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Characteristic of Red Ginger Jelly Stick with Variation Type of Gelling Agent

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ABSTRACT

Jelly stick is a semi-solid product which is made with the addition of a gelling agent. Jelly sticks have a different texture compared to ordinary jelly. This product is easy to consume, more sticky and chewy. Ginger is widely available in Indonesia, has high antioxidants and can enhance human immunity especially during the Covid-19 pandemic. The general objective of this research is to utilize ginger juice in the manufacture of jelly stick products that have texture like commercial ones. The research is divided into two stages. The first stage aims to determine the type of ginger that will be used for jelly sticks. The types of ginger are small white ginger (emprit), big white ginger (gajah), and red ginger. The selected ginger juice is red ginger juice with a value of antioxidant activity IC_{50} 33537.24±807.34 ppm, total phenolic 571.37 ± 19.20 mg GAE/L, and total flavonoid content was 73.43 ± 2.40 mg QE/L. In second stage, jelly stick was made using different types of gelling agents. There were carrageenan, carrageenan:pectin (1:1), carrageenan:pectin (1:2), carrageenan:pectin (2:1), carrageenan:konjac (1:1), carrageenan:konjac (1:2), and carrageenan:konjac (2:1). The samples were analyzed for texture, color and organoleptic test. The best red ginger jelly stick was jelly made using carrageenan:konjac (2:1). The red ginger jelly stick had values of hardness, springiness, cohesiveness, gumminess and chewiness closest to the commercial one. The best jelly stick had an antioxidant activity IC_{50} value of 63685.97±1990.85 ppm, total phenolic 266.50 mg GAE/L, total flavonoid 42.81 mg QE/L and dietary fiber content was 2.38%

Keywords: *Antioxidants, Gelling agents, Ginger, Jelly stick.*

1. INTRODUCTION

The SARS-CoV2 type of coronavirus has become a serious problem for the world since the end of 2019 until now. This virus causes a severe respiratory disease known as Coronavirus Disease-2019 (Covid-19). This disease spread rapidly to almost all countries in the world and resulted in the deaths of millions of people in the world [1]. Good immunity is believed to help the body fight the virus and speed up the healing. Endurance can be obtained by consuming healthy, nutritious food and better if it is a functional food [2].

Based on various organizations, it is stated that functional food is fresh and/or processed food that contains components that are useful for improving certain physiological functions, and/or reducing the risk of illness which is proven based on scientific studies, must show the benefits in the amount normally consumed as part of a diet. daily life, which must remain in the form of food, not medicine [3].

Ginger is a traditional spice that is commonly found in Indonesia and is a source of functional food [4]. Ginger can be beneficial for the body because the compounds in ginger are strong antioxidants that can provide anti-inflammatory effects and prevent cancer [5]. These compounds are phenolic compounds such as gingerol, shogaol, and zingerone [6]. The types of ginger that grow in Indonesia can be distinguished based on the size, color of the rhizome and its content, namely big white ginger (gajah), small white ginger (emprit), and red ginger [7].

Ginger juice extracted from three different types of ginger with a rasio (2:1) of water and ginger will produce different antioxidant and total phenolic activities. Antioxidant activity ranged from 58.84-75.61% with red ginger juice is the highest [8]. Heat treatment by boiling in an acidic environment for 5 minutes can produce higher antioxidant activity in ginger juice and red ginger extract because it can increase and bring out compounds that were not previously found in fresh ginger, for example shogaol compounds found in red ginger after boiling in acid [9].

Commonly ginger is used as a cooking spice, as a raw material for healthy traditional beverages, and as medicine. But ginger can also be processed in the form of food packaged as functional food so that the product has a higher commercial value [10]. Ginger in the form of ginger juice has the potential to be processed into jelly products. Jelly is a gel-shaped snack made of hydrocolloid compounds with the addition of sugar, acid, and/or without other food additives [11]. There are several variants of jelly with different texture characteristics in the market, such as jelly drinks, jelly candy, or ordinary jelly. Jelly stick products made from red ginseng is popular in Korea because it has a different texture from ordinary jelly, namely sticky and chewy, easy to consume and has health benefits. Ginseng has a strong taste and tends to be bitter, so it is not suitable for the Indonesian people. Ginger is widely available in Indonesia and is more familiar to the Indonesian people so that ginger can be processed into similar jelly sticks.

