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Effect of Gelatin and Iota-Caragenan (*Eucheuma spinosum*) on the Quality of Green Cincau (*Premna oblongifolia* Merr) Jelly

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ABSTRACT

Green cincau (Premna oblogifolia Merr*) can form gel, but it is fragile and easily syneresis, so gelatine is needed as another gel-forming material. However, the addition of gelatine with high concentration causes hard texture, therefore iota carrageenan as an alternative gel-forming material is substituted. The purpose of this study was to determine proper ratio of gelatine and iota-carrageenan concentrations for the quality of green grass jelly products. The experiment was arranged in completely randomized design (CRD) with 5 ratios of Gelatine to Iota Carrageenan, namely P1 (10%:0%), P2 (7%:3%), P3 (5%:5%), P4 (3%:7%) and P5 (0%:10%). Data was analyzed using ANOVA followed by HSD test at α = 0.05 for texture test, water content, ash content, antioxidant activity value, and organoleptic test. Results showed that the best treatment for green cincau jelly was treatment P3 with gel strength at* hardness *parameters of 2200.23 gf,* springiness *0.96%, chewiness 1911.30 gf, and* gumminess *2111.98 gf due to the interaction between gelatine and iota carrageenan. The water content was 47.28%, ash content was 1.06%, antioxidant content was 374.83 ppm, hedonic values for all parameters were in the range of 4 (taste) and 5 (colour, aroma, texture) and the results of the number of yeast molds <1×10² colonies/ml.*

1. INTRODUCTION

Jelly is a ready-to-consume product resulting from the mixing of gelling ingredients and the addition of sugar, with or without the addition of other permitted food ingredients (BSN, 2018). In jelly products, texture is a physical parameter that is very much considered. The texture of jelly products is influenced by gelling agents such as pectin, carrageenan, gelatin, and others that can be used to modify the texture of jelly so that it produces a chewy product that is liked by consumers (Mahardika, 2014). One of the gel-forming ingredients that is rich in pectin is green grass (*Premna oblogifolia* Merr), locally called green *cincau*.

Green cincau has the ability to form a gel because of low methoxyl pectin (LMP) content as the main composition. The pectin in green cincau is a gelling hydrocolloid group and is included as the source of dietary fiber. The content of pectin compounds contained in 100 g of green cincau leaves is 15.2% (Rachmawati *et al*., 2010). In *vitro* and *in vivo* studies have revealed that green cincau extract has an antioxidant capacity (Chalid, 2007) and is safe for consumption. One of the weaknesses of green cincau jelly gel is that it easily experiences syneresis which occurs because the water in the grass jelly extract is only mobilized mechanically, which shows the nature of free water that can be removed (Prangdimurti, 2014). In addition, the simple manufacturing process without the addition of other food ingredients causes the gel texture to be less sturdy (Widiana, 2019). In order to minimize the occurrence of syneresis, it is necessary to add other gel-forming ingredients such as gelatin.

Gelatin is added as a gelling agent, and dominates as a gelling agent in jelly products. Gelatin is a biopolymer that is often used in the food and pharmaceutical industries. In general, gelatin is a substance obtained by extracting collagen

from cartilage or the skin of animals, such as cattle, fish, and pigs (Endang *et al*., 2020). This causes weaknesses in the application of gelatin because most commercial gelatin is still imported so that the price is expensive and often doubts its halalness. In addition, too much gelatin can also cause the texture of the jelly to become hard (Prihardhani & Yunianta, 2016). Based on the weakness of the use of gelatin in jelly products, it is necessary to substitute alternative gel-forming ingredients that are less or even have no negative effects on health and also have a lot of availability in Indonesia. Recommended gelling ingredients include agar, xanthan gum, pectin, and carrageenan.

Carrageenan is a polysaccharide compound extracted from seaweed. The addition of carrageenan to food products functions as a *stabilizer*, thickener, and gel. Some food products with the addition of carrageenan as a composition include processed fish meat products (Nanda *et al*., 2023), jelly candy (Rismandari *et al*., 2017), and ice cream (Fatoni *et al.,* 2016). Iota-carrageenan derived from the seaweed *Eucheuma spinosum* is abundantly available in Indonesia and tends to increase every year, but its utilization is not yet optimal. In 2022, Indonesian seaweed production reached 9.28 million tons, with *Eucheuma spinosum* being one of the dominant species (Ditjen PDSPKP, 2023). In addition, iota-carrageenan was also chosen because of the elastic, clear and non-synerestic properties of the gel. Unlike kappa-carrageenan with its rigid gel properties, it is brittle and easily subjected to syneresis (Tasende & Manriquez-Hernandez, 2016).

