019). The results of the pH value parameters can be seen in Figure 3.

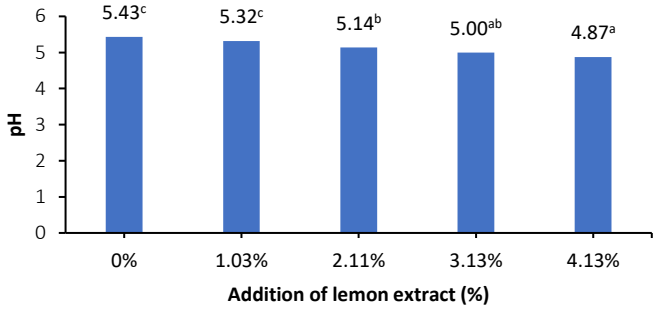

Figure 3. pH of coffee jelly candy

ANOVA results showed that the addition of lemon extract significantly affected the pH value of jelly candy with a significant level (0.001<0.005). The DMRT test results showed that the 0% and 4,13% treatments were significantly different. Figure 3 shows the pH values with a range of 4.87-5.43 with the lowest pH value obtained in the 4,13% treatment and the highest pH value obtained in the 0% treatment. The higher the concentration of lemon extract, the more citric acid is dissociated, so the pH value decreases further (Dianatasya, 2020).

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3.6 Antioxidant Activity

Antioxidants are substances that can inhibit oxidation from free radicals, so they can protect cells from damage caused by free radical molecules (Zulfa *et al.*,2024). The results of the antioxidant activity test on jelly can0dy can be observed in Figure 4.

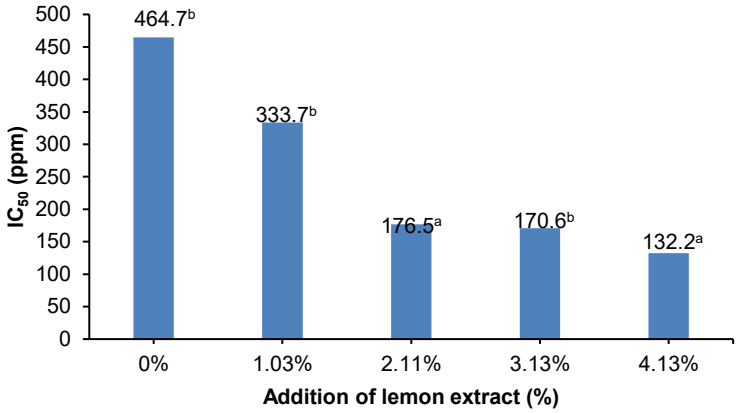

Figure 4. IC_{50} Value of Jelly Candy

ANOVA results showed that the addition of lemon extract had a significant effect on the antioxidant activity of jelly candy with a significant level (0.002<0.005). The DMRT test results showed that the 4,13% treatment had the lowest caffeine content and was significantly different from the 3,10%, 2,068%, 1,03%, and 0% treatments. However, the 3.10% treatment showed no significant difference from the 4,13% and 2,068% treatments. The decrease in the IC50 value indicates an increase in antioxidant activity along with the addition of lemon extract, which is thought to be related to the increase in phenolic compounds and vitamin C which function as free radical scavengers (Subarjo *et al.*, 2024).

3.7 Organoleptic

3.7.1 Color

Color is a key element in organoleptic assessments conducted through human vision because visual aspects play a crucial role in shaping consumers' initial perceptions of the product's visual appeal. Attractive and aesthetically pleasing colors can stimulate consumer interest in trying it (Handayani *et al.*, 2021). The results of the organoleptic color test can be seen in Figure 5.

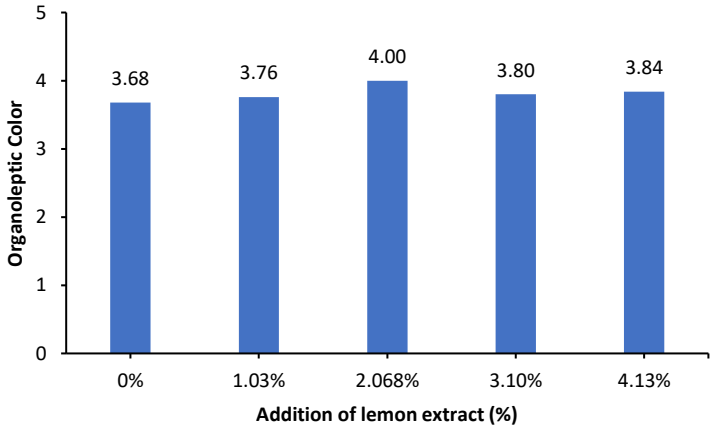

Figure 5. Organoleptic Color

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The results of the Friedman test showed that the addition of lemon extract had no significant effect on the panelists' level of preference for the color of jelly candy with a significant level (0.094>0.05). Figure 5 shows the panelists' level of preference for color ranging from 3,68 to 4,00. The highest level of color preference was obtained in the 3,10% treatment, and the lowest level of color preference was in the 1,03% treatment, but it was still in the somewhat preferred category, so all treatments were still acceptable to the panelists.

