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Submission date: 05-Jan-2021 10:53AM (UTC+0700)
Submission ID: 1483158237
File name: 3.2.Daun_Dewa_Gynura_Pseudochina_Lour_Dc_Jelly.pdf (453.79K)
Word count: 5003
Character count: 25194

International Journal of Eco-Innovation in Science and Engineering Vol 01 (2), 2020 (12-19)
https://ijeise.upnjatim.ac.id/ E-ISSN: 2721-8775

Article

Daun Dewa (*Gynura Pseudochina (Lour) Dc*) Jelly Candy Making with Addition of Gelling Agents (Alginate, Carrageenan, And Gum Arabic) in Various Concentrations

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Received: 12th October 2020; Revised: 27th October 2020; Accepted: 30th November 2020;
Available online: 1th December 2020; Published regularly: October 2020.

Abstract

Jelly candy is generally made from fruit juice with some hydrocolloid addition in order to the gelling formation. The characteristic of jelly candy is a clear and transparent appearance with chewiness in texture. To increase its functional value, jelly candy can be added with various ingredients, for example, the extract of Daun Dewa (*Gynura Pseudochina (Lour) Dc*). Daun Dewa (*Gynura Pseudochina (Lour) Dc*) contains some active components such as alkaloids, flavonoids, essential oils, saponins, and steroids, triterpenoids, and tannins, where these compounds show antioxidant activity. One parameter on jelly candy making was the gelling formation influenced by the hydrocolloid or gelling agent's existence. Some gelling agent that has been used in commercial jelly candy-like alginate, carrageenan and Gum Arabic. The combination of those gelling agents with various concentrations would give the different characteristics of jelly candy. This study aimed to observe the characteristic of jelly candy with the addition of gelling agents and determine the best treatment that most liked by the panelists. The concentration of gelling agents used in this study was 0, 2.5%, 5%, 7.5%, and 10% (w/v) with a single factor of Simple Completely Randomized Design (CRD). The data analyzed using ANOVA. Based on the result, the best treatment of Daun Dewa jelly candy was made with the addition of 7.5% carrageenan and 2.5% gum Arabic that has moisture content value of 16.742%, ash content 0.685%, reducing sugar 20.273%, total phenol 11.078 mg TAE / gr, pH 4.27, gel strength 46.3788 N, antioxidant 32.536%, and sensory evaluation covering 4.96 for color, 4.28 for aroma, 4.60 for texture, and 4.88 for taste.

Keywords: alginate, carrageenan, daun dewa, gum Arabic, jelly.

1. Introduction

Jelly candy is made from fruit juice and hydrocolloid material, which has a clear, transparent appearance and has a texture with a certain chewiness. The addition of preservatives is needed to extend the shelf life [1]. Jelly candy generally has a soft texture and easy to cut but is also stiff enough to maintain its shape, not sticky, not slimy, smooth, and soft [2]. Jelly candy is a semi-wet food that can last for 6 to 8 months when placed in a jar and up to 1 year [3].

Some commercial jelly candy is often added with certain compounds such as multivitamins and another specific component to increase their functional value. Indonesia is one of the countries with biodiversity that has many health benefits; one of them is Daun Dewa. Daun Dewa (*Gynura Pseudochina (Lour) Dc*) is one of the Indonesian medicinal plants that has been widely

DOI:10.4186/ijeise.upnjatim.ac.id/E-ISSN: 2721-8775

for the treatment of various diseases such as cancer, fever (antipyretics), diabetes, high blood pressure, and skin diseases (external medicine) [4]. Daun Dewa (*Gynura Pseudochina (Lour) Dc*) was reported to contain active components of alkaloids, flavonoids, essential oils, saponins, steroids, triterpenoids, and tannins. The flavonoid compound that has been isolated from Daun Dewa (*Gynura Pseudochina (Lour) Dc*) was quercetin 3,7-O-di-glycoside [5]. According to [6], other compounds found in Daun Dewa (*Gynura Pseudochina (Lour) Dc*) include alkaloids, tannins, and polyphenols.