The addition of iota-carrageenan in the formulation of green cincau jelly products is expected to improve the quality characteristics and functional properties of the product. The formulation of gelatin and iota carrageenan in the manufacture of green cincau jelly products has never been carried out. This combination of hydrocolloids has the potential to produce a unique jelly texture that is better than using each ingredient alone due to the interaction between different molecules, but there has been no specific research on the synergistic effects between pectin in cincau, gelatin, and iota carrageenan directly. Thus, this study aims to determine the exact comparison of gelatin and iota-carrageenan concentrations to the quality of green cincau jelly products.

2. RESEARCH MATERIALS AND METHODS

2.1. Place and Time of Research

Preliminary research included preparation of green cincau jelly and organoleptic testing that were carried out at the Food Laboratory of PT Symrise Indonesia. Chemical testing including moisture content, antioxidant capacity was carried out at the Food Processing Laboratory of Sahid University. The microbiology test of mold and khamir (yeast) number was carried out at the Microbiology Laboratory of Sahid University. Product texture testing including hardness, springiness, chewiness, and gumminess was carried out at the LAPTIAB BRIN Puspitek Agroindustry and Biomedical Laboratory. Ash content was analyzed at the iLaB and BRIN Cibinong Tissue Culture Laboratory.

2.2. Materials and Tools

The tools used in the manufacture of green cincau jelly products included glassware, stainless steel pan, electric stove, analytical balance (Mettler Toledo), blower oven (WTC Binder), and Fomac miller (FCT-Z300 type). Meanwhile, the tools used to analyze jelly products included furnace, desiccant, spectrophotometers (Hitachi type U-1 lo), incubator (WTC Binder), autoclave, microbiology pipettes, spirit burners, test tubes, and TA Texture Analyzers.

The materials used in making green cincau jelly products included green cincau leaves obtained from Bekasi, West Java, cow gelatin (HAYS FOOD) bought online, iota carrageenan (Indonesia Handmade), granulated sugar, bottled drinking water, $CaCl_2$ powder, and citric acid powder. The chemicals used for analyzing green cincau jelly products included DPPH (2,2-diphenyl-1-picrylhydrazyl) and methanol, as well as PDA (Potato Dextrose Agar) media and peptone solution.

2.3. Design of Experiment

The experiment was arranged in a completely randomized design with 5 different formulations of gelatin to iota carrageenan ratios, namely P1 (10%:0%), P2 (7%:3%), P3 (5%:5%), P4 (3%:7%), and P5 (0%:10%). Table 1 detailed the formulations evaluated during this experiment. All treatments were repeated three times.

Table 1. Formulation of green cincau jelly products in 100 g of dough

Formula	Green Cincau Extract (g)	Gelatin (g)	Iota Carrageenan (g)	Sucrose (g)	Citric acid (g)	Water (g)	Cincau Flavour (g)
P1	39.4	10	0	35	0.5	15	0.1
P2	39.4	7	3	35	0.5	15	0.1
P3	39.4	5	5	35	0.5	15	0.1
P4	39.4	3	7	35	0.5	15	0.1
P5	39.4	0	10	35	0.5	15	0.1

The measurements consisted of the quality of green cincau jelly products in term of rheological quality (hardness, springiness, chewiness, and gumminess), chemical quality (moisture content, ash content, and antioxidant activity), sensory quality (hedonic and quality score), and microbiological supporting tests of mold and yeast numbers. The collected data was analyzed using ANOVA. If there is a significant influence of each formulation, the analysis was continued by Duncan Multiple Range Test (DMRT) at $\alpha = 5\%$.

2.4. Research Stages

2.4.1. Preliminary Research

Preliminary research was conducted to determine the optimal concentration of gelatin used in the main study. Rusli & Ayu (2018) found gelatin concentration of 10% is optimal to form a good gel of singi juice jelly candy. During preliminary research, green cincau jelly was prepared using gelatin concentration of 9, 10, and 11%. The hedonic test covering color and texture parameters was conducted on 15 semi-trained panelists. The hedonic score was divided into 6 scales, namely 1-2 for very dislike, 2-3 for dislike, 3-4 for slightly dislike, 4-5 for slightly like, 5-6 for like, and >6 for very like. Based on the hedonic test results during the preliminary test, it was concluded that the average gelatin concentration of 10% obtained the highest hedonic scores, namely 5 (like) on color and 5.06 (like) on texture parameters. Jellies with a gelatin concentration of 9% produce a very soft texture, whereas at a gelatin concentration of 11% produce too hard texture. Therefore, a gelatin concentration of 10% was used in the main study.

