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The Effect of the Proportion of Ginger and Spices Extracts and the Addition of Sugar on the Physicochemical Properties of Instant Spiced Coffee

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A B S T R A C T

Coffee is a refreshing beverage which loved by any community. The addition of spices to coffee enhances the health benefits. Spices used are ginger, galangal, lemongrass, pandanus, and cinnamon. Instant spice coffee may be created through crystallization with sugar as a crystallizing agent. This study used Completely Randomize Design (CRD) from a two-factor factorial pattern. Factor I is the proportion of ginger and spice extract (2:8, 3:7, and 4:6), and factor II is the additional sugar (25.35%, and 45%). The data was analyzed using the Analysis of Variance (ANOVA) and the Duncan Multiple Range Test (DMRT) follow-up tests at a 5% level. The best treatment is combining the proportion of ginger and spice extract 4:6 with the addition of 45% sugar that produces instant spice coffee with a yield of 37,73%, water level 1.32%, ash level of 1.39%, solubility of 93.13 %, soluble speed 0.14g/s, total soluble solids of 17.15% brix, antioxidant activity of 85.66%, total phenol of 15.43 mgGAE/g.

1. INTRODUCTION

1.1. Research Background

Indonesia's coffee production in 2021 reached 786.19 thousand tons and is dominated by robusta coffee which reaches 87.1% of total production [1]. Robusta has several advantages, including having a more economical price compared to Arabica, having the general characteristics of a bitterer taste, sweeter aroma, and a rougher texture compared to Arabica coffee [2].

Coffee processing can be done with a mixture of spices which is called spiced coffee. Spiced coffee is a mixture of coffee and spices that has the aim of health and improving the taste of coffee [3]. The spices used in this research were ginger, galangal, lemongrass, cinnamon, and pandan. This spice has a distinctive refreshing aroma and taste, warms the body, and contains phytochemical compounds, such as antioxidant compounds which are good for health.

Ginger contains oleoresin phenol compounds such as gingerol and shogaol as antioxidants and carriers of the spicy aroma and taste [4]. Ginger contains 158.88 ppm of phenol and 72.94% antioxidant activity [5]. Galangal contains galangin, catechin, coumaric acid, quercetin, carnosic acid and quercetin as the main phenolics. Galangal extract has antioxidant activity of 77.76% [6]. Lemongrass main ingredients are citral, citronellal, geraniol, and citronellol. Citral plays a role in aroma formation, while citronellal and geraniol role as antioxidant compounds [7]. Lemongrass has an antioxidant activity of 6.07µg/ml [8]. Pandan is widely used as a flavoring containing quercetin, tocopherol, tocotrienol, and essential oils [9]. Pandan leaf extract has an IC50 (Inhibition Concentration) value of 24.4186 ppm [10]. The largest components in cinnamon are cinnamaldehyde, eugenol, safrole, and tannins which also act as antioxidant compounds [11]. Cinnamon has total phenols of 63.78 ppm and antioxidant activity of 45.42% [5].

Making spiced coffee requires a long process and takes a long time. Hence, innovation is needed to enjoy spiced coffee conveniently and quickly, by making instant spiced coffee. Instant drinks are processed in powder form, easily dissolved in water, and practical [12]. Instant drinks are made through two stages, extraction and drying [13]. One of the drying methods in making instant drinks is crystallization. Crystallization is the process of forming solid crystals from a homogeneous mother liquor. This process is a solid-liquid separation technique that will change the extracted liquid into crystals due to the evaporation of

water [14]. This method can produce the best water content in making powdered drinks [15]. Instant drinks can be made by crystallization with sugar which acts as a crystallizing agent [16]. Sugar acts as a crystallizing agent which influences the speed of crystallization and functions as a sweetener, preservative, and texture-forming agent [17]. The addition of sugar plays a role in balancing the bitter and unpleasant taste of coffee and spices.

This research aims to analyze the effect of the proportion of ginger and spice extracts and the addition of sugar on the physicochemical properties of instant spiced coffee and to determine the best treatment out of all treatments.

1.2. Literature Review

Instant drinks are processed foods in powder form, easily dissolved in water, and have a large surface area [12]. To be categorized instant drink it has to be dry and separate, easy to pour, not easy to clot, easy to wet, not hygroscopic, and dissolve quickly [16].

