



Characteristics of Thin Candy from Green Seaweed *Caulerpa* sp

Dina Fransiska, Nurhayati, Agusman, Nugraha Rizky Dwi Putranto, Heru Sumaryanto, Sugeng Heri Suseno

Abstract: *Caulerpa* sp. is green seaweed living in shallow waters that have a source of fiber to be processed into various products. *Caulerpa* sp. which is rich in fiber has the potential to be processed thin candy food products. This study aims to determine the best formulation of thin candy with comparative treatment of seaweed to water, analyze the physical and chemical characteristics, as well as the content of food fiber and analyze microbial and metal contamination in the best formulation based on preference tests. The results of the study on the best treatment obtained from the test of preference is the comparative treatment of water and *Caulerpa* sp. 1: 3. Ratio of *Caulerpa* sp. and water in thin candy affects the color, ash content, protein, reducing sugar, and food fiber. Thin candy seaweed *Caulerpa* sp. contain food fiber.

Keywords: Seaweed, *Caulerpa* sp., film strips, food fiber

I. INTRODUCTION

Seaweed is one of the marine plants that are classified as benthic macroalgae that live attached to the bottom of the water or substrate (1). Seaweed is an aquatic commodity that is widely used or a superior commodity in its processing. Seaweed is widely used as medicine, food, and raw materials for industry. Seaweed also contains antioxidants, and secondary metabolites that are very beneficial for the health of the human body. Some examples of processed products made from seaweed are candy, carrageenan, agar, seaweed nuggets, and beauty products.

Seaweed *Sargassum* sp. can be processed into jelly candy. Candy jelly with the addition of seaweed filtrate *Sargassum* sp. have an average total fiber is 40.99% - 51.85%. The fiber contained in jelly candy with the addition of seaweed filtrate has increased from the control jelly candy (2). *Eucheuma cottonii* seaweed can be used as functional food preparation. *Eucheuma cottonii* seaweed processed products are seaweed nuggets that are low in fat and have high protein and fiber. Seaweed nuggets can also be

consumed by people with diabetes, heart disease, or hypercholesterolemia (3). Research by (4) is to use *Eucheuma cottonii* seaweed as an instant powder drink. The levels of fiber produced in this study ranged from 5.25-11.83%. These results indicate that the value of the product fiber content produced is significantly affected by the comparison of sugar formulations and flavor ingredients. One of the seaweed processing that is still rarely done is seaweed of *Caulerpa* sp.

Caulerpa sp. or sea grapes are green seaweed that lives in shallow and calm waters. *Caulerpa* sp. still widely consumed in fresh and dried form which is used as a vegetable. *Caulerpa* sp. can also produce secondary metabolites in the form of antioxidants. The results of the chemical analysis of fresh sea grapes based on (5) are water content $76.47 \pm 0.09\%$, ash content of $1.33 \pm 0.12\%$, protein content of $3.58 \pm 0.14\%$, fat content of $0.35 \pm 0.04\%$, and carbohydrate content of $18.27 \pm 0.08\%$. Antioxidant activity of *Caulerpa* sp. fresh value based on IC₅₀ of 452.37 ± 8.29 ppm. Carbohydrate levels of *Luffa Schrool Caulerpa* sp. fresh is 18.97%, total food fiber content is $43.97 \pm 0.38\%$, insoluble food fiber is $22.88 \pm 0.38\%$, soluble food fiber is $21.09 \pm 0.13\%$, and crude fiber is $2.47 \pm 0.03\%$ (6). The crude fiber content of *Caulerpa* sp. based on dry weight is 8.429%. *Caulerpa* sp. which has the potential to be a source of fiber can be utilized into a variety of high-value products (7).

