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Physicochemical Properties of Jelly Candy Made with Pectin from Red Dragon Fruit Peel in Combination with Carrageenan

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Abstract

Jelly candy is a product with a soft and chewy texture due to a gelling agent such as pectin and carrageenan. Red dragon fruit peel widely uses as natural pectin in various products, one of which is jelly candy. However, the resulting product has a less chewy texture. Thus, combining the natural pectin and carrageenan is expected to improve jelly candy's physicochemical characteristics. Moreover, in jelly candy products, the combination of carrageenan with red dragon fruit peel pectin have not been applied. The methods in this research consisted of extraction of red dragon fruit peel and jelly candy making. This study uses completely randomized design with two factors: the concentration (3.5%, 4%, 4.5%) and ratio (2:1, 1:1 and 1:2) of red dragon fruit pectin and carrageenan. The jelly candy obtained were observed for its texture, color and moisture content. Hardness, cohesiveness, gumminess and chewiness were analyzed to determine the texture of jelly candy. The result showed a combination of red dragon fruit peel pectin and carrageenan within a ratio of 2:1 at 4.5%, selected as the best ratio and concentration in making jelly candy. The jelly candy had a hardness value of 421.59±7.94 g, cohesiveness 0.39±0.01, gumminess 122.22±2.77, chewiness 117.54±2.61, lightness 32.39±0.16 and moisture content 45.83±2.68%. This study provides new insight into gelling agents used to produce jelly candy and the effect on the physicochemical characteristics of jelly candy product.

Keywords: carrageenan; hydrocolloids; jelly formulation; pectin; red dragon fruit peel

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INTRODUCTION

Jelly candy is a confectionery with a soft and chewy texture due to gelling agents in the manufacturing process (BSN, 2008). The use of gelling agents in the manufacture of jelly candy can affect the quality of the resulting candy (Utomo et al., 2014). Gel formation can occur due to merging or cross-linking between polymer chains to form a three-dimensional network that binds water, thus resulting in a firm texture (Herawati, 2018). Jelly candy making widely used hydrocolloids as gelling agents. Examples of hydrocolloids are agar, gum, starch, gelatin, carrageenan and pectin.

Jelly candy commonly used gelatin as a gelling agent, but the usage of gelatin will relate to the Halal issue. Besides gelatin, agar is using as a gelling agent for jelly candy making. However, the used of agar resulted in jelly candy with a soft and brittle texture, thus decreasing the panelist's acceptance (Wahyuni, 2011; Rismandari et al., 2017). Thus, selecting the best type of gelling agent to produce jelly candy with the best physical

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and chemical characteristics is important. Other potential gelling agents in jelly candy making are pectin and carrageenan.

Pectin is a polysaccharide compound commonly found in fruit flesh and peel. The primary constituent of pectin is D-galacturonic acid (Ismail et al., 2012; Suwoto et al., 2017). Pectin itself can be obtained naturally from several parts of the plants, such as the fruits. With the change in diet habits and rising population, fruits' production and processing have exponentially improved to meet its increasing demand. The most common waste are pomace, rinds, seeds and peels. These are rich in valuable compounds (Abd Gani et al., 2020; Kumar et al., 2020).

Red dragon fruit is one of nature's most exotic plants. Different part of red dragon fruit such as flesh, peels and seeds exhibit various benefits. The percentage of red dragon fruit peel is 30–35% of the total weight of the fruit, even though red dragon fruit peel can have the potential to be utilized. The red dragon fruit peel contains 10.8% pectin. They are often regarded as waste materials and discarded, leading to environmental issue (Yati et al., 2017; Murtiningsih et al., 2018; Abd Gani et al., 2020).

Several studies have used red dragon fruit peel pectin as a thickening agent in the making of jam and a binder of fruit leather (Syaifuddin et al., 2019; Winarti et al., 2020). In addition, the jelly candy making has utilized the natural pectin of red dragon fruit peel, but the resulting jelly candy had a less chewy texture (Yuwidasari et al., 2019). Therefore, in its use, natural pectin needs to be combined with other hydrocolloid components to improve these characteristics.

Carrageenan is another type of hydrocolloid used as a gelling agent in the making of jelly candy. The use of 2% carrageenan produces jelly with soft and chewy tends to be preferred (Wahyuni, 2011). In addition, carrageenan is also used in conjunction with other gelling agents (Kreungngern and Chaikham, 2016). However, the combination of carrageenan with natural pectin has not been tested, especially in jelly candy products. Therefore, in this study, red dragon fruit peel pectin was mixed with carrageenan in various ratios (2:1; 1:1; 1:2) and concentrations (3.5%, 4%, 4.5%). Physical and chemical characteristics of the jelly candy including texture, color and moisture content, were analyzed.