Coffee not only has a distinctive taste and aroma but also has benefits for health. The benefits of coffee are obtained from bioactive compounds such as caffeine, chlorogenic acid, trigonelline, nicotinic acid, quinolinic acid, tannins, pyrogallic acid, and others [18]. Robusta coffee contains higher caffeine than arabica with an average of 2.2% [11].

Ginger contains oleoresin which plays a role in giving ginger a spicy and slightly bitter taste. The main components of oleoresin consist of gingerol, shogaol, and resin [19]. The antioxidant compounds in ginger are phenols, namely gingerol and shogaol. The gingerol and shogaol content in oleoresin ranges between 14-25% and 2.8-7% [20]. Ginger has a total phenol content of 158.88 ppm and an antioxidant activity of 72.94% [5]. Galangal's antioxidant compounds come from quercetin, kaemferol, and galangin which are included in the flavonol group. The flavonol group has a positive effect in preventing cancer, by preventing oxidative damage to cells, lipids, and DNA [21]. Galangal rhizome extract contains total phenols of 53.18 ± 1.45 mgGAE/g and DPPH antioxidant activity of 77.76% [6].

Lemongrass contains many essential oils and constituent substances that have pharmacological capabilities and act as anti-inflammatory, antioxidant, and anticancer agents [7]. Essential oil of lemongrass's stem distillation has antioxidant activity up to 72.724% inhibition [22]. Pandan contains alkaloids, saponins, flavonoids, tannins, polyphenols, phenyls, propanoids and dyes. Pandan extract has an IC50 value of 24.4186 ppm [10]. The total phenolic content of pandan leaves from ethanol extraction was 319.2 ± 15.9 mg GAE/100g [9]. Cinnamon is a source of antioxidants because it contains eugenol, safrole, cinnamaldehyde, tannin, and calcium oxalate. Cinnamon has 45.42% antioxidant compounds and total phenols of 63.78 ppm [5].

Crystallization is a simple method for making instant drinks. Crystallization is a solid-liquid separation process where solute molecules in the liquid phase will turn into solids. Making instant drinks using this method will change the extracted liquid into crystals due to the evaporation of water [14]. This method uses sucrose as a crystallization agent. Sucrose will melt when heated and mixed with other ingredients. Then after evaporating, the sucrose will return to solid granules or crystals [15].

1.3. Research Objective

This research aims to analyze the effect of the proportion of ginger and spices extracts and the addition of sugar (25%, 35%, and 45%) on the physicochemical properties of instant spiced coffee and to determine the best formulation out of all treatments.

2. MATERIALS AND METHODS

2.1. Materials and Tools

The materials used consist of raw materials and analysis materials. Ingredients for making instant spiced coffee include robusta coffee, red galangal, emprit ginger, lemongrass, cinnamon, and pandan obtained at the Wedoro Traditional Market, Sidoarjo, and sugar from the grocery store in Kepuhkiriman, Sidoarjo.

The analysis materials used include instant spiced coffee powder, filter paper, distilled water, DPPH solution, 99% ethanol, methanol, Folin Ciocalteu reagent, 5% Na_2CO_3 solution, and tannic acid. Tools used for making instant spiced coffee include a basin, knife, blender (Miyako), roaster (Pratter 1.5), filter fabric, measuring cup, stove, stainless steel pan, wooden stirrer, 80 mesh sieve, and jar.

Equipment used in testing includes ovens, furnaces, UV-Vis spectrophotometers, desiccators, analytical balances, hotplates, vortex, porcelain cups, measuring cups, tongs, stirrers, stopwatches, test tubes, pipettes, and weighing bottles.

2.2. Research Design and Analysis

The research design used in this study was a Complete Randomized Design (CRD) with a 2-factor factorial pattern with 2 replications. The treatment used was proportions of ginger and spices extract (2:8, 3:7, and 4:6) and the addition of sugar (25%, 35%, and 45%). The observation variable data was tested statistically using analysis of variance at α=5% using the DMRT follow-up test. The method used to determine the best treatment is the de Garmo effectiveness test.