Some ingredients used in jelly candy manufacturing are sucrose, glucose syrup, citric acid, and gelling agents such as alginate, carrageenan, and gum Arabic. The addition of sucrose in jelly candy making has a function to provide a sweet taste and be a preservative. A high sucrose concentration will inhibit microorganisms' growth by reducing water activity in the food system [1]. The sucrose amount should not be more than 65%, so crystal formation on the gel surface can be prevented. On the other hand, the addition of glucose syrup can increase the candy's viscosity, so it remains less sticky.

Citric acid gives a sour and fresh taste and prevents sugar crystallization by lowering the acidity or pH. The amount of citric acid added to jelly candy from 0.2-0.3%. The presence of acid has functioned as a jelly candy stabilizer. If the acidity is low, the jelly candy will not firm and crush easily because the pectin is dehydrated appropriately. Contrary, if the acidity is too high, the jelly candy will out of shape due to pectin hydrolysis [7].

Another factor that influences jelly candy making is the gelling agent's addition. The most common gelling agents used in jelly candy are gum Arabic, carrageenan, and alginate. Gum Arabic is used to improve viscosity, to form the texture of food. Alginate is a polysaccharide obtained from brown seaweed extraction such as *Sargassum sp*. and *Turbinaria sp*. Alginate is composed of D-mannuronic acid and L-guluronic acid groups, which can absorb water very well and are strong by forming a thick gel or solution [8]. Carrageenan is a polysaccharide composed of D-galactose and L-galactose 3,6 anhydrous-galactose units linked by 1-4 glycosidic bonds. Each galactose unit binds to a sulfate group.

The ratio concentration of the gelling agents would give jelly candy with specific characteristics. [9] explains that the best treatment of red dragon fruit jelly candy obtained with a ratio of carrageenan: gum Arabic= 10.0: 0.5 and it had a moisture content of 30.48%, an ash content of 2.50%, reducing sugar content of 22.70%, a pH of 5.3, and overall sensory assessment favoured by the panelist. The results of [10] research showed that the best treatment of ginger extract jelly candy was the combination of the 41.50% ginger extract and 7.5% carrageenan. Simultaneously, [11] stated that jelly candy with 10 % brown seaweed extract (alginate) concentration showed total phenol of 36 mg GAE / gr, antioxidant IC50 2.7 ppm, perception by panelists of its color 3.34, taste 3.30, aroma 1.66, and texture 3.58.

Based on the earlier experiments, the type of gelling agents and their concentration contributing to jelly candy characteristics. This study aimed to obtain jelly candy that had the best characteristic with the addition of some gelling agents in various ratio concentrations of 0, 2.5, 5, 7.5, and 10% whether in single used or combination used. Some parameters observed on jelly candy making were moisture content, ash content, reducing sugar, pH, gel strength, antioxidant activity, total phenol, and panelists' preference level.

2. Material and Method

2.1. Material

Daun Dewa (*Gynura Pseudochina (Lour) Dc*) used in this research was fresh leaves from Diwek, Jombang. The gelling agent used were carrageenan, gum Arabic, alginate, sugar, glucose syrup, citric acid, water, and castor sugar.

The materials used for analysis were distilled water, DPPH solution (Sigma), Folin ciocalteu (Merck), methanol (Merck), ethanol (Merck), tannic acid (Merck), Nelson A, Nelson B, arsenomolybdate reagent, standard glucose solution (Merck), and Na2CO3 (Merck).

2.2. Method

2.2.1. Extraction of Daun Dewa (*Gynura Pseudochina (Lour) Dc*)

DOI:10.4186/ijeise.upnjatim.ac.id/E-ISSN: 2721-8775

Daun Dewa (*Gynura Pseudochina (Lour) Dc*) was sorted and washed with water, and then it blanched with steam for 3 minutes. The steam blanched Daun Dewa was crushed with water (1:1) and then filtered to separate the extract and the cake. The extract would be used in jelly candy making.