The type of gelling agent used in the making of jelly affects the characteristics of the gel produced [12]. A mixture of carrageenan with konjac glucomannan is synergistic and the amount of use of both can affect the characteristics of the gel [13]. A mixture of carrageenan and pectin also can improve the product texture [14]. The purpose of this research is to utilize ginger juice as the main ingredient in ginger jelly sticks with various types of gelling agents so as to produce jelly sticks with the best characteristics and a texture that resembles commercial jelly sticks.

2. MATERIALS AND METHOD

Materials used in the production of ginger juice and ginger jelly stick were red ginger (*Zingiber officinale* var. *rubrum* Theilade), big white or gajah ginger (*Zingiber officinale* Roscoe), and small white or emprit ginger (*Zingiber majus* Rumph.) that obtained from BALITTRO Bogor, drinking water, sugar, citric acid, potassium citrate, kappa carrageenan, pectin (LM-101 AS), konjac, and jelly stick commercial "Atomy *Korean Red Ginseng Jelly Stick*".

This research consisted of two stages. The first stage is making ginger juice refers to the previous research [15, 9] with modifications. This process begins with sorting the three types of ginger, namely small white ginger (emprit), big white ginger (gajah), and red ginger. The ginger was then cleaned, peeled, chopped, and washed. After that, the ginger was boiled with 0.05% citric acid solution (pH ± 3) for 5 minutes and added water with a ratio of 1:1 ginger and water, then mashed using a blender and filtered using a filter cloth to obtain ginger juice. The second stage is making ginger jelly sticks which refers to the previous research [16,17] with modifications. The formulation and procedure for ginger jelly stick processing can be seen in Table 1 and Figure 1.

Table 1. Formulation of 200 g red ginger jelly stick

Materials	Amount (%)
Red ginger juice	77.35
Sugar	20.00
Potassium citrate	0.35
Citric acid	0.30
Gelling agent (according to the treatment)	2.00

Ginger jelly stick processing begins with mixing dry ingredients, such as sugar (20%), potassium citrate (0.35%), gelling agent (2%) according to the treatment. There are 7 combinations of gelling agents used as treatment in this study, namely carrageenan, carrageenan: pectin (1:1), carrageenan: pectin (1:2), carrageenan: pectin (2:1), carrageenan: konjac (1:1), carrageenan: konjac (1:2), and carrageenan: konjac (2:1). The dry ingredients mixture was added to the ginger juice, then dissolved at 30°C and heated to 85°C while stirring. The temperature is then lowered to 75° C. and citric acid (0.3%) was added while stirring. Furthermore, it was molded and cooled at room temperature until a gel texture was formed into a jelly stick product.

Ginger juice
↓
Heated to 30°C
↓
Added dry mix ingredients
(sugar, potassium citrate, gelling agent according to treatment)
↓
Heated while stirring to 85°C
↓
Temperature of the mixture is lowered to 75°C
↓
Added citric acid while stirring
↓
Forming or molding the jelly
↓
Cooled (at room temperature)
↓
Ginger jelly stick

Figure 1. Procedure of ginger jelly stick processing [16,17]

The analysis carried out in this study were texture [18], color [19], antioxidant activity [20], total phenolic [21], total flavonoids [22], proximate and total dietary fiber [23]. Antioxidant activity analysis was carried out using 0.1 mM DPPH solution and ethanol as a solvent. The DPPH and ethanol solutions were mixed in a certain amount until the absorbance value was between 0.9-1.1 A. The mixture was used as a control. The sample was crushed first and dissolved according to the desired concentration using ethanol. The test was then carried out by mixing samples of various concentrations with 0.1 mM DPPH into a test tube, then mixed until homogeneous using a vortex.

After being incubated for 30 minutes at room temperature in a dark place, the absorbance of the solution was measured at a wavelength of 517 nm using a spectrophotometer. The absorbance obtained was used to calculate the percentage of inhibition. Determination of the IC_{50} value was carried out using a linear regression equation from the relationship curve of the sample concentration to the percentage of inhibition

Analysis of variance One Way Anova was performed using the SPSS 25.0 software. In the first stage there was one treatment factor with 3 levels of ginger juice types and in the second stage there was one treatment factor with 7 levels of gelling agent type combination. Each treatment was replicated three times. Significant differences were detected using Duncan's test at the $p \leq 0.05$ level.