2.3. Research Implementation

2.3.1. Making of Coffee Extract

Add 300ml water until its boils. Then, add 100g of coffee powder, and stir over 5 minutes. Turn the fire off and leave until the sediment is down completely. Then, filter the coffee extract using filter fabric and measure the extract volume.

2.3.2. Making of Ginger and Spices Extract

Ginger and spices (galangal, lemongrass, and pandan with a ratio of (5:1:1)) are washed by the water and chopped into pieces. Then, puree with a blender and add 1:1 of water. Strain the ginger and spice solution using a filter fabric and let sit for 30 minutes. Separate the ginger and spice extract from the precipitated starch.

2.3.3. Making of Instant Spiced Coffee

350ml spice extract (with a ratio of ginger and spice extracts of 2:8, 3:7, and 4:6), 150ml coffee extract, and 10g cinnamon are heated in a pan for 15 minutes. Remove the cinnamon and add 25%, 35% and 45% sugar. Stir until the solution thickens and becomes crystalline. Then, cool and grind the instant spiced

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coffee powder using a blender. Sieve with 80 mesh to make the size uniform.

2.4. Analytical methods

2.4.1. Analysis of Ginger and Spices Extract

Analysis parameters include antioxidant activity of the DPPH method, total phenols, pH, and total solid.

2.4.2. Chemical Analysis

Analysis parameters include water content, ash content, total phenol, and antioxidant activity using DPPH.

2.4.3. Physical Analysis

Analysis parameters include yield, total dissolved solids, solubility, and dissolution rate.

3. RESULT AND DISCUSSION

3.1. Analysis of Ginger and Spices Extract

Analysis of raw materials in the form of ginger and spice extracts consisted of antioxidant activity tests, total phenols, pH and total solids. The results of the analysis of ginger and spice extracts can be seen in Table 1.

Table 1. Results of Ginger and Spice Extracts' Analysis

Parameter	Ginger Extract	Spices Extract
Antioxidant Activity (%)	64.75	80.23
Total Phenol (mgGAE/g)	17.30	26.32
pH	5.66	4.39
Total Solid (%)	1.75	2.28

Table 1 shows that the antioxidant activity of ginger extract is 64.75% with total phenols of 17.30 mgGAE/g. Ginger's antioxidant compounds are influenced by phenolic compounds such as flavonoids, cinnamic acid derivatives, coumarins, tocopherols, and organic acids [23]. The main antioxidant compounds are gingerol and shogaol. The antioxidant activity of spice extracts was 80.23% and total phenols were 26.32 mgGAE/g. The largest proportion of spice extracts is galangal. The antioxidant compounds in galangal mostly come from quercetin, kaempferol, and galangin. These three compounds belong to the flavonol group which can help prevent cancer growth, prevent oxidative damage to cell lipids and DNA [21]. The highest bioactive component in galangal is phenolic [24].

The pH of ginger extract is 5.66 and spice extract is 4.39. This shows that both raw materials have a fairly acidic pH close to neutral which is safe for crystallization. The pH of the raw material is an important factor that must be considered because it can affect the crystallization process. The properties of sucrose as a crystallizing agent are influenced by pH. If the pH is too acidic, the solution will become clay and no crystals will form [14]. The total solids of ginger extract is 1.75% and spice extract is 2.28%. Total solid is a measure of all suspended solids, colloids, and dissolved solids in a water sample.

3.2. Chemical Analysis

Chemical analysis of instant spiced coffee includes water content, ash content, antioxidant activity and total phenols.

3.2.1. Water Content

According to the analysis of variance result, there was a significant interaction ($p \leq 0.05$) between the treatment of the proportion of ginger and spices extracts with added sugar on the water content of instant spiced coffee. The average value of instant spice coffee water content in the treatment of the proportion of ginger extract and spices with sugar addition can be seen in Table 2.

