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CHARACTERIZATION OF QUALITY ON PEDADA FRUIT JELLY CANDY (*Sonneratia caseolaris*) WITH DIFFERENT ADDITION OF CARRAGEENAN

Karakterisasi Mutu Permen Jeli Buah Pedada (*Sonneratia caseolaris*) Dengan Penambahan Karagenan Yang Berbeda

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ABSTRACT

Jelly candy is a type of confectionery classified as a soft candy. The main ingredients used in making jelly candy include fruit juice, sugar, citric acid, and gelling agents. Carrageenan is one of the substances used in candy production due to its ability to form gels. The addition of carrageenan at the right concentration will result in jelly candy with a firm texture. The aim of this study was to determine the effect of different addition of carrageenan on the quality characteristics of pedada fruit (*Sonneratia caseolaris*) jelly candy. This research used a Completely Randomized Design (CRD) with 4 treatments and 5 replications. The treatments were P0 (15 grams of gelatin), P1 (10 grams of carrageenan), P2 (15 grams of carrageenan), and P3 (20 grams of carrageenan). The results showed that the addition of carrageenan had an effect on the physical, chemical, microbiological, and organoleptic characteristics of pedada fruit jelly candy. The treatment with 15 gram of carrageenan produced the best jelly candy according to the Indonesian National Standard (SNI), with the value of gumminess 308.08 gf, hardness 773.49 gf, gel strength 220.75 gf/cm², water content 16.07%, ash content 2.61%, reducing sugar 13.68% and total plate count 1.6×10^2 cfu/gram

Keywords: Carrageenan, Food Security, Jelly Candy, Mangrove, Pedada

ABSTRAK

Permen jelly merupakan salah satu permen yang termasuk ke dalam jenis permen lunak. Bahan utama pembuatan permen jeli yaitu sari buah, gula, asam sitrat, dan bahan pembentuk gel. Karagenan merupakan salah satu bahan yang digunakan dalam pembuatan permen memiliki kemampuan sebagai pembentukan gel. Penambahan karagenan dengan konsentrasi yang tepat akan menghasilkan permen jeli dengan tekstur kokoh. Tujuan dari penelitian ini yaitu untuk mengetahui pengaruh penambahan karagenan yang berbeda terhadap karakteristik mutu permen jeli buah pedada. Penelitian ini menggunakan Rancangan Acak Lengkap (RAL)

dengan 4 perlakuan dan 5 ulangan. Perlakuan yang digunakan adalah P0 (gelatin 15 gram), P1 (karagenan 10 gram), P2 (karagenan 15 gram), dan P3 (karagenan 20 gram). Hasil penelitian menunjukkan bahwa penambahan karagenan terhadap permen jeli buah pedada memberikan pengaruh terhadap karakteristik fisik, kimia, mikrobiologi dan penilaian organoleptik. Perlakuan penambahan karagenan 15 gram merupakan permen jeli terbaik sesuai SNI dengan nilai *gumminess* 308,08 gf, *hardness* 773,49 gf, kekuatan gel 220,75 gf/cm^2, air 16,07%, abu 2,61%, gula reduksi 13,68%, nilai angka lempeng total sebesar 1,6×10^2 cfu/gram.

Kata Kunci: Karagenan, Ketahanan Pangan, Mangrove, Pedada, Permen Jelly

INTRODUCTION

Jelly candy is a type of soft candy that is liked by almost all age groups, especially children and teenagers. Jelly candy is popular because of its sweet taste and unique texture (Putri *et al*., 2015). Jelly candy has a chewier texture (not hard) compared to other types of candy, which reduces the risk of choking when consumed. The chewy texture also adds a sensation in the mouth when eaten. Another advantage of this candy is its higher cohesion compared to adhesion, meaning that jelly candy does not stick when eaten (Kusumaningrum *et al*., 2016). The main ingredients in the production of jelly candy are fruit juice, sugar, citric acid, and gelling agents. Almost all fruits can be used in making jelly candy, one of which is the pedada fruit. The pedada fruit has a sour taste and a distinctive aroma, resembling the astringent scent of young mangoes, mixed with pineapple and apple aromas, making it an appealing fruit (Alharanu *et al*., 2020). The juice of the pedada fruit is used as a component that provides the fruit flavor, color, and aroma in jelly candy. The nutritional content of the pedada fruit is very high, which helps improve the quality of the jelly candy. One of the factors affecting the quality of jelly candy is the gelling agent (hydrocolloid). Fully ripe pedada fruit contains 0.32% pectin, while the ideal pectin content for gel formation in jelly candy is 0.75-1.5% (Setiawan *et al*., 2016). The pectin from pedada fruit is not sufficient to create the texture of jelly candy, so it is necessary to add gelling agents to achieve the chewy product (Parnanto *et al*., 2016).