Table 1. Concentration of Gelling Agent

Formulation (F)	Gelling Agent		
	Alginate	Carragee-nan	Gum Arabic
1	10	0	0
2	7.5	2.5	0
3	5	5	0
4	7.5	0	2.5
5	5	0	5
6	0	10	0
7	2.5	7.5	0
8	0	7.5	2.5
9	0	5	5
10	0	0	10
11	0	2.5	7.5
12	2.5	0	7.5

2.2.2. Jelly Candy Making

The extract of Daun Dewa was heated with glucose (40% w/v) and sucrose syrup (40% v/v), stirred. After the ingredients were dissolved, gelling agents were added according to the treatment ratio (Table 1) and heated for 5 minutes. The dough was poured into the tray and cooled at room temperature for 1 hour before it cooled in the refrigerator for 12 hours. It had to be dried in the cabinet dryer for 8 hours at 600C before it was cut into 2x2 cm.

Jelly candy analyzed for moisture content with dry oven method [12], ash content [12], reducing sugar (nelson-somogy) [13], pH with pH-meter [14], gel strength with tensile strength [13], antioxidant activity with DPPH method [15], Total Phenol [15] and sensory testing by panelists with parameters of color, taste, and aroma [16].

3. Results and Discussion

3.1. Water content

The moisture content of the Daun Dewa (*Gynura Pseudochina (Lour) Dc*) jelly candy was 11.40% - 19.68%, as was seen in Table 2. F12 showed the highest water content value of 19.68%, while F1 showed the lowest water content value, namely 11.40%. The high water content that showed in F 12 was due to the gum Arabic and alginate interaction, which could increase the viscosity of alginate, where the higher viscosity would increase the water trapped in the hydrocolloid tissue and causing the water challenging to evaporate [17]. F2 used a higher concentration of alginate than carrageenan, which caused its viscosity to lower. It made the water's bonding to alginate became lower, and water quickly to evaporate [18].

Jelly candy with single gelling agent addition showed the highest water content on F10 and the lowest water content on F1. [19] explained that gum Arabic was composed of proteins with covalent bonds which have hydrophilic amino and hydroxyl groups, that could form hydrogen bonds with one or more water molecules. It makes gum Arabic could absorb water and hold it in the molecular structure. Contrary to gum Arabic, alginate has a high syneresis ability that makes the water not completely trapped in the alginate.

Table 2. Water Content and Ash of Jelly Candy

Form (F)	Water Content (%)	Ash Content (%)	pH
1	11.41 ± 0.242a	1,85 ± 0.019h	4.93 ± 0.058g
2	12.54 ± 0.216b	1.72 ± 0.030i	4.83 ± 0.058f
3	14.14± 0.118c	1.37 ± 0.109g	4.27 ± 0.058c
4	15.49 ± 0.401d	1.35 ± 0.038g	4.73 ± 0.058e
5	15.66 ± 0.441d	1.03 ± 0.013e	4.57 ± 0.058d
6	15.71 ± 0.089d	1.23 ± 0.050f	5.10 ± 0.100h
7	16.46 ± 0.281e	1,49 ± 0.107h	4.67 ± 0.058d
8	16.74 ± 0.268e	0.69 ± 0.054c	4.27 ± 0.058c
9	17.70 ± 0.412f	0.84 ± 0.077d	4.13 ± 0.058b
10	18.59 ± 0.077g	0.08 ± 0.058a	4.73 ± 0.058e

DOI:10.4186/ijeise.upnjatim.ac.id/E-ISSN: 2721-8775

11	18.59 ± 0.351g	0,48 ± 0,022[b]	3.90 ± 0.100a
12	19.68 ± 0.285h	0,50 ± 0,015[b]	4.53 ± 0.058d

3.2. Ash content

Table 2 showed that F1 had the highest ash content of 1.85%, while F10 had the lowest ash content of 0.09%. These phenomena caused the alginate used in this study was sodium alginate. [20] stated that common sodium alginate had an ash content of 19.76%. In comparison, gum Arabic had an ash content of 3.4%, and also it contains 1117 mg of calcium, 292 mg of magnesium, and 2 mg of iron in every 100 grams of Gum Arabic [21].