Table 2. The Average Value of Water Content in Instant Spiced Coffee

Treatment		Water Content (%)	DMRT (5%)
Proportion of Ginger and Spices Extract	Sugar Addition		
2:8	25%	2.05±0.01^{i}	-
	35%	1.70±0.01^{g}	0.017
	45%	1.49±0.01^{c}	0.018
3:7	25%	1.83±0.01^{h}	0.018
	35%	1.56±0.01^{e}	0.019
	45%	1.43±0.00^{b}	0.019
4:6	25%	1.66±0.01^{f}	0.019
	35%	1.52±0.01^{d}	0.019
	45%	1.32±0.01^{a}	0.019

Note: Average values accompanied by the different letters indicate significant differences at $p \leq 0.05$

Table 2 shows that the average water content of instant spiced coffee ranges from 1.32% - 2.05%. The lowest water content was 1.32% which was found in the treatment with a proportion of ginger extract and spices of 4:6 with 45% addition of sugar, while the treatment with a proportion of ginger extract and spices of 2:8 with 25% addition of sugar produced highest water content of 2.05%.

The higher proportion of ginger extract, lower proportion of spices extract and more sugar addition produces a lower water content. The higher proportion of ginger can reduce the water content. It is related to the dissolved solids content, where a high total dissolved solids value can increase the shelf life because it produces a lower water content. The total dissolved solids content can increase as the water content decreases [25]. The more sugar added, the more water evaporates, which can reduce the water content of instant spiced coffee. Sugar has hygroscopic properties which cause the water removal process quicker alongside the addition of more sugar compared to the addition of low sugar during the drying process 26].

3.2.2. Ash Content

According to the analysis of variance result, there was a significant interaction ($p \leq 0.05$) between the treatments of the proportion of ginger and spice extracts with sugar addition in the ash content of instant spiced coffee. The average value of the ash content in instant spice coffee with the treatment of a proportion of ginger extract and spices with sugar addition can be seen in Table 3.

Table 3 shows that the average value of ash content for instant spiced coffee ranges from 1.39% -2.14%. The lowest ash content

was 1.40% which found in the treatment with proportion of ginger extract and spices of 4:6 with 45% sugar addition, while the highest ash content was 2.14% which found in the treatment with the proportion of ginger extract and spices of 2:8 with 25% sugar addition. The ash content aims to determine the mineral content or inorganic compounds in instant spiced coffee.

Table 3. The Average Value of Ash Content in Instant Spiced Coffee

Treatment		Ash Content (%)	DMRT (5%)
Proportion of Ginger and Spices Extract	Sugar Addition		
2:8	25%	2.14±0.00^{g}	-
	35%	1.78±0.01^{e}	0.037
	45%	1.47±0.03^{b}	0.038
3:7	25%	2.06±0.00^{f}	0.039
	35%	1.63±0.00^{c}	0.040
	45%	1.40±0.01^{a}	0.040
4:6	25%	2.03±0.01^{f}	0.041
	35%	1.69±0.02^{d}	0.041
	45%	1.39±0.02^{a}	0.041

Note: Average values accompanied by the different letters indicate significant differences at p≤0.05

The higher proportion of ginger extract, lower proportion of spices extract, and higher addition of sugar produce lower ash content in instant spiced coffee. Since the ash content of spice extracts is higher than the ash content of ginger extract. Spices extracts consist galangal, lemongrass, and pandan are known to have an ash content of 5.38% [6], 7.15% [27], and 1.63% [28], while ginger has an ash content of 3. 70% [29]. The higher the sugar addition, the lower the ash content in instant spiced coffee. Sugar has a very low ash content around 0.04-0.07%. The more sugar addition can increase the quantity of instant spiced coffee ingredients and reduce the overall ash content. A decrease in ash content can occur due to differences in ash content values in the type of sweetener used. [30].

3.2.3. Antioxidant Activity

According to the analysis of variance result, there is no significant interaction (p≥0.05) between the treatment of the proportion of ginger extract and spices with sugar addition on the antioxidant activity in instant spiced coffee. The treatment proportion of ginger and spices extract had a significant effect (p≤0.05) between treatment levels. The average value of antioxidant activity in instant spiced coffee with treatment of the proportion of ginger and spices extract can be seen in Table 4.