Texture analysis was carried on the attributes of hardness, cohesiveness, gumminess and chewiness. The addition of a gelling agent mainly influenced the texture of jelly candy. Therefore, it is crucial to precisely know the texture characteristics of jelly candy, especially on the attributes of hardness, cohesiveness, gumminess and chewiness. Hardness and gumminess can determine the strength of the gel formed and affect the panelists' acceptance of the product (Kusumaningrum et al., 2016). The higher the hardness value of the jelly candy produced, the higher the gumminess value of the product (Yusof et al., 2019) because the energy required to crush semi-solid food products until they are ready to be swallowed greater when the resulting jelly has a higher hardness value. In addition, jelly candy with good quality must be easy to chew and swallow, which is influenced by the cohesiveness and chewiness value (Yusof et al., 2019).

This study aimed to determine the best ratio and concentration of hydrocolloids in jelly candy's physical and chemical characteristics. Therefore, this research will provide new insight into the types of gelling agents used to produce jelly candy and their effect on the physicochemical characteristics of jelly candy. Moreover, utilizing low-cost waste from red dragon fruit peel into natural pectin for producing value-added jelly candy is a novel step in its sustainable utilization (Kumar et al., 2020).

MATERIALS AND METHOD

Materials

This research used an experimental method to determine the ratio and the best concentration of hydrocolloids for optimum jelly candy's physical and chemical characteristics. The hydrocolloids used were carrageenan and natural pectin from the peel of the red dragon fruit. The carrageenan used was kappa carrageenan obtained from CV Nura Jaya. At the same time, natural pectin from red dragon fruit peel was made in the research before mixed with carrageenan and applied to jelly candy making. The red dragon fruit peel obtained were around 150-200 g.

Methods

The methods in this research consisted of extraction of red dragon fruit peel, jelly candy making and data analysis.

Extraction of red dragon fruit peel pectin

The extraction process of red dragon fruit peel pectin followed Ismail et al. (2012); Zaidel et al. (2017); Nguyen and Pirak (2019) with modifications. The peel of the red dragon fruit obtained from juice store's waste in Tangerang, washed with running water and cut using a knife to reduce its size and then dried using a 50°C cabinet dryer ("Wangdi") for 24 hours. The dried dragon fruit peel was mashed using a dry blender ("Philips") and then sieved using a 35-mesh sieve to obtain red dragon fruit peel powder.

The red dragon fruit peel powder was then dissolved with distilled water (1:25) and added with 0.1 N citric acids until it reached pH 4 and continued with heating on the heather ("Cimarec") at 75°C for 120 minutes. The extraction results were filtered using a filter cloth. The filtrate obtained was added with 96% ethanol in a 1:1 ratio (v/v) and allowed to stand at room temperature for 24 hours. Through a filter cloth, the wet pectin precipitate filtered. The residue clumps were washed with 96% ethanol four times. The results of wet pectin were dried in an oven ("Memmert UNB 500") at 50°C for 24 hours. The yield, equivalent weight, methoxyl and galacturonic acid content of the resulting red dragon fruit peel pectin were analyzed refers to Nguyen and Pirak (2019). At the same time, the analysis of galacturonic acid content refers to Latupeirissa et al. (2019). The calculation for these analyses displayed as the following Equations (1; 2; 3; 4).

$$\text{Yield of pectin (\%)} = \frac{\text{weight of pectin}}{\text{weigh of red dragon fruit peel}} \times 100\% \quad (1)$$

$$\text{Equivalent weight} = \frac{\text{weight of pectin (mg)}}{\text{Vol. NaOH (ml)} \times \text{N NaOH}} \times 1000 \quad (2)$$

$$\text{Methoxylcontent (\%)} = \frac{\text{Vol. NaOH} \times 31 \times \text{N NaOH}}{\text{weight of pectin (mg)}} \times 100\% \quad (3)$$

$$\text{Galacturonic acid content (\%)} = \frac{(\text{mEq equivalent} + \text{mEq methoxyl}) \times 176}{\text{weight of pectin (mg)}} \quad (4)$$

Where; 31 is molecular weight of methoxyl, and 176 is molecular weight of galacturonic acid.

Jelly candy

The method by Murtiningsih et al. (2018); Romo-Zamarrón et al. (2019); Meilianti et al. (2020) with modifications followed to make the jelly candy. Table 1 showed the formulae of jelly candy per 100 g of the product. The initial stage of making jelly candy was mixing red dragon fruit peel pectin and carrageenan at various ratios (2:1; 1:1; 1:2) and concentrations (3.5%, 4%, 4.5%). An amount of 100 ml of hot water was used to dissolve the hydrocolloid mixture. After complete dissolution, sucrose and glucose syrup were added, then heated to 90°C for 15 minutes using heater ("Cimarec"). After heating, the jelly candy dough and citric acid were mixed.