2.4.2. Main Research

The production of green cincau jelly begins with the manufacture of green cincau powder (Figure 1) and dried extract of green cincau (Figure 2) which refers to research Rizal *et al.* (2019), then the process of making green cincau jelly products (Figure 3) referring to Koswara (2008).

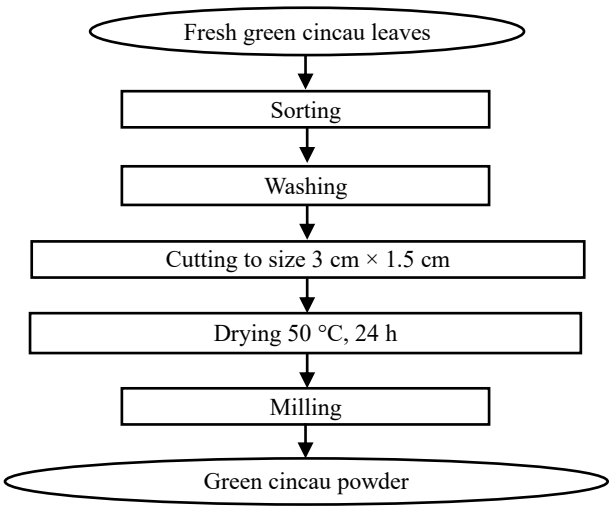

Figure 1. Flow diagram for making green cincau powder (Rizal *et al*., 2019)

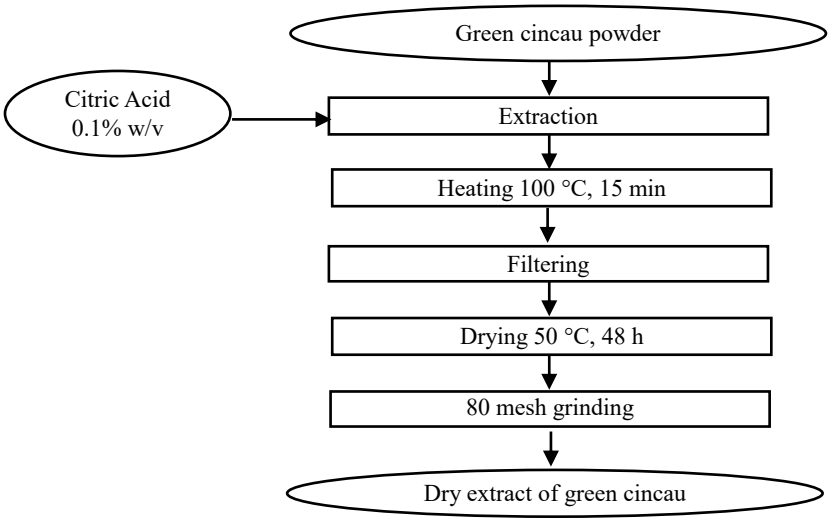

Figure 2. Flowchart of making dried extract of green cincau (Rizal *et al*., 2019)