3. RESULTS AND DISCUSSION

3.1. Characteristics of Ginger Juice

The three types of ginger used in this study belonged to the Zingiberaceae tribe, namely emprit or small white ginger (*Zingiber majus* Rumph.), red ginger (*Zingiber officinale* var. rubrum Theilade), and gajah or big white ginger (*Zingiber officinale* Roscoe). The results of One-Way ANOVA statistical analysis showed that the type of ginger had a significant effect ($p \leqslant 0.05$) on the total phenolic, total flavonoids and antioxidant activity of ginger juice, as can be seen in Table 2.

The highest total phenolic content was found in red ginger juice which was 571.37 ± 19.20 mg GAE/L. The phenolic content in ginger juice caused by red ginger has the highest phenolic compounds compared to other ginger [24]. These compounds are found in ginger oleoresin which is a mixture of resin and essential oils. Red ginger essential oil content is 2.58-3.9%, while emprit (small white) ginger is 1.5-3.5% and gajah (big white) ginger is 0.82-3.5%. The content of zingiberene compounds found in red ginger is about 22.72% [25]. Overall, the total phenolic content of ginger juice in this study was higher than several other studies. This could be due to the fact that boiling ginger with an acid solution for 5 minutes in the early stages of making ginger juice can increase ginger phenolic compounds such as zingiberene and shogaol [9]. The difference ratio of water and ginger used in ginger juice can also have an effect because if the amount of water is bigger, the phenol content will decrease [26].

Red ginger juice had the highest total flavonoids compared to the other two types with total flavonoids 73.43 ± 2.40 mg QE/L. These results are parallel with the total phenolic content in the three types of ginger because flavonoids are included in the phenolic compound group, so ginger that has high phenolic content will have higher flavonoid content [27]. The flavonoid compound in red ginger is 4,7-dihydroxyflavone [28]. The highest antioxidant activity was shown in ginger juice made from red ginger with the smallest IC_{50} value (33537±807.34 ppm). This is because red ginger contains the most oleoresin and essential oils compared to the other two types of ginger. High oleoresin levels (5.86-6.36%) also characterized by the hottest red ginger taste. Oleoresin is a phenolic compound that has the ability to inhibit free radicals [24, 29].

The results of this study showed that red ginger juice had the lowest IC_{50} value with the highest total phenolics and total flavonoids. This result is parallel with other research that indicates total phenolic, total flavonoid, and antioxidant activity had a linear relationship [27]. Based on the results of this analysis, red ginger juice is used as the main ingredient for making ginger jelly sticks.

3.2. Red Ginger Jelly stick

The purpose of this research was to make jelly that resembles the texture of commercial Korean jelly sticks using ginger juice. The ginger juice used was red ginger based on the highest total phenolic, flavonoid and antioxidant activity. Red ginger sticks jelly are made using various types of gelling agents.

3.2.1. Texture

The results of One Way ANOVA statistical analysis showed that the seven types of gelling agent combinations had a significant effect ($p \leqslant 0.05$) on hardness, springiness, cohesiveness, gumminess, and chewiness of red ginger jelly stick, respectively, as can be seen in Table 3. Commercial Korean jelly sticks made from red ginseng with carrageenan and amidated pectin as gelling agents were used as control for comparison of textures.

Table 2. Total phenolic and flavonoid contents and the antioxidant activity of the ginger samples

Type of ginger	Total phenolic (mg GAE/L)	Total flavonoid (mg QE/L)	Antioxidant activity (IC_{50}, ppm)
Emprit (small white) ginger	489.87 ± 21.90^{b}	61.07 ± 0.70^{b}	37889.04 ± 565.35^{b}
Gajah (big white) ginger	422.63 ± 12.10^{a}	40.73 ± 1.40^{a}	47508.42 ± 1000.20^{c}
Red ginger	571.37 ± 19.20^{c}	73.43 ± 2.40^{c}	33537.24 ± 807.34^{a}

Note: Data are means and standard deviations. Data on the same column with different letter superscripts are significantly different (n=3, Duncan's test, $p \leq 0.05$)