The most commonly used gelling agent in the production of jelly candy is gelatin. However, jelly candy made with gelatin has the disadvantage of producing a less chewy texture (Grace *et al*., 2021). The production of gelatin is predominantly sourced from pig skin (46%), cow skin (29.4%), a mixture of pig and cow bones (23.1%), and other sources (1.5%). This limits its use in the food industry, as its halal status is still questioned (Endang *et al*., 2020). One alternative gelling agent that can be used in the production of jelly candy, aside from gelatin, is carrageenan. Carrageenan is a product derived from the extraction of seaweed, which has the ability to stabilize texture, bind, emulsify, and form gels. The type of carrageenan used in this study is kappa carrageenan, which functions as a gelling agent in jelly candy (Rifani *et al*., 2016).

The addition of carrageenan can improve the texture and chewiness of jelly candy products. The concentration or volume of gelling agents and raw materials has a significant impact on the quality of the final product (Giyarto *et al*., 2020). The addition of carrageenan at the right concentration will result in jelly candy with a firm texture that is still easy to chew when eaten (Fajarini *et al*., 2018). This study was conducted to determine the quality characteristics of pedada fruit jelly candy with different concentrations of carrageenan and to identify the optimal concentration of carrageenan in the production of pedada fruit jelly candy.

RESEARCH METHODS

Time and Place

This research was conducted from January to June 2024 at the Food Laboratory and Chemistry Laboratory, located at the Faculty of Fisheries and Marine Sciences, Airlangga University, Surabaya.

Tools and materials

The tools used in this research includes knives, scales, stirrers, blenders, cheesecloth, funnels, filter paper, gas stoves, refrigerators, ovens, furnaces, porcelain crucibles, Erlenmeyer flasks, analytical balances, pipettes, volumetric flasks, burettes, stir bars, spoons, trays, gloves, containers, heaters, thermometers, stopwatches, texture analyzers, desiccators, petri dishes and moisture analyzers. The materials used in this research include pedada fruit (*Sonneratia caseolaris*), carrageenan, sorbitol, fructose syrup, citric acid, and water. The chemicals used include distilled water, hydrochloric acid, lead acetate, sodium thiosulfate, Luff-Schoorl solution, potassium iodide, sulfuric acid, sodium hydroxide, ammonium hydrogen phosphate, starch indicator, phenolphthalein indicator, and Plate Count Agar (PCA) medium.

Research Design

The method used in this research is an experimental method, which involves the production of pedada fruit jelly candy with the addition of carrageenan at different concentrations. The experimental design used is a Completely Randomized Design (CRD) with 4 treatments and 5 replications. The treatments refer to Sudaryati dan Jariyah (2017), are as follows:

P0 = Production of jelly candy with the addition of 15 grams of gelatin (Control)
P1 = Production of jelly candy with the addition of 10 grams of carrageenan
P2 = Production of jelly candy with the addition of 15 grams of carrageenan
P3 = Production of jelly candy with the addition of 20 grams of carrageenan

Production of jelly candy

The jelly candy production process refers to the study by Fitriani *et al*., (2020) with some modifications. 100 grams of fruit juice is mixed with 20 grams of fructose syrup, 30 grams of sorbitol, and gelling agents according to the treatment (15 grams of gelatin, 10 grams of carrageenan, 15 grams of carrageenan, and 20 grams of carrageenan). The mixture is then heated to 80ºC while stirring until it thickens. After the cooking process, 0.1 gram of citric acid is added. Once the mixture is evenly combined, the thick jelly candy liquid is immediately poured into molds measuring 23x12x1 cm, with each cube being 1 cm in size. The molds are left at room temperature for about 1 hour to solidify, then covered with aluminum foil and placed in a refrigerator at 5°C for 24 hours. Afterward, the jelly candy is taken out of the refrigerator and left at room temperature for 1 hour to allow the temperature to normalize. The jelly candy is then removed from the molds and dusted with powdered sugar as a coating. The pedada fruit jelly candy product is then subjected to testing. The addition of carrageenan in pedada fruit jelly candy can be seen in the Table 1.