Table 4. The Average Value of Antioxidant Activity in Instant Spiced Coffee with Treatment of The Proportion of Ginger and Spices Extract

Proportion of Ginger and Spices Extract	Antioxidant Activity (%)	DMRT (5%)
2:8	86.64^{c}	-
3:7	85.50^{b}	0.920
4:6	83.94^{a}	0.960

Note: Average values accompanied by the different letters indicate significant differences at p≤0.05

Table 4 showed that the average value of the antioxidant activity of instant spice coffee in the treatment of the proportion of ginger extract and spices ranged between 83.94%-86.64%. A lower proportion of ginger extract and a higher proportion of spice extract tend to increase the antioxidant activity of the product. This is following the results of raw material analysis where the spice extract has a higher antioxidant activity value, which was 80.23% compared to the antioxidant activity value of ginger extract which was 64,75%.

Table 5. The Average Value of Antioxidant Activity in Instant Spiced Coffee with Treatment of Sugar Addition

Sugar Addition	Antioxidant Activity (%)	DMRT (5%)
25%	83.84^{a}	-
35%	85.23^{b}	0.920
45%	87.01^{c}	0.960

Note: Average values accompanied by the different letters indicate significant differences at p≤0.05

Table 5 showed that the average value of the antioxidant activity of instant spiced coffee with additional sugar treatment ranged from 83.84%-87.01%. During crystallization, sugar acts as a coating agent which will cover the surrounding extract mass [16]. The higher sugar addition, results in more coating agents which tend to protect antioxidant compounds so the antioxidant activity value in spiced coffee tends to increase.

3.2.4. Total Phenol

According to the analysis of variance result, there was a significant interaction (p≤0.05) between the treatments of the proportion of ginger and spices extracts with sugar addition on the total phenols in instant spiced coffee. The average total phenolic value of instant spiced coffee with the treatment of the proportion of ginger and spices extract and additional sugar can be seen in Table 6.

Table 6. The Average Value of Total Phenol in Instant Spiced Coffee

Treatment		Total Phenol (mgGAE/g)	DMRT (5%)
Proportion of Ginger and Spices Extract	Sugar Addition		
2:8	25%	13.84±0.13^{d}	-
	35%	15.01±0.18^{e}	0.278
	45%	17.72±0.12^{h}	0.291
3:7	25%	11.74±0.12^{b}	0.298
	35%	13.61±0.09^{d}	0.302
	45%	15.90±0.19^{g}	0.305
4:6	25%	11.31±0.10^{a}	0.307
	35%	13.21±0.02^{c}	0.308
	45%	15.43±0.07^{f}	0.308

Note: Average values accompanied by the different letters indicate significant differences at p≤0.05

Table 6 shows that the average total phenol value in instant spiced coffee ranges from 11.31-17.72mgGAE/g. The highest total phenol content was found in treatment with a proportion of ginger extract and spice extract of 2:8 with 45% sugar addition, amounting to 17.72mgGAE/gr, while the lowest total phenol content was in treatment with the proportion of ginger and spice extract of 4:6 with 25% sugar addition which was

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11.31mgGAE/g. The lower proportion of ginger extract, the higher proportion of spice extract and higher sugar addition, resulting higher total phenol in instant spiced coffee.

The higher proportion of spices extract produces higher total phenols because the spices extract raw material contains higher total phenols compared to ginger extract. The total phenol of spice extract was 26.32 mgGAE/g and ginger extract was 17.30 mgGAE/g. Sugar acts as a coating agent which will cover the surrounding extract mass around it so the compounds that are vulnerable or lost due to heating can become more stable and not evaporate [16].

3.3. Physical Analysis

Physical analysis of instant spiced coffee includes yield, total dissolved solids, solubility, and dissolution rate.

3.3.1. Yield

According to the analysis of variance result, there was a significant interaction ($p \leq 0.05$) between treatments of the proportion of ginger and spices extract with sugar addition on the yield in instant spiced coffee. The average yield value of instant spiced coffee with treatment of the proportion of ginger and spices extract with sugar addition can be seen in the Table 7.