Table 3. Effect of gelling agent type to red ginger jelly stick texture

Gelling agent type	Hardness (g.force)	Springiness (mm)	Cohesiveness (kg.sec)	Gumminess (g.force)	Chewiness (g.force)
Control	358.79 ± 27.09	0.97 ± 0.01	0.65 ± 0.02	233.87 ± 19.91	225.88 ± 18,35
Carrageenan	780.30 ± 31.38^{f}	0.92 ± 0.05^{bcd}	0.57 ± 0.04^{d}	445.15 ± 11.91^{f}	412.09 ± 33.78^{f}
Carrageenan:pectin (1:1)	274.34 ± 15.90^{c}	0.91 ± 0.03^{abc}	0.26 ± 0.03^{a}	71.62 ± 7.19^{b}	64.91 ± 4.62^{b}
Carrageenan:pectin (1:2)	74.52 ± 6.74^{a}	0.89 ± 0.00^{ab}	0.32 ± 0.02^{b}	23.85 ± 1.18^{a}	21.34 ± 1.07^{a}
Carrageenan:pectin (2:1)	620.70 ± 54.61^{e}	0.87 ± 0.02^{a}	0.50 ± 0.02^{c}	306.74 ± 14.64^{e}	268.19 ± 17.02^{e}
Carrageenan:konjac (1:1)	218.40 ± 20.19^{b}	0.96 ± 0.02^{d}	0.68 ± 0.02^{e}	148.89 ± 13.66^{c}	142.8 ± 11.12^{c}
Carrageenan:konjac (1:2)	119.24 ± 12.77^{a}	0.94 ± 0.02^{bcd}	0.73 ± 0.04^{f}	86.77 ± 5.35^{b}	81.36 ± 6.23^{b}
Carrageenan:konjac (2:1)	336.02 ± 16.06^{d}	0.96 ±0.01^{cd}	0.65 ± 0.00^{e}	219.10 ± 10.86^{d}	209.53 ± 11.78^{d}

Note: Data are means and standard deviations. Data on the same column with different letter superscripts are significantly different (n=3, Duncan's test, $p \leq 0.05$)

It can be seen in Table 3 that the highest hardness values were found in jelly sticks made of carrageenan, while the closest to the control were those made of carrageenan:konjac (2:1). In general, jelly sticks with higher amounts of carrageenan have higher hardness values. It is because kappa carrageenan can form a strong double helix structure to produce a strong and rigid gel [13]. Beside it, the addition of potassium citrate (0.35%) in the manufacture of jelly sticks can stabilize the fragile junction zone due to the presence of K+ ions to produce a more solid and stronger gel [17].

The lowest hardness values were found in jelly sticks made of carrageenan: pectin (1:2) and carrageenan: konjac (1:2). The increase in the amount of konjac causes a weak junction zone to form and causes the kappa carrageenan bond to break, resulting in a less hardness and more elastic gel [30]. Korean jelly sticks (control) used carrageenan and pectin as a gelling agent. But the hardness value of ginger jelly sticks with the same gelling agent was lower than the control. This is because amide pectin forms a gel by forming bonds with calcium so that the lack of Ca^{2+} ions can cause the decreasing of the gel strength [31].

The highest springiness value and the closest to the control was found in red ginger jelly sticks made from carrageenan:konjac (1:1). The addition of konjac can increase the springiness value because of the nature of konjac which can make a thick solution so that it can affect the interaction between konjac and kappa carrageenan and reduce gel stiffness [30]. Different results were obtained in jellies with a mixture of carrageenan and pectin due to the small amount of Ca^{2+} ions that could decrease the elasticity of the gel [31].

Jelly sticks with a mixture of carrageenan and pectin (1:1) had the lowest cohesiveness value. Ginger jelly sticks with a carrageenan-pectin combination gelly agent in all ratios had a lower cohesiveness value and was different from the control. This could be due to the fact that LM pectin was used in this study so that Ca^{2+} ions were needed. The increase of Ca^{2+} ions can form strong gels in the presence of salt bridge formation, which is also assisted by the presence of sugars to stabilize the junction zone and contribute to the formation of hydrogen bonds to bind water [32]. However, due no addition of Ca^{2+} ions, the junction zone has not yet been formed. Different results were obtained on jelly sticks with a mixture of carrageenan and konjac which overall had a high cohesiveness value. This is because the two work synergistically to form a more compact, dense, and elastic texture [13].