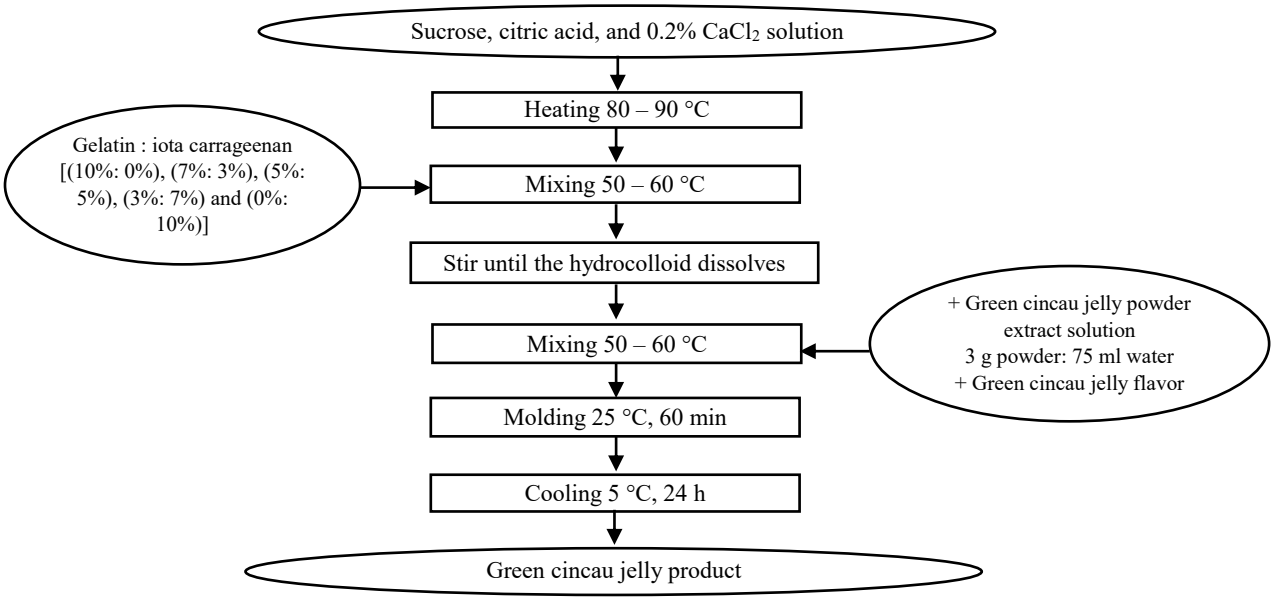

Figure 3. A modified flow chart of the manufacture of green cincau jelly products (Koswara, 2008)

The initial stage of making green cincau jelly products was carried out by sorting green cincau leaves to obtain uniform and appropriate quality. The cincau leaves must be fresh and light green to dark green in color. The green cincau leaves were washed, dried, and cut to the desired size of 3×1.5 cm, then dried with a blower oven, and ground to get green cincau leaf powder. Next, the powder was extracted and dried.

Green cincau jelly production began with a mixture of sucrose, citric acid, and $CaCl_2$ 0.2% solution which was heated until the entire crystal dissolved. Then, put gelatin and iota carrageenan into it and stirred until homogeneous, characterized by the absence of clumps of gelatin and iota carrageenan. Next, the dried extract of green cincau was dissolved in water at ratio of 1:25, the solution was put into the mixture of gelatin and iota carrageenan, and cincau flavor was added and stirred until homogeneous. The mixture was cooked for a few moments, then molded and cooled

at room temperature until the jelly dough hardens and the jelly was stored in the refrigerator. The use of dried green cincau extract in the formulation of green cincau jelly products gives rise to an unpleasant (*langu*) aroma in the resulted product. The more grass jelly extract added, the lower the level of acceptance of the aroma (Widaronia, 2017). Whereas, the addition of iota carrageenan also gives a fishy aroma that can affect the organoleptic profile of the product. Iota carrageenan gives a distinctive sea fishy aroma because the seaweed *Euchemma spinosum* contains amine or ammonia compounds that have a distinctive pungent odor (Keyimu & Abdullah, 2014). The more substitution of iota carrageenan concentration in the formulation, the stronger the fishy aroma produced. Therefore, synthetic flavoring of green cincau jelly is added to disguise the unpleasant and fishy aroma.

2.5. Green Cincau Jelly Product Test Parameters

2.5.1. Rheological Quality (Texture) (Shrilakshmi, 2020)

The texture of jelly products was measured using *Texture Profile Analyzer* (TPA) with the working principle of measuring the durability of the product due to the application of compressive force from the tool through the probe to the sample or the ability of the sample to return to the initial condition after applying pressure to the sample using a cylindrical probe. The texture parameters measured in this study included hardness, springiness, chewiness, and gumminess.

2.5.2. Moisture Content (AOAC, 2012)

Moisture content was determined using a gravimetric method. Around 10 g of samples were heated in oven at temperature of 100 °C for approximately 8 h, and then cooled in a desiccator. Moisture content (MC) was calculated from the following relation:

$$MC = \frac{(W_i - W_f)}{W_i} \times 100\% \quad (1)$$

where W_i is initial sample weight, and W_f is final weight of the sample.

2.5.3. Ash Levels (AOAC, 2012)

Oven dry sample was put into a porcelain cup and then burnt in a furnace at temperature of 600 °C for 2 hours. Ash content (*Ash*) was calculated from the weight of oven dry sample (W_0) and ash (W_{ash}) using following relation:

$$Ash = \frac{W_{ash}}{W_0} \times 100\% \quad (1)$$

2.5.4. Antioxidant Activity with DPPH Method (Jiao *et al.* 2012)

A total of 2µL of samples was put into the test tube and then 2 ml of DPPH (Sigma-Aldrich) 0.2 µM in ethanol was added, then vortexed. The solution was left to sit for 30 min in a dark room. The solution was measured with a UV-Vis Spectrophotometer with a 517 nm wave propagation. As a blank, a sample and non-standard DPPH solution was used. For standard curves, ascorbic acid with a graded concentration was used. The antioxidant activity is expressed as % scavenging against DPPH.

2.5.5. Organoleptic Analysis (SNI ISO 11056:2021)

Organoleptic analysis includes hedonic tests and hedonic quality tests consisting of scales of 1 – 6. Then the test was carried out by 30 untrained panelists by assessing the parameters of color preferences, aroma, taste, and texture.