3.7.2 Aroma

Aroma is a sensation that arises through the sense of smell when detecting odors that are smelled when inhaling air (Jutrialni *et al*., 2024). The findings of the organoleptic test of aroma attributes in jelly candy can be seen in Figure 6.

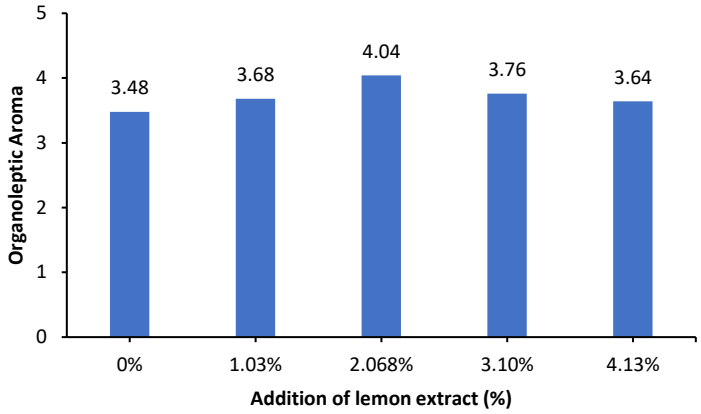

Figure 6. Organoleptic Aroma

The results of the Friedman test showed that the addition of lemon extract had no significant effect on the panelists' level of preference for the aroma of jelly candy with a significant level (0.132>0.005). Figure 6 shows the panelists' level of preference for the aroma ranging from 3,48 to 4,04. The highest level of preference for the aroma was obtained in the 3,10% treatment and the lowest level of preference for the aroma was obtained in the 1,03% treatment, but it was still in the somewhat liked category so that all treatments were still acceptable.

3.7.3 Texture

Texture is a sensation felt through the sense of taste when chewing food at the level of elasticity or firmness of the resulting food product (Putri, 2022).

The organoleptic results of the texture attributes of jelly candy can be observed in Figure 7.

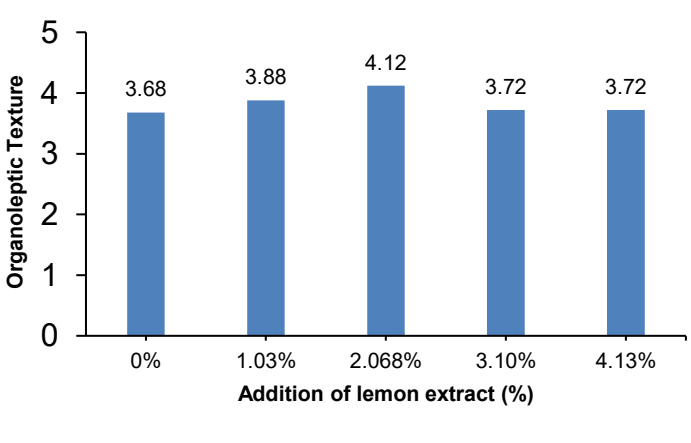

Figure 7. Organoleptic Texture

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The Friedman test results showed that the addition of lemon extract had no significant effect on the panelists' preference for the texture of jelly candy at a significant level (0.127>0.05). Figure 7 shows that the panelists' preference scores for the aroma ranged from 3,68 to 4,12. The highest preference for texture was obtained at 2,068% and the lowest preference for texture was obtained at 0%. However, it was still in the somewhat preferred category so it was still acceptable to the panelists.

3.7.4 Taste

Taste is the response produced by taste buds in response to certain stimuli from food or drink. The sense of taste detects various flavors, such as sour, bitter, sweet, salty, and umam (Astuti & Ishartani, 2021). The results of organoleptic testing of the jelly candy's flavor attributes can be seen in Figure 8.