The jelly candy dough was poured into molds and cooled at room temperature for 1 hour and then cooling at 5°C for 24 hours inside the cooler ("Sharp"). The jelly candy obtained were analyzed for its physical and chemical characteristics, including texture, color and moisture content. A texture analyzer ("TA-XT Plus") with a P/0.5-cylinder probe was analyzed the hardness, cohesiveness, gumminess and chewiness. Chromameter ("Konica Minolta CR-400") was used to analyze the lightness attribute (Pathare et al., 2013). The moisture content analysis followed the AOAC (2005).

Data analysis

This study used a completely randomized design with two factors: the concentration and ratio of red dragon fruit pectin and carrageenan. The ratio (2:1, 1:1 and 1:2) and concentration (3.5%, 4% and 4.5%) made into three levels. This research used three replicates; each replicate performed in the three repetitions. Data was analyzed with ANOVA on the IBM SPSS version 25 system followed by Duncan's Multiple Range Test as the post-hoc analysis.

Table 1. Formulation of jelly candy with different concentration and ratio of red dragon fruit pectin and carrageenan

Composition	JC1 (%)	JC2 (%)	JC3 (%)
Water	59.0	58.5	58.0
Sucrose	25.0	25.0	25.0
Glucose syrup	12.2	12.2	12.2
Citric acid	0.3	0.3	0.3
Concentration of hydrocolloids *)	3.5	4.0	4.5

Note: *) red dragon peel pectin : carrageenan 2:1; 1:1; 1:2

RESULTS AND DISCUSSION

Characteristics of red dragon fruit peel pectin

Table 2 showed the characteristics of the red dragon fruit peel pectin. Based on Nguyen and Pirak (2019), the yields of red dragon fruit peel pectin ranged from 4.98-12.32%. Differences in extraction time and temperature can cause the difference in yield. The longer the extraction time, the longer the contact time between the material and the solvent so that the pectin component that comes out of the tissue cells increases (Zaid et al., 2016). The high extraction temperature can help the solvent diffusion into the tissue so that the yield of pectin produced increases as the solvent activity increases in hydrolysis (Oliveira et al., 2016).

The equivalent weight indicates the amount of pectin. It also indicates the free unesterified galacturonic groups in the pectin molecular chain. The low equivalent weight indicates lower pectin content (Roikah et al., 2016). Based on Table 2, the equivalent weight of red dragon fruit peel pectin produced in this study (1110.78±16.19 mg) was lower than the Aziz et al. (2018) results, which ranged from 1452.86 to 2543.00 mg. The pH, temperature and extraction time caused the difference in the equivalent weight of the pectin produced. The extraction temperature and time used in Aziz et al. (2018), namely 50-70°C for 30, 60 and 90 minutes while in this study, a temperature of 75°C for 120 minutes have carried out for the extraction. The higher extraction time and temperature can cause a decrease in the equivalent weight of the pectin produced (de Oliveira et al., 2016). They were decreasing caused by the depolymerization of pectin at long extraction times and high temperatures. Based on Aziz et al. (2018), pectin with a high equivalent weight has better gelling properties.

Table 2. Characteristics of red dragon fruit peel pectin

Characteristics	Value
Yield (%, d.b.)	13.84±0.67
Equivalent weight (mg)	1110.78±16.19
Methoxyl content (%, d.b.)	3.44±0.09
Galacturonic acid content (%, Meq mg^{-1})	35.38±0.34
Lightness	41.45±0.26

Based on Table 2, the pectin produced had a methoxyl content around 3.44±0.09%. The methoxyl content in this study was lower than the methoxyl pectin content of the red dragon fruit peel obtained in Nguyen and Pirak (2019), which has 3.69±0.18% of methoxyl content. In this study, the extraction was carried out at 75°C and pH 4, while Nguyen and Pirak (2019) maintaining extraction process at pH 2 (75°C). The acidic condition will accelerate the hydrolysis of protopectin into pectin, thus explaining the higher content of methoxyl obtained in the Nguyen and Pirak (2019).

Pectin with a methoxyl content of more than 7.12% is categorized as high methoxyl pectin, while low methoxyl pectin within the value between 2.5-7.12% (Aziz et al., 2018). The red dragon fruit peel pectin produced in this study had low methoxyl pectin with a methoxyl content of 3.44±0.09%. Based on its properties, low methoxyl pectin can form a gel properly in the use of sugar with a low concentration (less than 58%). This research used 37.5% sugar concentration, which was relatively low. In this study, a red dragon fruit peel pectin was mixed with the carrageenan into a mixture. Carrageenan also contains minerals, such as calcium, which can help form gels. The presence of calcium ions can form bonds between dissociated carboxyl groups to increase the strength of the gel formed (Bono et al., 2014; Mellinas et al., 2020).