2.5.6. Mold and Yeast Numbers (SNI 3547.2-2008)

Mold and yeast analysis was carried out by putting 1 ml of sample into a petri dish which was then poured with *Potato Dextrose Agar* (PDA) media. Incubation is carried out at a temperature of 25°C for 3-5 days. After incubation, the number of mold and yeast colonies is calculated by calculating the average number of colonies and multiplying by the dilution factor. The mold and yeast number was expressed as the number of colony per gram (CFU/g).

3. RESULTS AND DISCUSSION

3.1. Rheological Quality Analysis

Texture analysis of green cincau jelly products was carried out using the Texture Profile Analyzer (TPA). The texture parameters tested consisted of hardness, springiness, chewiness, and gumminess. The following are the average values of the parameters of hardness, springiness, chewiness, and gumminess of green cincau jelly products with gelatin and iota carrageenan formulations in Table 2. Based on the ANOVA results, the ratio of gelatin to iota carrageenan significantly affected all texture parameters of green cincau jelly products with a *p*-value <0.05. Furthermore, the DMRT results at the α = 0.05 level concluded that the P3 formulation (5% gelatin, 5% iota) produced the highest values for the hardness, springiness, and gumminess parameters, while the highest value for the chewiness parameter was produced by the P2 formulation (3% gelatin, 7% iota).

Table 2. Table of average values *of* hardness, springiness, chewiness, and gumminess of green cincau jelly products

Treatment	Average value			
	Hardness (gf)	Chewiness (gf)	Gumminess (gf)	Springiness *(%)*
P1 (10% gelatin : 0% iota)	2039.49^{d}	1331.92^{d}	1970.62^{d}	0.68^{b}
P2 (7% gelatin: 3% iota)	1407.88^{c}	992.17^{c}	1355.14^{c}	0.73^{c}
P3 (5% gelatin: 5% iota)	2200.23^{e}	1911.30^{e}	2111.98^{e}	0.91^{d}
P4 (3% gelatin: 7% iota)	1288.80^{b}	855.64^{b}	893.71^{b}	0.96^{e}
P5 (0% gelatin: 10% iota)	-2.84^{a}	-1.14^{a}	-1.87^{a}	0.62^{a}

Note = different superscript letters stating that there is a significant difference according to DMRT at α = 0.05.

Hardness is the maximum force needed to penetrate to a certain depth, and therefore influence the strength of the gel (Srilakshmi, 2020). The hardness values obtained in the study ranged from -2.84 gf to 2200.23 gf. These results align with Rusli & Ayu (2018), which found that adding high concentrations of gelatin to jelly candy products resulted in a hard texture. According to Tiara (2014), gelatin and iota carrageenan have distinct characteristics in producing gel textures. Anggraini *et al*. (2012) added that high gelatin concentrations can produce stiff gels. A parameter that is close to hardness is chewiness, which is the energy needed to chew food (Chandra & Shamasundar, 2015). The chewiness values resulted in this study ranged from -1.14 gf to 1911.30 gf. Meanwhile, gumminess value is the ability needed to chew a jelly product until it is ready to be swallowed. The value of gumminess reflect the energy required to break down or destroy the structure of the jelly gel. The value of gumminess produced in the study ranged from -1.87 gf to 2111.98 gf. Springiness or elasticity is the ability of a jelly product to return to its original state (bouncy) after getting pressure (Srilakshmi, 2020). The springiness value can be expressed as the ratio between the recovery distance to the maximum deformation distance (Putri, 2022). The springiness values in our study ranged from 0.62% – 0.96%. The value of chewiness, springiness, and gumminess decreases with the increase of iota carrageenan. According to Tasende & Manriquez-Hernandez (2016), increase in iota carrageenan resulted in a soft and elastic gel.

3.2. Chemical Quality Analysis

Table 3 summarizes chemical quality of cincau jelly in terms of moisture and ash content, as well as inhibition and antioxidant values.