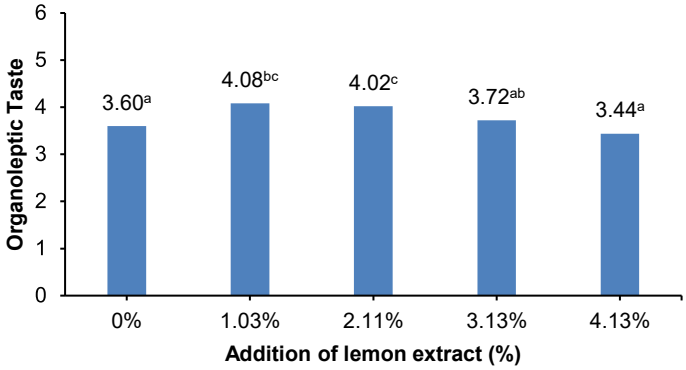

Figure 8. Organoleptic Taste

The results of the Friedman test showed that the addition of lemon extract significantly affected the panelists' level of preference for the taste of jelly candy with a significant level (0.003 <0.05). The results of the Wilcoxon signed rank test further showed that the 0% treatment was significantly different from the 1,03% treatment and the 2,068% treatment. The 3,10% treatment was significantly different from the 4,13% treatment. The 2,068% treatment was significantly different from the 3.10% treatment and the 4,13% treatment. Figure 8 shows that the panelists' level of preference scores for the taste ranged from 3,60 to 4,20. The highest level of taste preference was obtained in the 2,068% treatment and the lowest level of taste preference was obtained in the 4,13% lemon extract addition treatment, which indicates that increasing the concentration of lemon extract tends to decrease the level of taste acceptance due to the increasingly strong sour taste. The results of this study are consistent with the findings of Zia *et al.* (2019), who reported that lemon juice concentration significantly affected the sensory taste scores of coffee cherry peel jelly candy. The addition of lemon juice at certain concentrations can enhance panelists' acceptance, whereas excessive concentrations may result in an overly sour taste, thereby reducing overall preference.

3.7.5 Overall

Overall, this is an overall assessment made by the panelists before consuming the product, which is quite easily identified depending on characteristics such as color, aroma, texture, and taste (Efendi & Zulkifli, 2018). The results of the organoleptic analysis regarding the panelists' overall preference for the jelly candies can be found in Figure 9.

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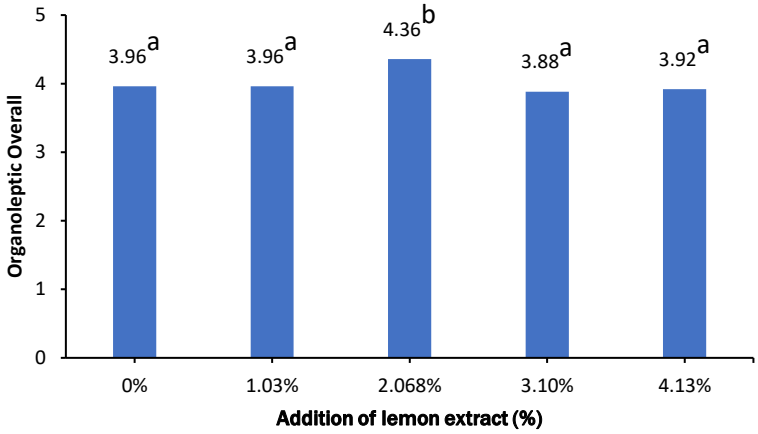

Figure 9. Organoleptic Overall

The results of the Friedman test showed that the addition of lemon extract had a significant effect on the overall panelist assessment of jelly candy with a significant level (0.032 <0.05). The results of the Wilcoxon signed rank test further showed that the 2,068% treatment was the only treatment that had a significantly different effect on all other treatments and the 0%, 1.03%, 3,10, 4,13% treatments were not significantly different from each other. Figure 9 shows that the panelists' overall preference score ranged from 3,88-4,36 which was in the slightly like to like category. The highest overall preference level was obtained in the 2,068% treatment and the lowest overall preference level was obtained in the 4,13% treatment.

4. CONCLUSION

The addition of lemon extract significantly affected the physical characteristics (color (i.e., hue angle), texture (i.e., hardness, cohesiveness, springiness, gumminess, chewiness), and insignificantly affected the physical characteristics (color (i.e., lightness (L*), a* value, b* value, chroma), and texture (i.e., resilience) of Robusta coffee jelly candies. The addition of lemon extract significantly affected the caffeine content, pH, and antioxidant activity of Robusta coffee jelly candies. The addition of lemon extract significantly affected the taste and overall organoleptic properties, but insignificantly affected the color, aroma, and texture of Robusta coffee jelly candies. Based on the overall evaluation of all parameters, the formulation containing 2.068 % lemon extract was selected as the best formulation.

5. AUTHORS' NOTE

Para penulis menyatakan bahwa tidak ada konflik kepentingan terkait penerbitan artikel ini. Penulis menegaskan bahwa artikel ini bebas dari plagiarism.

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