The highest gumminess value was obtained from jelly sticks made of carrageenan, while jelly sticks made from carrageenan:konjac (2:1) had the closest gumminess value to control. This could be due to the joining of polymer chains to form a strong and rigid three-dimensional network to retain water to form colloids that can form a strong gel by kappa carrageenan [33]. Other results were obtained on jelly sticks made from a mixture of carrageenan and pectin (1:2) with the smallest gumminess value and also much different from the control. This could be due to the lack of Ca^{2+} ions. Although in the absence of Ca^{2+} ions, gel formation on pectin still occurs because pectin has a tendency to form aggregates, but will produce a weak and easily destroyed gel. Thus the energy required to destroy the product is also small [34]. The chewiness value of ginger jelly stick is parallel to the hardness and gumminess values, with the highest value obtained in jelly sticks made of carrageenan, while jelly sticks made of carrageenan:konjac (2:1) have the chewiness value closest to the control (209.53 ± 11.78). The use of kappa carrageenan significantly increased the hardness, gumminess, and chewiness values [35].

3.2.2. Color

The color of the red ginger jelly stick is indicated by the value of the degree of Hue and lightness (L*). The value of the Hue degree of the seven types of ginger jelly stick ranges from 81.07 – 85.67° which can be categorized as yellow [36]. This yellow color is influenced by the color of the red ginger juice used. This yellow color is due to the presence of curcumin, demethoxycurcumin, and 6-dehydrogingerdione in red ginger [37]. The results of One-Way ANOVA statistical analysis showed that the type of gelling agent had no significant effect ($p>0.05$) on the lightness value. The seven kinds of jelly sticks were obtained in the range of 42.2-45.1 which means slightly dark or not bright. This means that the color of the red ginger jelly stick is a slightly dark yellow. The sugar caramelization process during the processing of jelly can affect the brightness of the product [38]. The color of the jelly sticks is more influenced by the color of the ginger juice. The gelling agent used has almost the same color, namely brownish white and is used in small quantities so neither the color nor the brightness of the jelly sticks are not different.

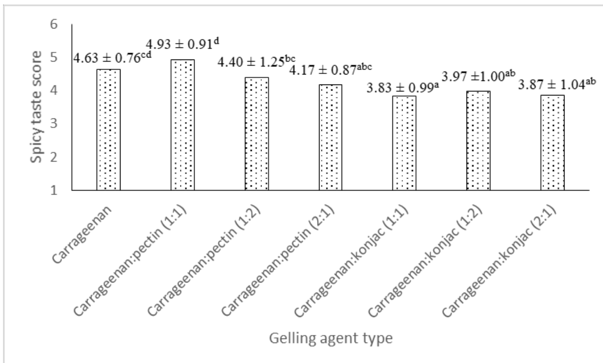
3.2.3. Organoleptic Test

The organoleptic test of red ginger jelly sticks was carried out by scoring and hedonic tests on 30 panelists. The scoring test is carried out with a scale of 1-6, while the hedonic test is carried out on a scale of 1-5. In this organoleptic test, no control was used because of differences in ingredients where Korean jelly sticks used ginseng so they could not be used as a comparison with red ginger jelly sticks. The results of One-Way Anova statistical analysis showed that the type of gelling agent had no significant effect ($p>0.05$) on the score and hedonic value of aroma, color and sweetness of the red ginger jelly stick produced.

Red ginger juice has a strong aroma so that the aroma of different gelling agents does not affect the aroma of the jelly sticks [7]. The aroma score ranges from 4.1 to 4.6, which means it has a slightly ginger aroma. While the hedonic value ranges from 3.7 to 4.1, which means that the panelists like the aroma of ginger in ginger jelly sticks. The presence of a mixture of zingerone, shogaol, and gingerol which is about 1-3% of the weight of fresh ginger can affect the aroma characteristics of ginger [39]. The aroma of ginger is also refreshing, so this can affect the panelists' preference for the smell of the jelly sticks produced. Making jelly requires a heating process of ginger juice so that the ginger aroma on the jelly sticks is not very strong. The content of volatile components such as shogaol and gingerol contained in ginger rhizomes will decrease if it is heated at temperatures above 60°C [40].

The score for the ginger jelly stick color ranged from 3.8 to 4.2 which indicated a slightly brownish yellow color, while the hedonic test value ranged from 3.9 to 4.3 which indicated that the panelists liked it. Color assessment according to organoleptic test linear with color analysis based on the degree of Hue and lightness which shows a slightly dark yellow. The yellow color of jelly sticks is due to the presence of yellow pigments in ginger, such as curcumin, demethoxycurcumin, and 6-dehydrogingerdione [37].