Jelly candy that used a combination of gelling agents showed the highest ash content on F2 and the lowest ash content on F11. The high content of ash that showed on F2 was due to the high mineral content in seaweed used for sodium alginate as raw material [20]. Meanwhile, a small amount of ash on F11 was due to the low mineral content of Gum Arabic [21].

3.3. PH value

Table 2 showed the pH value 20 jelly candy. F6 had the highest average pH value of 5.10, while F11 had the lowest average pH value of 3.90. The low pH value in F11 occurred because of the synergistic interaction between carrageenan and Gum Arabic, resulting in a bond to the active OH- group. The group will react with citric acid, which causes a decrease in the acidity [22].

Meanwhile, the high pH in F2 was due to the high pH value of the alginate and carrageenan used that caused the jelly candy's pH to get higher. [23] stated that carrageenan has a pH value of 8.02. [20] established a quality standard for the pH value of sodium alginate in the food industry, 7.20.

Jelly candy with only carrageenan addition F6 showed the highest pH. It was caused the pH of carrageenan was classified as alkaline to increase the Daun Dewa jelly candy's pH. [24] stated that the higher addition of carrageenan, causing an increasing pH value. Meanwhile, Daun Dewa jelly candy with the lowest pH was found in the gum Arabic F10. It was caused by gum Arabic that has a low pH value, ranged from 3.9 to 4.9. The higher amount of Gum Arabic concentration used, the lower pH showed in the result.

3.4. Gel Strength

Table 3. Gel Strength and Reducing Sugar of Jelly candy

Form (F)	Gel Strength (N)	Reducing Sugar (%)
1	38,83 ± 0.803d	21,22 ± 0.174f
2	32.95 ± 0.430a	23.64 ± 0.286h
3	38.35 ± 0.074d	24,78 ± 0.174i
4	39.86 ± 0.065e	22.39 ± 0.347g
5	39,83 ± 0.009e	19,25 ± 0.114d
6	57.59 ± 0.258h	23,42 ± 0.347h
7	43.22± 0.292f	16,83 ± 0.174b
8	46.38 ± 0.398g	20.27 ± 0.227e
9	35.67 ± 0.437c	17.77 ± 0.114c
10	53.52 ± 0.072i	19.17 ± 0.174d
11	35.0 ± 0.051b	24.36 ± 0.227i
12	50,57 ± 0,513h	16.41 ± 0.227a

The combination of gelling agents' addition showed the highest gel strength on F8 and the lowest gel strength on F2. The presence of a 3,6-Anhydrous-D-galactose group in kappa-carrageenan can form a high double helix structure [25], resulting in high gel strength on F8. Meanwhile, the low gel strength in the F2 was since sodium alginate has poor stability in water binding resulting in low viscosity [17].

The carrageenan individually showed the highest gel strength, as seen at F6. This phenomenon was because carrageenan able to bind water well. The addition of a large amount of carrageenan, causing the bonding of water and carrageenan becomes strong, the gel's strength increases, and the product's texture becomes firm.

On the other hand, the jelly candy with single gelling agent addition showed the lowest gel strength on F1. The use of alginate independently as a thickener causing low viscosity. Alginate's ability to bind water was low; the water was not wholly trapped to the alginate's tissue, resulting in the thinner gel. Besides, the ability of binding water to alginate was influenced by the number of carboxylate ions, where a large number of carboxylate ions causing binding of

water increases. Increased binding of water can produce a sturdy jelly candy.

3.5. Reducing Sugar

Reducing sugar of jelly candy ranged from 16.41% - 24.78%. F3 showed reducing sugar was 24.78%, while F12 had the lowest point, 16.41%. The combination of hydrocolloid in F3 resulted in the highest reducing sugar, which was influenced by the high carbohydrate content in carrageenan (61.25%), and the content of galactose units [26]. F12 showed the lowest reducing sugar. It was influenced by gum Arabic that contains 2.1% arabinose, 9.9% rhamnose, 4.1% galactose, and glucuronic acid 9, 4% (Qi et al., 2009). Galactose in gum Arabic is low, so it does not increase the reducing sugar jelly candy significantly.