Table 3. Average value of green cincau jelly product with gelatin and iota carrageenan *formulation*

Formulation	Moisture Content (%)	Ash Content (%)	Inhibition Value (%)	Antioxidant value IC_{50} (ppm)
P1 (10% gelatin : 0% iota)	48.21^{bc}	0.20^{a}	17.53	722.82^{e}
P2 (7% gelatin: 3% iota)	48.02^{b}	**1.06^{b}**	25.54	533.07^{d}
P3 (5% gelatin: 5% iota)	48.45^{c}	1.72^{c}	22.83	485.94^{c}
P4 (3% gelatin: 7% iota)	48.80^{d}	1.74^{c}	25.51	437.39^{b}
P5 (0% gelatin: 10% iota)	**47.28^{a}**	3.06^{d}	**29.25**	**374.83^{a}**

Note = superscript letters in the notation field stating that there is a real difference (α = 0.05)

3.2.1. Moisture Content

Table 3 presents the effect of formulation treatment on the water content of cincau jelly products. Although the ANOVA results show that the gelatin and iota carrageenan formulations have a significant effect (p-value < 0.05) on the water content of green cincau jelly, the water content is very close in the range of 47.28% - 48.80%. The national standard SNI 3552:2018 regarding hydrocolloid jelly products does not include a water content limit for jelly products. However, the SNI 3552:2018 defines jelly products as products with a gel or semi-liquid texture that indicates a high water content. According to Rahmi *et al*. (2012), the high water content of jelly products is caused by the substance in the material containing too much water or very low dissolved solids, resulting in a weak consistency. Too low a gel-forming consistency causes the material tissue to be unable to hold the liquid, causing the jelly product to experience syneresis and result in a high water content.

3.2.2. Ash Content

The ash content of grass jelly produced in the study ranged from 0.20% - 3.06%. Based on the results of the ANOVA test, the gelatin and iota carrageenan formulations showed a significant effect (p-value <0.05) on the ash content parameters of green grass jelly products. Table 3 shows that the addition of gelatin concentration reduced the ash content of grass jelly. The quality requirements for ash content in jelly products vary depending on the type of jelly. In jelly candy products in SNI 3547-2-2008, it is regulated that the maximum ash content is 3.0% which when compared with the ash content of the research results is still within the permitted limits except for sample P5 (without gelatin) with an ash content of 3.06%. It can be seen from the results of the study that the higher ash content of jelly products is caused by the increasing number of iota carrageenan substitutions added to the formulation. According to Diharmi, (2015), carrageenan contains the minerals potassium (5.05%), sodium (0.6%), magnesium (0.55%) and potassium (1.69%) so that the combination of gelatin and iota carrageenan can increase the ash content of the product.

3.2.3. Antioxidant activity

The average percentage of inhibition and antioxidant activity in green cincau jelly products with gelatin and iota carrageenan formulations can be seen in Table 3. Based on the results of the antioxidant activity test, the average IC_{50} value was 374.83 - 722.82 ppm, with the inhibition % obtained ranging from 17.53 - 29.25%. According to Tristantini (2016), the lower the IC_{50}, the higher the antioxidant activity. The P5 sample of green cincau jelly products had the highest antioxidant value compared to other treatments even though the antioxidant activity was relatively weak (IC_{50} = 374.83 ppm). This can be caused by several drying and heating processes in the manufacture of green cincau jelly. According to Mahmudatussa'adah (2014), antioxidant activity has unstable properties, especially to heat. Increasing temperature and heating time during product processing, will decrease the antioxidant activity.

3.3. Sensory Tests

3.3.1. Hedonic Preferences

Figure 4 shows the score of the sensory attributes (color, aroma, taste, and texture). The color score of the green cincau jelly ranges from 2.40 (dislike) to 4.59 (like). Sample P3 (5% gelatin, 5% carrageenan) results in favorite color with a score of 4.59 (slightly like) to 5 (like). Meanwhile, the for aroma ranges from 3.07 (slightly disliked) to 5.38 (like). The cincau jelly P1 (10% gelatin, 0% carrageenan) results in the most preferred aroma with hedonic value 5.38 (like). The hedonic quality test for taste of green cincau jelly products resulted in score of 2.04 (dislike) 4.76 (slightly like). The P2 sample (7% gelatin, 3% carrageenan) provided the most preferred taste by panelists with hedonic score 4.76 (slightly like). Meanwhile, the hedonic quality for texture attribute of the green cincau jelly products shows a wider range of 1.39 (very dislikes) to 5.09 (like). The green cincau jelly product with the panelist's most preferred taste was found in the P3 sample with hedonic score 5.09 (like). Based on the ANOVA results, hedonic data including color, aroma, taste, and texture were obtained that the formulation of gelatin and iota carrageenan showed a significant influence on the hedonic quality of green cincau jelly products with a p-value < 0.05. From Figure 4 we can see that increasing gelatin concentration resulted in a decrease preferences for aroma and taste. For color and texture attributes, increasing gelatin concentration was followed by an increase in color and texture preference, reaching a maximum score at a concentration of 5%. Further increases in gelatin concentration resulted in a decrease in the color and texture scores for green cincau jelly.