The sweetness score of ginger jelly stick ranges from 3.1 to 3.8 which indicates the taste tends to be a little less sweet, while the hedonic value ranges from 3.3 to 3.9 which means that the panelists like the taste of ginger jelly stick even though it is not sweet. Generally, jelly has a sweet taste. The sugar used in making red ginger jelly sticks is only 20% of the total formulation, so the resulting taste tends to be less sweet. The taste of the red ginger jelly stick is also influenced by the spicy taste that comes from the ginger juice. Based on One-Way Anova statistical analysis, the type of gelling agent had a significant effect ($p \leq 0.05$) on the scoring and hedonic values for the spicy taste of ginger jelly sticks. Based on Figure 2, it can be seen that the jelly made with a mixture of carrageenan and konjac has a lower intensity of spicy taste than other jelly stick with the lowest score on the use of carrageenan:konjac 1:1 which is 3.83±0.99 and is not significantly different from carrageenan: pectin 1:2 which shows a slightly spicy taste.

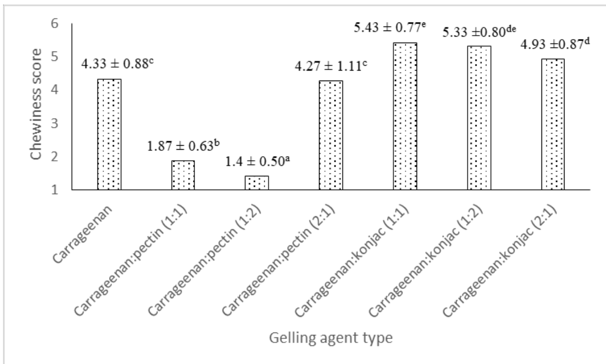


Note1: Data are means and standard deviations. Different superscripts indicate there is a significant difference (n=3, Duncan' s test, $p \leq 0.05$)
Note2: (1 – Not very spicy taste to 6 – Very spicy taste)

Figure 2. Scoring test on spicy taste of red ginger jelly stick

The highest spicy taste score was obtained for jelly sticks made from carrageenan:pectin (1:1), which was 4.93±0.91 which indicated a spicy taste. Carrageenan and pectin have no taste [41,42]. The spicy taste of jelly sticks is due to the non-volatile oleoresin component of ginger juice [24]. These hot and spicy compounds are gingerol, shogaol, and zingerone [5]. Based on texture analysis, the use of different gelling agents affects the texture of the ginger jelly stick. Texture parameters such as hardness, chewiness, gumminess indicate how the character of the product when bitten and chewed so that it's possible the differences in the texture of the jelly sticks affect the intensity of the spicy taste that appears. The results of the hedonic test show that the panelists' preference for the spicy taste of jelly sticks is high, which is found in jelly sticks made of carrageenan:pectin (2:1), which is 4.17±0, 91 and not significantly different from all treatments using carrageenan:konjac which means that the panelists like jelly sticks with a slightly spicy taste. Low hedonic value was found in jelly sticks made of carrageenan:pectin (1:1) with a value of 3.20±1.06 which indicated that the panelists tended to be neutral. This shows that the panelists tend to prefer jelly sticks with a lower intensity of spicy taste.

Based on the statistical analysis of One-Way Anova, the gelling agent type had a significant effect ($p \leq 0.05$) on the scoring value and hedonic elasticity of jelly sticks. In Figure 3 it can be seen that jelly sticks with a mixture of konjac carrageenan produced a more chewy texture than other jelly sticks with the highest elasticity score obtained in jelly sticks made of carrageenan:konjac (1:1), namely 5.43±0.77 which shows a chewy texture.



Note1: Data are means and standard deviations. Different superscripts indicate there is a significant difference (n=3, Duncan' s test, $p \leq 0.05$)
Note2: (1 – Not very spicy chewy to 6 – Very chewy)

Figure 3. Scoring test on chewiness of red ginger jelly stick

The lowest score was jelly sticks made of carrageenan:pectin (1:2), which was 1.40±0.5 which means very not chewy. The more the amount of konjac used, the softer and more elastic the gel will be because konjac has good water binding ability [13]. Jelly sticks with the use of pectin ratios are increasingly considered non-spongy by panelists and linear with the results of texture analysis. This can be due to the lack of calcium ion pectin so that the gel formed is inelastic and not strong [31]. The hedonic test results show that the carrageenan:pectin (1:2) treatment has the lowest hedonic value 1.5 ± 0.57 which means that the panelists did not like the elasticity of the ginger jelly stick. The highest hedonic value was jelly sticks with carrageenan which was 4.37 ± 0.72 and did not differ significantly with carrageenan:pectin 2:1 and carrageenan: Konjac 2:1, which means that the panelists like the elasticity of the ginger jelly sticks. The more chewy the jelly sticks are, the higher the panelists' preference level. None of the panelists gave the rating as like very much, which is linear with the results of the jelly stick scoring test that no jelly is considered very chewy.