Table 7. The Average Value of The Yield in Instant Spiced Coffee

Treatment		Yield (%)	DMRT (5%)
Proportion of Ginger and Spices Extract	Sugar Addition		
2:8	25%	26.12±0.13^{c}	-
	35%	36.18±0.08^{f}	0.278
	45%	42.52±0.09^{i}	0.291
3:7	25%	22.44±0.10^{b}	0.298
	35%	32.40±0.05^{e}	0.302
	45%	39.14±0.02^{h}	0.305
4:6	25%	20.49±0.26^{a}	0.307
	35%	29.80±0.02^{d}	0.308
	45%	37.73±0.04^{g}	0.308

Note: Average values accompanied by the different letters indicate significant differences at $p \leq 0.05$

Table 7 shows that the average yield value in instant spiced coffee ranges from 20.49%-42.52%. The highest yield was found in treatment with the proportion of ginger and spices extract of 2:8 with 45% sugar addition, which was 45.52%, while treatment with the proportion of ginger and spice extract of 4:6 with of 25% sugar addition produced the lowest yield of 20.49%. The lower proportion of ginger, higher proportion of spices, and higher sugar addition produce a higher yield.

Spice extract has higher total solids of 2.28% compared to ginger extract of 1.75%. The addition of total solids will increase the final weight of a product because solids did not disappear when it dried so the yield value might increase [31]. The higher the sugar addition, the faster and more crystals will form, causing the yield in instant spiced coffee to increase. Sugar as a crystallizing agent will melt when heated and mixed with other ingredients, then return to forming solid crystals when the water is evaporated [15].

3.3.2. Total Dissolved Solid

According to the analysis of variance result, there was an interaction that was not significant ($p \geq 0.05$) between treatments of the proportion of ginger and spices extracts with the sugar addition in the total soluble solids of instant spiced coffee. The total soluble solids average value in instant spiced coffee with treatment of the proportion of ginger and spices extract can be seen in the Table 8.

Table 8. The Average Value of Total Soluble Solid in Instant Spiced Coffee Kopi with Treatment of The Proportion of Ginger and Spices Extract

Proportion of Ginger and Spices Extract	Total Soluble Solid (%brix)	DMRT (5%)
2:8	16.42^{a}	-
3:7	16.54^{a}	0.884
4:6	17.13^{a}	0.923

Note: Average values accompanied by the different letters indicate significant differences at $p \leq 0.05$

Table 8 shows that the average total soluble solids value of instant spiced coffee in the ginger and spice extract proportion treatment ranged from 16.42%Brix-17.13%Brix. The lowest total soluble solids were found in the ginger and spice extract proportion treatment of 2:8, whereas the highest proportion of ginger and spices extract is 4:6. Components that are counted as total dissolved solids are sucrose, reducing sugars, organic acids, minerals, pigments, and proteins. Total dissolved solids show the breakdown of complex carbohydrates into simple sugar components such as fructose, glucose, and sucrose. [32].

Table 9. The Average Value of Total Soluble Solid in Instant Spiced Coffee with Treatment of Additional Sugar

Sugar Addition	Total Soluble Solid - (%Brix)	DMRT (5%)
25%	16.00^{a}	-
35%	16.71^{ab}	0.884
45%	17.38^{b}	0.923

Note: Average values accompanied by the different letters indicate significant differences at $p \leq 0.05$

Table 9 shows that the average total soluble solids value in instant spice coffee with treatment of of sugar addiction ranges from 16-17.38%Brix. The lowest total dissolved solids were found in the 25% sugar addiction treatment, while the highest was in the 45% sugar addiction treatment. Total dissolved solids can increase due to the solubility of sugar in water where sugar is also a solid fraction so the higher the addition of sugar, the greater the total dissolved solids produced. The components dissolved in water are glucose, fructose, sucrose, and protein [13].

3.3.3. Solubility

According to the analysis of variance result, there was a significant interaction ($p \leq 0.05$) between the treatment of the proportion of ginger and spice extract with sugar addition on the solubility of instant spiced coffee. The average solubility value of instant spice coffee with the treatment of the proportion of ginger and spices extract with sugar addition can be seen in Table 10.

Table 10 shows that the average solubility value of instant spiced coffee ranges from 78.49-93.13%. The lowest solubility was found in treatment with the proportion of ginger and spices

extract of 2:8 with 25% sugar addition, which was 78.49%, while the highest solubility was in the proportion of ginger and spice extract of 4:6 with 45% granulated sugar addition, amounting to 93.13%.