Based on Table 2, the resulting pectin in this study had galacturonic acid content of 35.38±0.34%. The galacturonic acid content indicates the number of galacturonic acid groups in the polymer chain. The galacturonic acid content can determine the purity of the pectin produced. Other compounds carried along cause differences in the composition of the pectin produced during the extraction process. Thus, the difference in the composition of the pectin compounds will affect the galacturonic levels produced (Liew et al., 2016).

Suwoto et al. (2017) produced red dragon fruit pectin with 32.85% of galacturonic acid content, lower than the pectin produced in this study (35.38±0.34%). The galacturonic acid content is directly proportional to the quality of the pectin produced. That is, the higher the galacturonic acid content, the higher the quantity of the pectin produced. The differences in time, temperature and pH of extraction will cause differences in the levels of galacturonic acid produce. The longer the solvent contact time with the material will increase the galacturonic acid (Maryati et al., 2018). Moreover, based on Jariyah et al. (2015), the increasing temperature can also accelerate the hydrolysis process to increase galacturonic acid levels. The pectin was extracted at 70°C for 60 minutes by Suwoto et al. (2017). While in this research, 75°C for 120 minutes (pH 4) was applied for the extraction process.

The pectin powder has low level of lightness because the lightness value obtained in this study was 41.45±0.26. However, the lightness of pectin powder in this study was higher than that of Izalin et al. (2016), 39.95±0.16. The difference in lightness value due to differences in the pH of the extraction used. This study using pH 4 during the extraction. While pH 2 was carried out in the extraction process by Izalin et al. (2016). High acidity levels can cause hydrolysis to occur quickly. The cells in the fruit peel tissue become broken so that the polyphenols come out and interact with the polyphenol oxidase enzyme in the cytoplasm, reducing the brightness of the pectin produced (Pasandide et al., 2017). In addition, there is a thickening process during extraction conducted by Izalin et al. (2016), thereby increasing the heating time in the extraction process. Increasing the extraction time will lead to the brown color formation (Marić et al., 2018).

Physical characteristics of jelly candy

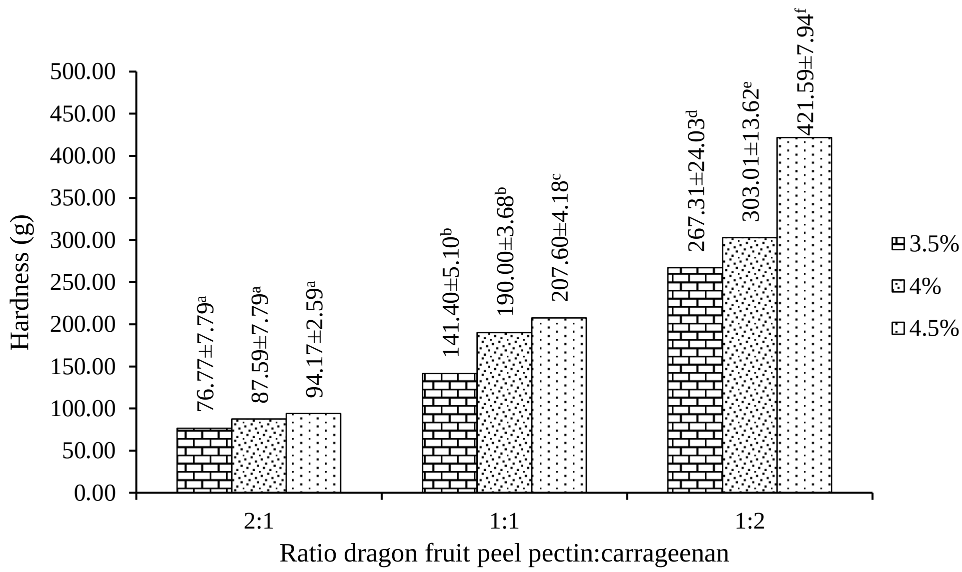
There were two physical characteristics observed on jelly candy in this research, namely texture and lightness. The texture analysis consists of several attributes, which was hardness, gumminess, cohesiveness and chewiness.

Hardness of jelly candy

Hardness is the force required to suppress a product in the first cycle and shows the strength of the gel structure (Mahardika et al., 2014). Hardness is one of the essential parameters in making jelly candy because it can determine the strength of the gel formed and affect the panelists' acceptance of the product (Kusumaningrum et al., 2016). Figure 1 showed the interaction ($p < 0.05$) between the concentration and ratio of hydrocolloids to the hardness of the jelly candy.