Table 1. Formulation of Pedada Fruit Jelly Candy

Ingredients (Gram)	Treatments			
	P0	P1	P2	P3
Pedada fruit	100	100	100	100
Carrageenan	0	10	15	20
Gelatin	15	0	0	0
Fructose syrup	20	20	20	20
Sorbitol	30	30	30	30
Citric acid	0.1	0.1	0.1	0.1
Sugar	20	20	20	20
Total	185.1	180.1	185.1	190.1

Physical test

The physical tests conducted in this research included gel strength, texture profile, and yield. Gel strength testing was performed using a texture analyzer. Texture profile testing in this study included hardness and gumminess. This testing began with sample preparation, measuring 1.5 x 1.5 x 0.5 cm. Testing was performed using a TA-XT Plus Texture Analyzer with a 75 mm diameter cylindrical probe and a 30 kg load cell. The test speed was 2.0 mm/s and the length was 10 mm (Cheng *et al.,* 2011).

Chemical test

Chemical tests conducted in this research included water content, ash content, reducing sugar. Water content was determined using a moisture analyzer, referring to Nurhidayati (2021). Determination of ash content was carried out using the dry ash method, which refers to Laili (2019). Determination of reducing sugar levels was carried out using the Luff Schoorl method referring to Wulandari (2017).

Total Plate Count

The total plate count test conducted by weighing 1 gram of pre-ground jelly candy sample and placing it in a test tube containing 9 mL of physiological saline solution. The solution and sample are homogenized using a vortex mixer. A dilution of 10^{-5} is then made. Microbial analysis is performed by taking 1 mL of each dilution sample and placing it in a sterile Petri dish containing plate count agar (PCA) medium. The PCA medium containing the sample is then homogenized by rotating it in a figure-eight shape. The mixture is then allowed to solidify. The Petri dish is then placed in an incubator, in an inverted position. The incubation process is at 36 ± 1ºC for 24 hours (Sukmawati *et al.,* 2020).

Organoleptic

Organoleptic testing is a testing procedure that uses human senses such as smell, taste, and sight to assess the quality and safety of food products. Organoleptic testing plays a crucial role in product development, assessing changes, observing changes during storage, and providing product promotional data. The organoleptic assessment of jelly candy products includes appearance, aroma, taste, and texture using a scoring test using 35 panelists (Badan Standarisasi Nasional, 2006).

Data analysis

Quantitative data, such as gumminess, hardness, gel strength, water content, ash content, reducing sugar, and total plate count, were analyzed using a One-way ANOVA (Analysis of Variance) at a 95% confidence level. If the results indicate a significant difference ($P<0.05$), the Duncan Multiple Range Test (DMRT) was then performed to identify the differences

between treatments more specifically. For hedonic data, including organoleptic evaluations, the Kruskal-Wallis test was applied at the same 95% confidence level. If the Kruskal-Wallis test reveals a significant difference (P<0.05), the analysis is followed by the Mann-Whitney test to compare values across different groups and pinpoint the parameters with significant differences.

RESULTS

Physical Characteristics of Jelly Candy

The gumminess test is conducted to determine the force required to deform the pedada fruit jelly candy, making it ready to be swallowed. The hardness test is aimed at determining the property of the jelly candy that indicates its resistance to breaking under applied pressure. The gel strength test measures the amount of force required to break the pedada fruit jelly candy. The average result of the physical characteristics of Pedada fruit jelly candy can be seen in Table 2.