3.3 Characteristics of the Best Sample Red Ginger Jelly Stick

Based on the results of the analysis, the best red ginger jelly stick was obtained by using the type of gelling agent carrageenan:konjac (2:1). Determination of the type of gelling agent is determined based on texture analysis which includes parameters of hardness, springiness, cohesiveness, gumminess, and chewiness which are closest to Korean jelly sticks as a control. These results are also supported by high organoleptic test scores, both scoring and hedonic.

The results of the analysis of the chemical characteristics of the best red ginger jelly stick were total phenolic 266.50 mg GAE/L, flavonoid 42.81 mg QE/L and antioxidant activity (IC50) 63685.97 ppm. The content of active compounds in red ginger jelly sticks has decreased or is lower when compared to red ginger juice. This is due to the cooking process at a temperature of up to 85°C when making jelly. The presence of heat causes compounds that act as antioxidants to be easily oxidized, so the higher the temperature and the longer the heating, the lower the antioxidant activity due to reduced phenolic compounds [43,44]. The antioxidant activity of the red ginger jelly stick is low, but compared to the duwet fruit juice drink jelly and the watermelon-tomato jelly drink this red ginger jelly stick has better antioxidant activity [45,46].

The results of proximate analysis of red ginger jelly sticks obtained water content of 71.3%, ash 0.87%, fat 1.1%, protein 0.87%, and carbohydrates 25.87%. This proximate content is not much different from jelly made using water and a combination of carrageenan and gelatin [16]. The total dietary fiber content obtained in ginger juice jelly sticks is 2.38% or 2.38g/100g. Hydrocolloids used as gelling agents in the manufacture of jelly, namely carrageenan and konjac are rich in dietary fiber and ginger also has a fiber content about 2g/100g that can affect dietary fiber on jelly sticks [47, 39]. Fiber content from red ginger jelly sticks is greater than cincau jelly drink which has 2% dietary fiber content [48]. Red ginger jelly stick has the potential to be a functional food because it has active components and dietary fiber and has a taste that is not too sweet so that it can help increase the body's immunity by consuming it.

The weakness of this red ginger jelly stick is the texture that can't resemble a control jelly stick. Control jelly stick using gelling agent carrageenan and pectin. However, the best results in this study were using carrageenan and konjac. In the presence of carrageenan which can form a double helix bond, the more aggregates will be formed so that a harder texture is produced, while in the presence of a konjac mixture the more elastic and softer gel will be produced because konjac has the ability to bind water [13]. A mixture of carrageenan and pectin can also produce a better texture because both can increase the ability to form gels by forming a double helix or three-dimensional structure which if the formation is wider, the gel strength will increase [14]. This is because both LM pectin and kappa carrageenan have gaps that can support the gel formation process because they are able to confine or retain water [49]. However, in the formation of the gel, the resulting texture will be influenced by the ratio between calcium and pectin. The amount of pectin and calcium ions used must be appropriate [50]. Red ginger juice is not a source of calcium and in this study there was no addition of calcium source material so that the texture obtained in red ginger jelly stick was different from the control.

4. CONCLUSION

Red ginger juice had the best results compared to small white ginger or emprit and big white ginger or gajah with IC50 value of 33537.24±807.34 ppm, total phenolic of 571.37 ± 19.20 mg GAE/L, and total flavonoid of 73.43 ± 2.40 mg QE/L. The type of gelling agent affects the physicochemical and organoleptic characteristics of red ginger jelly stick. The type of gelling agent that was selected was carrageenan:konjac (2:1) which has the closest texture to Korean jelly stick with high scoring and hedonic values. A mixture of carrageenan and konjac will produce a gel that is more chewy than a mixture of carrageenan and pectin because the formation of the gel requires the right amount of pectin and calcium. The hot temperature during jelly processing resulted in a decrease in antioxidant activity, but the dietary fiber content in red ginger jelly sticks was quite good at 2.38%. The content of active compounds, food fiber content and a taste that is not too sweet make red ginger jelly sticks have the potential to be a source of functional food so that further research is needed to increase the content of the active compounds.

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