Table 10. The Value of The Solubility in Instant Spiced Coffee

Treatment		Solubility (%)	DMRT (5%)
Proportion of Ginger and Spices Extract	Sugar Addition		
2:8	25%	78.49±0.04[a]	-
	35%	82.03±0.18[b]	0.359
	45%	85.40±0.15[d]	0.374
3:7	25%	82.51±0.03[c]	0.384
	35%	86.34±0.02[e]	0.389
	45%	89.47±0.23[g]	0.393
4:6	25%	86.77±0.05[f]	0.395
	35%	89.83±0.27[h]	0.397
	45%	93.13±0.20[i]	0.397

Note: Average values accompanied by the different letters indicate significant differences at p≤0.05

A higher proportion of ginger extract, a lower proportion of spice extract, and a higher sugar addition produce higher solubility in instant spiced coffee. The content of dissolved compounds in ginger extract is higher than in spice extracts. Compounds in ginger extract that are polar include oleoresin and other phenolic compounds. Gingerol and shogaol in oleoresins are polar phenolic compounds because they have hydroxyl groups that bind to sugar as glycosides [33]. The increasing solubility in the product is caused by more compounds being dissolved so that the components are not dissolved in small ingredients. Sucrose is soluble in water so the addition of sugar can provide different solubility values in instant drinks. Solubility is influenced by the components contained in the product [26].

3.3.4. Dissolution Rate

According to the analysis of variance result, there was a significant interaction (p≤0.05) between the treatment of the proportion of ginger and spices extract with sugar addition on the dissolution rate in instant spiced coffee. The average value of the dissolution rate in instant spiced coffee with treatment of the proportion of ginger and spice extract and sugar addition can be seen in Table 11. The average value of dissolution rate in instant spiced coffee ranges from 0.07-0.14 g/sec. The highest dissolution rate was found in treatment with the proportion of ginger and spice extract 4:6 with 45% sugar addition, which was 0.14g/second, while the lowest dissolution rate was found in treatment with the proportion of ginger and spice extract 2:8 with 25% sugar addition, which was 0. 07g/sec. The dissolution rate is related to the solubility value, where the higher the solubility value, the more the instant powder dissolves in water within seconds and indicates better product quality.

The higher the ginger extract, the solubility value increases the dissolution rate value. Because there are compounds in ginger that dissolve well in the water, such as oleoresin. Oleoresin can dissolve well in polar solvents such as water and ethanol. [33]. The higher the sugar addition in instant spiced coffee powder, the higher the dissolution rate due to the high solubility of sugar. The dissolution rate in a product is influenced by composition, conditions during the drying process, mixing method, and stirring aid [34].

Table 11. The Value of Dissolution Rate in Instant Spiced Coffee

Treatment		Dissolution Rate (g/s)	DMRT (5%)
Proportion of Ginger and Spices Extract	Sugar Addition		
2:8	25%	0.07±0.00[a]	-
	35%	0.09±0.00[c]	0.003
	45%	0.11±0.00[ef]	0.004
3:7	25%	0.08±0.00[b]	0.004
	35%	0.10±0.00[de]	0.004
	45%	0.12±0.00[g]	0.004
4:6	25%	0.10±0.00[cd]	0.004
	35%	0.11±0.00[f]	0.004
	45%	0.14±0.00[h]	0.004

Note: Average values accompanied by the different letters indicate significant differences at p≤0.05

3.4. Determination of The Best Treatment

Determination of the best treatment using the de Garmo effectiveness test. This test determines the best treatment for all parameters by giving each parameter a weighted value of 0-1 according to the importance of the parameter. From this test, it was found that the best treatment was found in the treatment with a proportion of ginger and spice extracts of 4:6 with 45% sugar addition which had the highest total NH.

4. CONCLUSION

According to the research, it was found that: (1) there was a significant interaction (p≤0.05) between treatments on water content, ash content, total phenols, yield, solubility and dissolution rate, and there was no significant interaction (p≥0.05) on antioxidant activity and total dissolved solids; (2) The best treatment for instant spiced coffee is treatment with a proportion of ginger and spices extract of 4:6 with 45% sugar addition produces water content of 1.32%; ash content 1.39%; antioxidant activity 85.66%; total phenol 15.43mgGAE/g; total dissolved solids 17.15%brix; solubility 93.13%; and a dissolution rate of 0.14 g/s.

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