Table 2. Result of Physical Characteristics of Pedada Fruit Jelly Candy

Physical Characteristics	Result (Average ± Standard Deviation)			
	P0 (Control)	P1 (10 gram)	P2 (15 gram)	P3 (20 gram)
Gumminess (gf)	$210.45^{a} \pm 41.52$	$285.71^{b} \pm 21.20$	$308.68^{bc} \pm 9.66$	$337.53^{c} \pm 18.01$
Hardness (gf)	$617.86^{a} \pm 29.26$	$740.37^{b} \pm 25.68$	$773.49^{b} \pm 34.10$	$811.16^{c} \pm 19.88$
Gel strength (gf/cm^2)	$156.53^{a} \pm 9.19$	$202.07^{b} \pm 6.81$	$220.75^{c} \pm 7.40$	$253.55^{d} \pm 14.93$

The results of the physical characteristics test of pedada fruit jelly candy showed that the addition of carrageenan had a significant effect on the parameters of gumminess, hardness and gel strength. The gumminess value increased with the increase in carrageenan, where P0 (control) had the lowest value of 210.45±41.52 gf, while P3 had the highest value of 337.53±18.01 gf. Hardness also increased, from 617.86±29.26 gf at P0 to 811.16±19.88 gf at P3, indicating that jelly candy with carrageenan was harder. Meanwhile, the gel strength increased progressively from 156.53±9.19 gf/cm^2 at P0 to 253.55±14.93 gf/cm^2 at P3 indicating that pedada fruit jelly candy becomes chewier.

Chemical Characteristics of Jelly Candy

The chemical characteristics examined in this study include tests for moisture content, ash content, and reducing sugar content. The average results of the chemical characteristics of the pedada fruit jelly candy with the addition of carrageenan are presented in Table 3.

Table 3. Result of Chemical Characteristics of Pedada Fruit Jelly Candy

Chemical Characteristics	Result (Average ± Standard Deviation)			
	P0 (Control)	P1 (10 gram)	P2 (15 gram)	P3 (20 gram)
Water content (%)	$12.72^{a} \pm 1.46$	$19.49^{c} \pm 1.54$	$16.07^{b} \pm 0.61$	$14.86^{b} \pm 1.48$
Ash content (%)	$1.25^{a} \pm 0.13$	$1.97^{b} \pm 0.57$	$2.61^{c} \pm 0.38$	$3.11^{c} \pm 0.43$
Reducing sugar (%)	$8.98^{a} \pm 0.60$	$10.89^{c} \pm 0.61$	$13.68^{c} \pm 0.65$	$15.21^{d} \pm 0.77$

The results of the chemical characteristics test of pedada fruit jelly candy showed that the addition of carrageenan had a significant effect on the parameters of water, ash and reducing sugar content. The water content value decreased with the increase in carrageenan, where P0

(control) had the lowest value of 12.72±1.46%, while P1 had the highest value of 19.49±1.54%. Ash content value increased, from 1.25±0.13% at P0 to 3.11±0.43% at P3. Meanwhile, the reducing sugar increased progressively from 8.98±0.60% at P0 to 15.21±0.77% at P3 indicating that a high reducing sugar value indicates an increased breakdown of sucrose into simple sugars (glucose and fructose), which may occur due to heating processes or enzymatic reactions during product preparation. This also suggests that the product has a higher potential sweetness and may affect the chemical properties and sensory quality of the jelly candy

Total Plate Count

The Total Plate Count (TPC) test aims to determine the number of microorganisms or bacteria present in a substance by counting the bacterial colonies grown on agar media (Yunita *et al*., 2015). The average results of the Total Plate Count (TPC) for the pedada fruit jelly candy with the addition of carrageenan are presented in Table 4 below.

Table 4. Result of Total Plate Count on Pedada fruit Jelly Candy

Treatments	Result (Average ± Standard Deviation) Cfu/gram
Po (Control_	$2.76x10^{2} \pm 93.50^{c}$
P1 (10 gram)	$2.18x10^{2} \pm 38.34^{bc}$
P2 (15 gram)	$1.6x10^{2} \pm 72.37^{b}$
P3 (20 gram)	$7.0x10^{1} \pm 36.74^{a}$

The results showed that the total plate count in pedada fruit jelly candy with carrageenan addition in treatment P0 was not significantly different from P1, but was significantly different from P2 and P3. Treatment P1 and P2, according to the Duncan test, did not show a significant difference in microbial count between them, but both had significantly different effects compared to P0 and P3. Treatment P3 showed a significantly different effect compared to P0, P1, and P2. The addition of carrageenan in the jelly candy had the lowest microbiological activity in treatment P3 (20 grams of carrageenan), with a value of $7.0\times10^{1}\pm36.74$, while the highest microbiological activity was found in treatment P0 (control), with a value of $2.76\times10^{2}\pm93.50$.