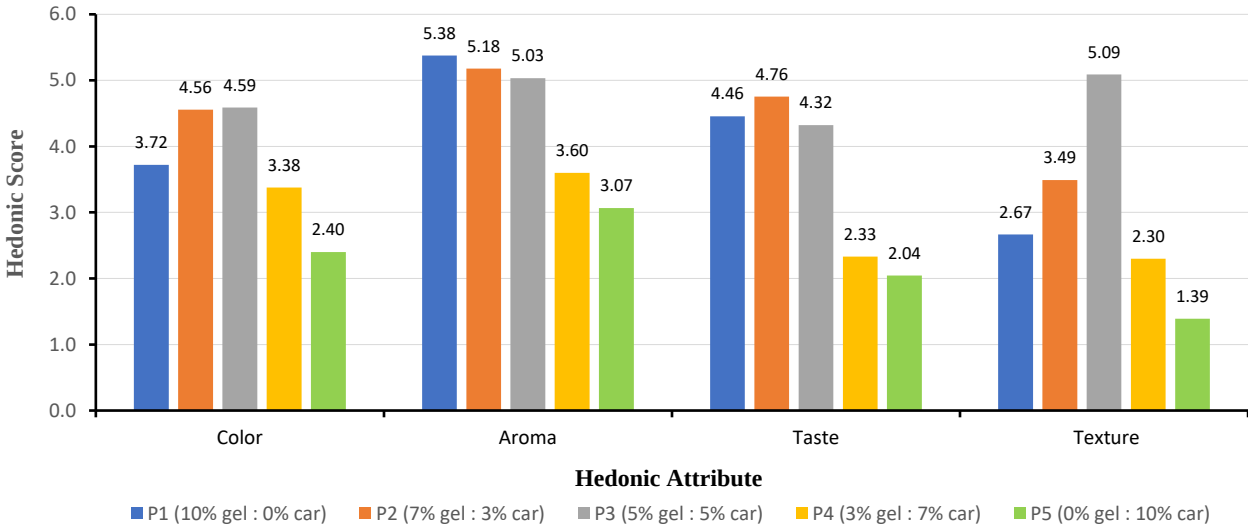

Figure 4. Spider web for hedonic score of green cincau jelly products

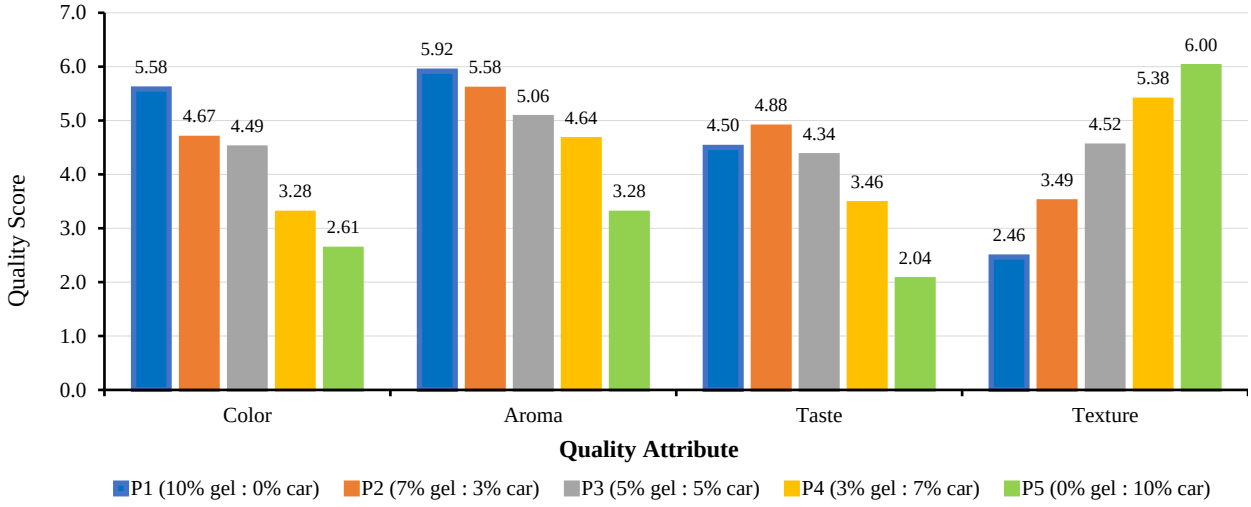

Figure 5. Spider web for quality score of green cincau jelly products

3.3.2. Quality Score

Figure 5 shows quality score in term of sensory attributes (color, aroma, taste, and texture). The color quality score of green cincau jelly is in the range of 2.61 (slightly light green and slightly cloudy) to 5.58 (very clear dark green). The color change of green cincau jelly from clear, very dark green to slightly light green and somewhat cloudy occurs along with the increase in the concentration of iota carrageenan in the green cincau jelly product formulation. For the aroma attribute, the quality score of the green grass jelly product ranges from 3.28 (slightly odorless cincau jelly) to 5.92 (very odorous cincau jelly). Iota carrageenan gives a distinctive fishy sea aroma when dissolved because *Euchemma spinosum* seaweed contains amine or ammonia compounds consisting of nitrogen and hydrogen elements that have a distinctive pungent odor (Keyimu & Abdullah, 2014). The more substitution of iota carrageenan concentration in the formulation, the stronger the fishy aroma produced. This certainly has an impact on the hedonic assessment of aroma, so the addition of green cincau flavor to the formulation is expected to disguise the fishy aroma. The taste quality score of the green cincau jelly product ranges from 2.04 (not tasty) to 4.88 (tasty). The addition of iota carrageenan in the formulation of green cincau jelly caused a slightly fishy taste even though the addition of cincau flavor has been done to help disguising the fishy taste. The texture quality score of green cincau jelly products ranges from 2.46 (hard) to 6.00 (melting or soft).

The addition of iota carrageenan in the formulation of jelly products will produce an elastic but soft gel. According to Tiara (2014), the combination of gelatin and carrageenan produces a variety of textures considering the different characteristics of carrageenan and gelatin in producing gel textures. Based on the results of ANOVA of quality score data for color, aroma, taste, and texture, it was found that the ratio of gelatin to iota carrageenan showed a significant effect on the hedonic quality of green cincau jelly with a *p*-value <0.05. From Figure 5, it is clear that increasing the concentration of gelatin in the formulation of green cincau jelly results in the decrease of quality score for the attributes of color, aroma, taste. However, increasing the gelatin concentration resulted in an increase of the quality score for texture of green cincau jelly.

3.4. Microbiological Quality