Daun Dewa jelly candy with single addition of gelling agent, F6, showed the highest reducing sugar. It was because carrageenan is a linear polysaccharide and contains galactan molecules with central units being galactose [19]. Carrageenan has a carbohydrate content of 61.25% [26]. On the other hand, jelly candy with gum Arabic addition F10 showed the lowest reducing sugar. The presence of reducing sugar content in gum Arabic with a small percentage causes gum Arabic to increase the reducing sugar levels of the Daun Dewa jelly candy significantly. [27] explained that using gum Arabic in large amount in making snake fruit jelly candy affected lower reducing sugar.

3.6. Antioxidant Levels

Table 3 showed the antioxidant activity of jelly candy. F9 showed the highest antioxidant activity of 36.39%, while F2 had the lowest antioxidant activity of 23.51%. The combination of hydrocolloids resulted in the highest antioxidant activity of F9, and F2 resulted in the smallest antioxidant activity. The high antioxidant activity of F9 was due to the interaction of carrageenan with gum Arabic, which could form a strong skin layer that can protect phenolic compounds from the heating process [28]. According to [29], the antioxidant activity of *E. cottonii* was 67.63%. [30] reported that *E. cottonii* seaweed contains active compounds, including flavonoids, triterpenoids, steroids, and alkaloids. Meanwhile, the low antioxidant activity in the F2 was due to the low viscosity of sodium alginate, which made the shell-less strong. Therefore, the core material becomes less protected and it was causing many components to evaporate during the heating process [31].

Table 4. Antioxidant Activity and Total Phenol of Jelly Candy

Form (F)	Antioxidants Activity (%)	Total Phenol (mg TAE/gr)
1	24,57 ± 0.230b	6.78 ± 0.051c
2	23.51 ± 0.398a	5,48 ± 0.051a
3	24,44 ± 0.230b	6,21 ± 0.069b
4	26.29 ± 0.399c	7.52 ± 0.051d
5	27.36 ± 0.230d	9,21 ± 0.069g
6	27,49 ± 0.398d	9,52 ± 0.051h
7	27,22 ± 0.608d	8.88 ± 0.051f
8	32,54 ± 0.230e	11.08 ± 0.051j
9	36.39 ± 0.230f	14.88 ± 0.051l
10	36.25 ± 0.398f	13.78 ± 0.051k
11	32.40 ± 0.230e	10.88 ± 0.051i
12	27.09 ± 0.690d	8,08 ± 0.051e

The antioxidant of Daun Dewa's extract in this study was 50.59%, and it showed degradation of some antioxidants such as phenolic compounds for about 15-25% during the heating process in jelly making [32]. The component that has responsibility for the antioxidant ability of jelly candy was Daun Dewa's extract itself. According to Rivai (2012), Daun Dewa (*Gynura pseudochina (Lour) DC*) have the antioxidant activity of 87.32% by the methanol extraction method. Daun Dewa has potential as an antioxidant due to the content of phenolic compounds. Flavonoids are the largest group of phenolic compounds.

3.7. Total Phenol Content

The total phenol of jelly candy ranged from 5,48 mg TAE/gr - 14,88 mg TAE/gr. F9 showed the highest total phenol of 14,88 mg TAE/gr, while F2 showed the lowest total phenol of 5,48 mg TAE/gr. The combination hydrocolloids resulted in F9 with the highest total phenol, and F2 showed the lowest total phenol. The high total phenol in F9 was due to carrageenan interaction with gum Arabic, which can form a

firm layer that protects phenolic compounds from the heating process [28]. According to Zakaria et al. (2017) that the total phenol of *E. cottonii* seaweed is 1.88 mg GAE/gr, where *E. cottonii* seaweed is the raw material for making carrageenan. F2 using a higher concentration of that made the consistency of the jelly candy were low. Therefore, the layer formed was not strong enough to protect phenolic compounds that changed by heating [31].