Organoleptic of Jelly Candy

The organoleptic test includes the evaluation of appearance, taste, aroma, and texture. The organoleptic results for the pedada fruit jelly candy with the addition of carrageenan are shown in Table 5.

Table 5. Result of Organoleptics of Pedada Fruit Jelly Candy

Parameter	Result (Average ± Standard Deviation)			
	P0 (Control)	P1 (10 gram)	P2 (15 gram)	P3 (20 gram)
Appearance	$8.36^{a} \pm 0.60$	$7.64^{b} \pm 0.65$	$7.44^{b} \pm 0.72$	$5.28^{c} \pm 1.19$
Aroma	$7.42^{a} \pm 1.14$	$6.98^{b} \pm 0.99$	$6.76^{b} \pm 1.06$	$4.81^{c} \pm 0.98$
Taste	$4.77^{a} \pm 1.28$	$5.33^{b} \pm 0.98$	$7.71^{c} \pm 0.71$	$8.04^{d} \pm 0.62$
Texture	$5.07^{a} \pm 1.38$	$4.45^{b} \pm 0.89$	$6.67^{c} \pm 1.29$	$7.34^{d} \pm 0.79$

The average organoleptic scores of pedada fruit jelly candy with the addition of carrageenan showed the highest values for appearance and aroma parameters in treatment P0 (Control), while the lowest scores were found in treatment P3 (20 grams of carrageenan). On the other hand, the highest average organoleptic scores for taste and texture were obtained in treatment P3 (20 grams of carrageenan), whereas the lowest scores were recorded in treatment P0 (Control).

DISCUSSION

Physical properties of the jelly candy were observed using a specialized instrument for measuring texture in food materials such as gumminess, hardness, elasticity, and other characteristics. Texture profile is one of the key quality parameters for jelly candies. The gumminess test results for the pedada fruit jelly candy value is 210.45 – 337.53 gf. There was an increase in gumminess values with the addition of carrageenan concentration as the gelling agent in the pedada fruit jelly. This is consistent with Haryati's (2020) study, which stated that higher concentrations reduce moisture content, thus increasing gumminess or chewiness, as carrageenan has the property of binding water. Carrageenan has thickening properties; when added to food, it increases viscosity and reduces moisture content (Putra *et al*., 2015). The hardness test results for the pedada fruit jelly candy showed variable values 617.86 - 811.16 gf. The increase in carrageenan concentration resulted in higher hardness values for the pedada fruit jelly candy. This is because the kappa carrageenan used has a rigid and firm gel property. The gel formed by carrageenan also has a solid structure (Kusumaningrum *et al*., 2016). Jelly candies made with gelatin have softer physical properties compared to those made with kappa carrageenan (Atmaka *et al*., 2013). The gel strength test results for the pedada fruit jelly candy showed varying values 156.53 - 253.55 gf. The higher the concentration of carrageenan added, the greater the gel strength of the pedada fruit jelly candy. This is because carrageenan has the ability to form a gel as the hot solution cools. The gelation process is thermoreversible, meaning the gel can melt when heated and re-gel when cooled (Zainuddin, 2016). Gel strength can also be influenced by the amount of water present in the jelly. The addition of gelling agents reduces the free water content in the jelly, as water is absorbed into the molecular structure (Suseno, 2013).