As displayed in Figure 1, the increase in hydrocolloid concentration at ratio 2:1 did not significantly increase the hardness. On the contrary, at ratio 1:2 of red dragon fruit peel pectin: carrageenan, the increase in hydrocolloid concentration was directly proportional to hardness, i.e., the higher the concentration of hydrocolloids, the hardness value of the resulting jelly candy increases significantly. The red dragon fruit peel pectin produced is low methoxyl pectin, so that the addition of pectin in a higher amount can increase the strength of the gel.

Broomes and Badrie (2010) showed a higher amount of the low-methoxyl pectin, resulting in a firmer texture. In addition, the addition of carrageenan can increase the hardness value of the resulting jelly candy. Pectin and carrageenan are hydrocolloids in the form of long-chain polymers. They can form gels when dispersed in water to change the rheological properties of food, such as viscosity and texture (Saha and Bhattacharya, 2010). The ability to form a gel can occur due to cross-links that form a stable three-dimensional structure. This structure will connect and trap the water molecules to form a solid and rigid structure (Siregar et al., 2016; Herawati, 2018).



Note: Bars with different superscript letter indicated significant difference ($p < 0.05$)

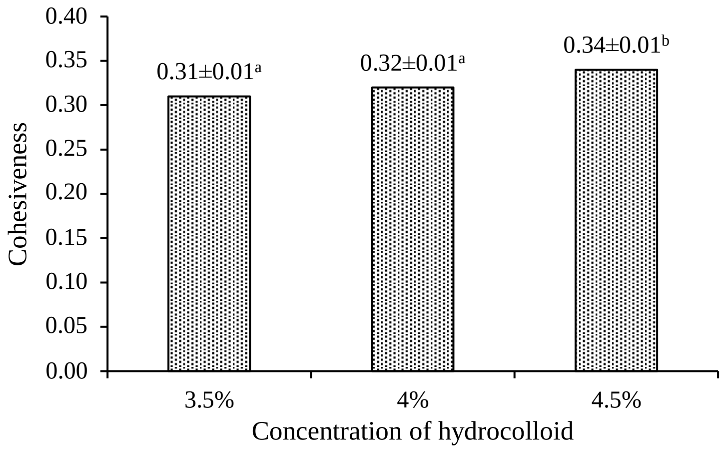
Figure 1. The effect of different ratio and concentration of hydrocolloid (red dragon fruit peel and carrageenan) toward hardness of jelly candy

Cohesiveness of jelly candy

Cohesiveness is the strength of the internal bond that composes a product from the degree of deformation under mechanical stress (Hurler et al., 2012). Jelly that is easy to chew and swallow has a low cohesiveness value (Yusof et al., 2019). There was no interaction ($p > 0.05$) between those two factors in this research toward the cohesiveness of the jelly candy. Furthermore, different ratios did not have a significant effect ($p > 0.05$) on the cohesiveness of jelly candy. The cohesiveness value of jelly candy was 0.31±0.01, 0.32±0.01 and 0.33±0.01, respectively, for ratios 1:1, 1:2 and 2:1.

Despite that, there was significant effect ($p < 0.05$) of concentration on the cohesiveness of jelly candy, as displayed in Figure 2. Thus, only the data from the significant factor will show a graph in this discussion.

Figure 2 shown the significant effect ($p < 0.05$) of hydrocolloid concentration on the cohesiveness of jelly candy. The cohesiveness value was directly proportional to the hydrocolloid concentration used. The higher the hydrocolloid concentration, the higher the cohesiveness value produced. However, the addition of 3.5% hydrocolloid was not significantly different from jelly candy with 4% hydrocolloid.



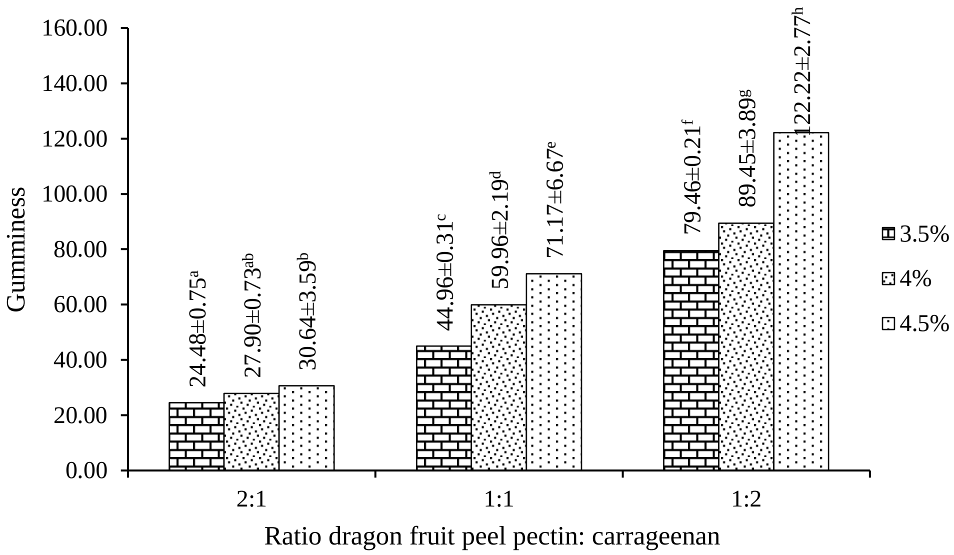
Note: Bars with different superscript letter indicated significant difference ($p < 0.05$)