The calculation of mold and yeast numbers as a supporting test was only carried out on the best treatment of green cincau jelly products, namely P3 treatment (5% gelatin: 5% iota carrageenan). Mold and yeast number is important to determine the shelf life of the product. The shelf life of this green cincau jelly product is influenced by several things such as the physical or chemical properties of the product, packaging and the environment. Based on the analysis of microbial contamination with three replications, mold and yeast numbers in green cincau jelly products were obtained in average of 0.7 colony/g. This shows that the value of mold and yeast of green cincau jelly products is within the national standard formulated in SNI 3552:2018 (BSN, 2018) with a maximum value of 1×10^2 colonies/g.

4. CONCLUSION

Based on the results of the research that has been conducted, it can be concluded that the ratio of gelatin to iota carrageenan has a significant effect (p-value < 0.05) on the characteristics and quality of green grass jelly products as indicated by differences in the test values of texture parameters (hardness, springiness, chewiness, and gumminess), water content, ash content, antioxidant activity, and organoleptic (hedonic preference level and quality score) for the attributes of color, aroma, taste, and texture. Based on physical, chemical, and organoleptic quality tests, the formulation of 5% gelatin and 5% iota carrageenan produced the best green grass jelly product with a texture value of 2200.23 gf hardness, 0.91% springiness, 1911.30 gf chewiness, 2111.98 gf gumminess, 48.45% water content, 1.72% ash content, IC50 antioxidant activity of 374.83 µg/mL, hedonic quality values are in the range of 4-5 (slightly like), and quality scores on color attributes 4.49 (slightly dark green), aroma 5.06 (fragrant cincau jelly), taste 4.34 (slightly delicious), texture 4.52 (chewy). The results of microbiological tests produced a yeast mold number value of $<1\times10^2$ colonies/g.

Based on the research findings, the 5% gelatin and 5% iota carrageenan formulation can be recommended as a standard in the production of green grass jelly. To maintain product quality and consistency, further research is needed to analyze the influence of the quality and source of gelatin, iota carrageenan, and green grass jelly on the final product characteristics. Furthermore, it is also important to conduct stability tests to determine the shelf life of the green grass jelly product with the best formulation under various storage conditions to determine the expiration date and appropriate storage recommendations.

AUTHOR CONTRIBUTION STATEMENT

Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
JAR	✓	✓		✓				✓		✓		✓	✓	✓
APA		✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓

C: Conceptualization
M: Methodology
So: Software
Va: Validation
Fo: Formal Analysis
I: Investigation
D: Data Curation
R: Resources
O: Writing - Original Draft
E: Writing - Review & Editing
Vi: Visualization
Su: Supervision
Fu: Funding Acquisition
P: Project Administration

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