The water content in pedada fruit jelly decreases as the concentration of carrageenan increases. This is because carrageenan acts as a thickening agent with the ability to bind water. As the concentration of carrageenan added to food increases, the amount of solids in the product increases, leading to a reduction in water content. This is in line with research by Sari *et al*. (2016), which states that higher carrageenan concentrations enhance the gel matrix bonds and reduce the hollow structure. The stronger the gel matrix bonds, the more water is bound, and the less free water remains, reducing water evaporation and leading to lower moisture content in the product. The water content in the pedada fruit jelly from this study meets the quality standard (SNI 3547-2-2008) for jelly candy, which specifies a maximum of 20%. The ash content in pedada fruit jelly increases with the higher concentration of carrageenan added during production. This is because carrageenan contains a relatively high amount of minerals. It is rich in minerals such as Na, Ca, K, Cl, Mg, Fe, S, and iodine, which contribute to the ash content. This finding aligns with research by Fajarini *et al*. (2018), which indicates that the mineral content in carrageenan can reach 10.47%. Carrageenan is capable of forming a three-dimensional network that can trap minerals in the jelly, helping to retain the mineral content. In this study, the jelly was made using pedada fruit juice, which has an ash content of 0.32% (Dari *et al*., 2020). The ash content of pedada fruit jelly in treatments P0, P1, and P2 meets the quality standard (SNI 3547-2-2008) for jelly candy, which specifies a maximum ash content of 3%. The reducing sugar content increases with the addition of higher concentrations of carrageenan. This is because the structure of carrageenan contains galactan molecules, primarily composed of galactose units, which have reactive and reducing hydroxyl (OH) groups at the ends of their structure. Therefore, as the concentration of carrageenan increases, the number of reducing groups also increases, leading to a rise in the resulting reducing sugars (Haryati, 2020). The reducing sugar content changes due to various factors, one of which is heating. The heating process causes chemical structural changes, such as the breakdown of glycosidic bonds. This breakdown allows non-reducing sugars (like sucrose) to be converted into reducing sugars such as glucose and fructose (Sonya *et al*., 2021).

The microbial count of the pedada fruit jelly decreases as the concentration of carrageenan added increases during the jelly production process. This is because carrageenan is a polysaccharide compound with antibacterial properties (Tejakusuma, 2015). This finding is in line with the research by Haryati *et al*. (2018), which states that the phytochemical test of the *Kappaphycus alvarezii* seaweed extract contains compounds such as flavonoids, alkaloids, terpenoids, saponins, and tannins, which are suspected to have antibacterial activity. The results of this study show that the microbial count remains within tolerable limits, meaning the product is still safe for consumption, as it is below the maximum allowable microbial contamination for jelly, which is set by SNI 3547-2-2008 at a maximum of $5x10^4$ CFU/g.

Organoleptic testing refers to evaluating food products based on personal preferences and sensory attributes. Also known as sensory or sensory perception testing, it involves using human senses as the primary tools to assess the acceptance of a product. The organoleptic test for pedada fruit jelly includes aspects such as appearance, aroma, taste, and texture. The preference for the appearance parameter decreases as the concentration of carrageenan increases. This is because carrageenan, a complex mixture of polysaccharides, causes the jelly to lose its bright color and appear dull when exposed to heat. The reduction in carrageenan levels strengthens the aroma of the fruit, as carrageenan has a characteristic fishy odor (Giyarto *et al*., 2020). The taste preference decreases with higher concentrations of carrageenan. The jelly with lower carrageenan content is preferred by the panelists due to its sweet and slightly acidic taste, while higher concentrations are associated with a more acidic flavor. Sorbitol and high fructose syrup (HFS) contribute to the sweetness, while the acidity comes from pedada fruit juice and citric acid. The jelly in this study contained the same amounts of sorbitol, HFS, and citric acid. As the concentration of carrageenan increases, the jelly tends to have a stronger sweetness, likely because the higher gelation effects of carrageenan mask some of the flavors (Setiawati and Sari, 2020). The texture parameter is also affected by the increasing concentration of carrageenan. A higher water content can impact the texture, making the jelly softer. The addition of carrageenan to pedada fruit jelly has a significant impact on its gumminess, as higher concentrations of carrageenan result in a firmer texture (Fajarini *et al*., 2018).

CONCLUSION

There is an effect of carrageenan concentration on the quality of pedada fruit jelly candy, including its physical, chemical, microbiological, and organoleptic characteristics. The optimal addition of carrageenan is 15 grams, which produced the best jelly candy characteristics in accordance with Indonesian National Standards (SNI), with the value of gumminess 308.08 gf, hardness 773.49 gf, gel strength 220.75 gf/cm², water content 16.07%, ash content 2.61%, reducing sugar 13.68% and total plate count 1.6×10^2 cfu/gram.

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