Figure 2. The effect of different concentration of hydrocolloid (red dragon fruit peel and carrageenan) toward cohesiveness of jelly candy

Increasing the hydrocolloid concentration can increase the ability to form a three-dimensional mesh structure and capture water molecules in the matrix to increase the gel (Herawati, 2018). Carrageenan also has water-binding properties, so that the addition of carrageenan in the manufacture of jelly candy causes the free water in the product to decrease so that it can form a solid and compact gel structure (Chen et al., 2019). In addition, Akesowan (2015) stated that the higher concentration of carrageenan used could lead to an increase in total solids and a decrease in water content. Increasing total solids and decreasing water content can cause the distance between the particles to be smaller so that the attraction between the particles increases. The greater the attraction between the particles, the more compact the product is (Rochmah et al., 2019).

Gumminess of jelly candy

There was an interaction ($p < 0.05$) between the concentration and ratio of hydrocolloids to the gumminess of jelly candy, as displayed in Figure 3. *Gumminess* is the force required to oppose the direction of the probe force and is influenced by cohesion and adhesion forces (Kusumaningrum et al., 2016). Figure 3 shows that the higher the concentration of hydrocolloids in each ratio (2:1, 1:1, 1:2), the increased the gumminess value of the resulting jelly candy.



Note: Bars with different superscript letter indicated significant difference ($p < 0.05$)

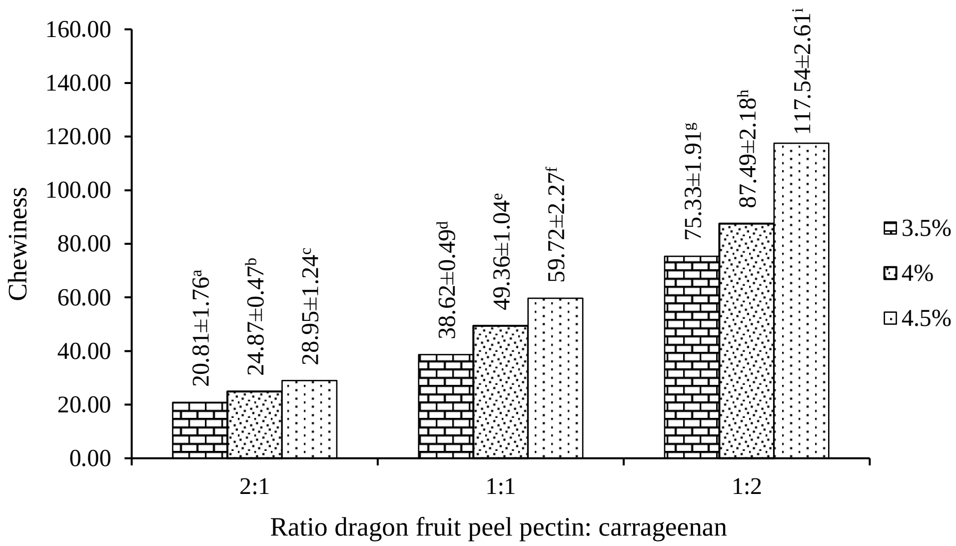
Figure 3. The effect of different ratio and concentration of hydrocolloid (red dragon fruit peel and carrageenan) toward gumminess of jelly candy

Hydrocolloids such as pectin and carrageenan are long-chain polymers that can form gel dispersions in water. The ability to form a gel in water due to the hydroxyl groups can increase the affinity for binding water molecules (Saha and Bhattacharya, 2010). Moreover, Utomo et al. (2014) stated that increasing the amount of carrageenan used in making jelly candy can also increase the strength of the gel produced. The higher the ratio of carrageenan can also increase the gumminess of jelly candy. Based on Kusumaningrum et al. (2016), the gumminess value of pumpkin jelly produced ranged from 29.30-98.78, which showed an increase in the gumminess value along with the increasing amount of hydrocolloid used. These previous studies were also coherent with the gumminess value obtained in this study.

The gumminess value is related to the gel's strength produced and directly proportional to the hardness value (Hurler et al., 2012; Yusof et al., 2019). The higher the hardness value, the higher the gumminess. The energy required to crush semi-solid food products until they are ready to be swallowed more significant when the resulting jelly has a higher hardness value (Kreungngern and Chaikham, 2016). The gumminess value of the jelly candy in this study was in line with the previous analysis of hardness, as displayed in Figure 1.