The total phenol also affects the antioxidant activity of a product. High contain phenolic compounds that show as total phenol indicates high antioxidants activity of the product [33]. The phenolic compounds of Daun Dewa (*Gynura pseudochina (Lour) DC*) could be identified as Quercetin 3,7-O-di-glycosides (Qi et al., 2009), 3,5-di-caffeoylquinic acid, 4,5-di-caffeoylquinic acid, and 5- mono-caffeoylquinic acid [34]. Quercetin is the largest flavonol group compound believed to protect the body from several types of degenerative diseases by preventing the oxidation of lipid, where the ability to prevent it is done by capturing free radicals.

3.8. Sensory Evaluation

Table 5. Sensory Evaluation of Jelly Candy

Formulation(F)	Color	Aroma	Texture	Taste
1	3.88	3.92	4.36	2.48
2	5.44	3.84	3.36	2.60
3	4.28	4.24	4.04	3.96
4	4.16	4.16	3.96	2.48
5	3.72	4.16	3.96	3.60
6	5.16	4.12	3.88	5,52
7	4.20	4.12	3.88	4.92
8	4.96	4.28	4.60	4.88
9	3.20	3.92	3.68	3.96
10	5.16	3.92	4.20	2.32
11	3.68	3.92	3.08	3.04
12	3.84	3.92	3.36	2.96

Color was a crucial physical parameter of a food product and plays a vital role in food acceptance [35]. Table 5 showed panelists' level of preference for the color of Daun Dewa jelly candy. The addition of 7.5% alginate and 2.5% carrageenan (F2) was most liked by the panelists, while the addition of 5% carrageenan and 5% gum Arabic (F9) showed the lowest score on panelist's preference.

The aroma was one parameter that became a determinant of the delicacy of the food. The aroma could define as panelists can be observed with the sense of smell. Table 5 showed F8 had the highest preference level according to the most liked by the panelists, while F2 had the lowest preference level among most panelists.

Another parameter observed for the jelly candy was the texture. The texture is one of the characteristics of food products, which was crucial in influencing consumers' acceptance of food products. Table 4 showed that F8 had the highest level of preference according to the panelists, and F11 had the lowest preference.

The taste was the most crucial parameter in testing food. Generally, food ingredients have a plain taste, but the combination of various kinds of flavours would raise a real food taste. Table 4 showed F6 had the highest level of preference according to the panelists, which means the panelists most liked it. Contrary, F10 showed the lowest preference; in other words, it was most disliked by the panelist.

DOI:10.4186/ijeise.upnjatim.ac.id/E-ISSN: 2721-8775

4. Conclusion

A food ingredient's quality can be determined based on three characteristics, chemical, physical, and sensory. Sensory factors mostly determine acceptance of food or products because they are directly related to consumer preference [36]. The parameters were needed for decision analysis, such as moisture content, ash content, reducing sugar, total phenol, pH, gel strength, and antioxidant activity. Simultaneously, the quality aspects of the sensory evaluation include color, aroma, texture, and taste.

The best treatment of Daun Dewa jelly candy was F8 with c7.5% carrageenan gel and 2.5% gum Arabic. The results of some parameter that have been observed were water content 16.74%, ash content 0.68%, reducing sugar 20.27%, total phenol 11.0778 mg TAE / gr, pH 4.27, gel strength 46.38 N, antioxidants 32.54%, and sensory evaluation total score were 18.72 with each parameter score for color 4.96, aroma 4.28, texture 4.60, and taste 4.88.

Aknowledgement

This work was supported by LPPM Universtitas Pembangunan Nasional "Veteran" Jawa Timur, budgeting year 2020.

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3.2. Daun Dewa (Gynura Pseudochina (Lour) Dc) Jelly Candy Making with Addition of Gelling Agents (Alginate, Carrageenan, And Gum Arabic) in Various Concentrations

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