Chewiness of jelly candy

Chewiness determines the energy required to chew food until it is ready to be swallowed (Yusof et al., 2019). The statistical analysis results showed an interaction ($p < 0.05$) between the concentration and ratio of hydrocolloids to the chewiness of the jelly candy, as displayed in Figure 4.



Note: Bars with different superscript letter indicated significant difference ($p < 0.05$)

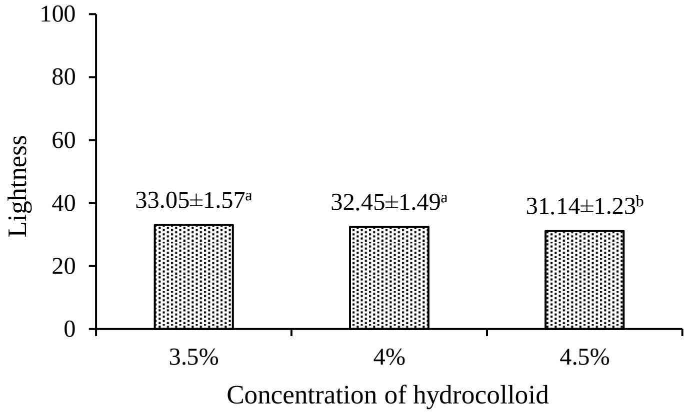
Figure 4. The effect of different ratio and concentration of hydrocolloid (red dragon fruit peel and carrageenan) toward chewiness of jelly candy

Figure 4 shows that the chewiness value produced is directly proportional to the increase in the concentration of hydrocolloids at ratios of 2:1, 1:1 and 1:2. Based on Habilla and Cheng (2015); Nhi et al. (2020), the elasticity and chewiness of the jelly candy increased along with the increase in the amount of hydrocolloid used. Based on De Avelar and Efraim (2020), low methoxyl pectin has a network structure with a large pore size. This network causes a decrease in the elasticity of the jelly candy produced; thus, in this study, the increasing ratio of pectin in the hydrocolloid mixture will produce jelly candy with a lower chewiness value. However, when the hydrocolloid concentration increased, the chewiness value increases. The carrageenan in the hydrocolloid mixture can help increase the chewiness of the jelly candy. Therefore, when the ratio of carrageenan is higher than pectin, the chewiness value will also increase.

Lightness of jelly candy

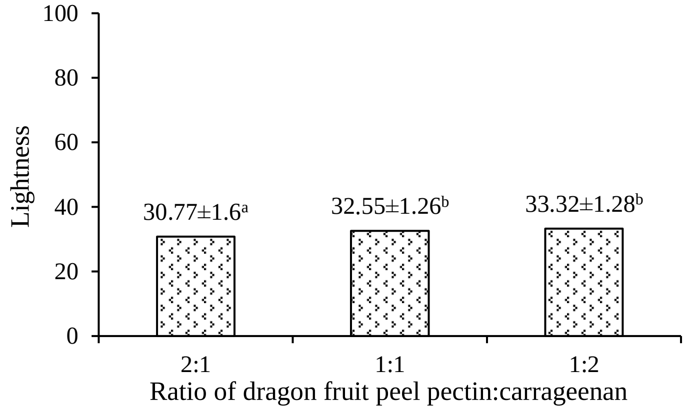
There was no interaction ($p > 0.05$) between the concentration and the ratio of pectin: carrageenan on the lightness of jelly candy. However, the concentration and ratio of pectin: carrageenan each had a significant effect ($p < 0.05$) on the lightness of the jelly candy. Thus, the data will show individually for each significant factor as shown in Figure 5 and Figure 6. Figure 5 shows that the lightness value produced is inversely correlated to an increase in hydrocolloids' concentration. The higher the lightness value, the higher the brightness of the resulting product (Pathare et al., 2013). Jelly candy made with 4.5% hydrocolloid mixture was darker than the addition of 3.5 and 4% hydrocolloid.

According to Rosida and Taqwa (2019), the lightness value of jelly candy decreases along with the increase in the concentration of carrageenan used. Lima et al. (2019) supported this, which shows that the higher the addition of hydrocolloid concentration will produce a darker orange jelly with a lightness value ranging from 29.09-30.84. The pectin produced in this study has a low lightness value (41.45±0.26). Therefore, the increase in the pectin ratio in the hydrocolloid mixture used can cause the lightness level of the candy to decrease, as shown in Figure 6. The lightness value of the jelly candy decreased significantly from 33.32±1.28 to 30.77±1.60 when the ratio pectin: carrageenan also increased from 1:2 to 2:1.



Note: Bars with different superscript letter indicated significant difference ($p < 0.05$)

Figure 5. The effect of different concentration of hydrocolloid (red dragon fruit peel and carrageenan) toward lightness of jelly candy



Note: Bars with different superscript letter indicated significant difference ($p < 0.05$)

Figure 6. The effect of different ratio of hydrocolloid (red dragon fruit peel and carrageenan) toward lightness of jelly candy

Chemical characteristics of jelly candy

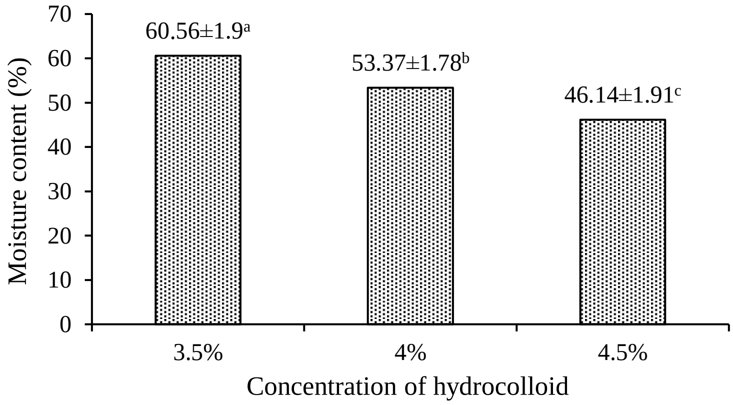
Moisture content is one of the crucial parameters in food products because it can affect the quality and determine shelf life (Lima et al., 2019). Thus, in this research, the moisture content was observed toward the jelly candy.

Moisture content of jelly candy

The statistical analysis results showed no interaction ($p < 0.05$) between the concentration and ratio of hydrocolloids to the moisture content of jelly candy. There was also no significant effect ($p > 0.05$) of different ratios on the moisture content of jelly candy. The moisture content values of jelly candy were 53.56±2.21%, 53.18%±2.24% and 53.31±1.39%, respectively for ratio 1:1, 1:2 and 2:1.

Figure 7 showed that the hydrocolloid concentrations significantly affect the moisture content of the jelly candy. The increase in the concentration of hydrocolloids used inversely correlated to the moisture content of the resulting jelly candy. However, there was significant effect ($p < 0.05$) of concentration on the cohesiveness of jelly candy; thus, only the data from the significant factor will show in the form of a graph in this discussion.

Pectin and carrageenan are polymers that can form gels so that they can capture water molecules in them. The gel formation can increase the viscosity and reduce the water content of a product (Akesowan., 2015; Herawati, 2018); therefore, the higher the concentration of pectin and carrageenan can reduce the moisture content of the jelly candy produced. This study used 37% sugar to make jelly candy, while Yuwidasari et al. (2019) use 60% sugar. The difference in sugar concentration also affects the moisture content produced, where the moisture content in this study is higher than that produced by Yuwidasari et al. (2019), which is 42.81%. The relatively low sugar concentration can also cause a decrease in binding water to the product (Lefsih et al., 2016; Marsigit, 2018).



Note: Bars with different superscript letter indicated significant difference ($p < 0.05$)

Figure 7. The effect of different concentration of hydrocolloid (red dragon fruit peel and carrageenan) toward moisture content of jelly candy

Based on Ergun et al. (2010), the decrease in moisture content can increase the product's hardness because the product's total solids increase. The water content results in this study were also in line with hardness results with a texture analyzer, as displayed in Figure 1. The higher the concentration of hydrocolloids, the lower the moisture content of the jelly candy, which caused the hardness value to increase. The hardness value of jelly candy made with 4% hydrocolloids consisting of pectin: carrageenan (1:2), was 303.01±13.62 g. When the hydrocolloid concentration increased to 4.5% at the same ratio, the hardness of jelly candy also increased to 421.59±7.94 g.

CONCLUSIONS

4.5% hydrocolloid consisting of pectin: carrageenan (1:2) was chosen as the best formulation of jelly candy. The resulting hardness value was 421.59±7.94 g, cohesiveness 0.39±0.01, gumminess 122.22±2.77, chewiness 117.54±2.61, lightness 32.39±0.16 and moisture content 45.83±2.68%. This research provides novelty in utilizing red dragon fruit peel waste into natural pectin to produce a value-added product. The combination of natural pectin from red dragon fruit peel with carrageenan also provides new insight into gelling agents used to produce jelly candy. This study also observed the effect of the treatments on the physicochemical characteristics of jelly candy produced. Sensory analysis toward all the formulation jelly candy could be carried out in further research to know the degree of acceptance of the panelists and degree of intensity of panelists toward specific sensory attributes to know the correlation between objective and subjective analyses.

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