Dietary fiber is an edible part of plants with carbohydrates that are resistant to digestion and absorption in the fermented small intestine of humans. Dietary fiber includes polysaccharides, carbohydrates, oligosaccharides, lignin, and materials related to plant cell walls. Dietary fiber is generally divided into two, namely water-soluble fiber and water-insoluble fiber. Soluble dietary fiber, which is included in this fiber, is pectin and gum which are the inside of a plant food cell. This fiber is found in many fruits and vegetables, and insoluble fiber (insoluble dietary fiber), including in this fiber are cellulose, hemicellulose, and lignin (8). Water-soluble fiber is also associated with a decrease in blood sugar by speeding up food time while in the small intestine so that carbohydrates are absorbed less. Water-soluble fiber can also prevent cancer (2).

Caulerpa seaweed sp. which like fiber can potentially be used as processed food products such as candy, sausages, vegetables, and edible food. *Caulerpa racemose* seaweed can be used as a cooking ingredient, because the amino acids that can form the taste of nori. Amino acids contained in *Caulerpa* sp. in large quantities including alanine, glutamic acid, and glycine (9).

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Seaweed of *Caulerpa* sp. can be used as processed jelly candy because it contains fiber, and antioxidant activity and processing of seaweed can extend the shelf life (10). *Caulerpa racemosa* seaweed contains a lot of insoluble dietary fiber which can be useful for the prevention of constipation, hemorrhoids, and colitis. Insoluble dietary fiber contains cellulose and hemicellulose.

One of the processed products *Caulerpa* sp. is making candy (11).

Candy is one form of processed food from heating a mixture of sugar and fruit juice or other food additives that can give flavor. Making candy that must be considered is the solubility of sucrose when cooking. Candies that use pure sucrose are easily crystallized so other ingredients need to be used to increase solubility and inhibit crystallization, such as glucose syrup. The role of glucose syrup can be replaced by invert sugar, both of which have the same function, namely to prevent crystallization (12).

Invert sugar can be made from hydrolyzed sucrose using acid. The use of acid can increase the concentration of reduced sucrose, thereby causing the product to become sticky. Candy is much loved by the people who even now have various kinds of candy flavors. Candy currently in circulation has a variety of flavors ranging from fruits to vegetables. Thin candies are soft candies with a solid interlude, made from sugar or a mixture of sugar with other sweeteners, with or without the addition of other food ingredients and food additives (BTP) that are permitted, have relatively soft texture or become soft if chewed up (13).

Caulerpa sp. is still underutilized by processing agents in Indonesia. *Caulerpa* sp. has great potential and is useful for human health. Seaweed *Caulerpa* sp. contain food fiber that has the potential for health (6). Food fiber functions for the treatment of degenerative diseases. Degenerative diseases are caused by lack of fiber consumption, which results in hypertension, stroke and obesity. This seaweed can also be used as processed products. One of the preparations that can be made is thin candy (strips). Candy is often thought to cause cough when consumed too much (14).

This study aims to determine the best formulation of thin candy with comparative treatment of seaweed to water. This study also aims to analyze the physical and chemical characteristics, as well as the food fiber content contained in thin seaweed candy based on the treatment given.

II. MATERIAL AND METHOD

A. Material

Material used in this study was *Caulerpa* sp. Fresh *Caulerpa* obtained in Binuangeun, Banten, Indonesia. Other ingredients used in making the thin candy layer are gelatin, distilled water, sorbitol, mint flavour, and guava flavour.

B. Method

Fresh *Caulerpa* sp. washed for 45 minutes using depurator, then extracted using a juicer so obtained *Caulerpa* juice. Juice of *Caulerpa* sp. was filtered to separate the pulp that is removed so it is not mixed. Juice of *Caulerpa* sp. that has been filtered is stored in cold temperatures at a temperature of 1 °C. Juice of *Caulerpa* sp. add some ingredient, namely gelatin, distilled water, sorbitol, mint

flavor, and guava flavor. The ratio of *Caulerpa*'s juice with 0: 4 (F1), 1: 3 (F2), 2: 2 (F3), 3: 1 (F4), and 4: 0 (F5).

The research continued with making candy. Making candy is done by heating water and seaweed filtrate *Caulerpa* sp. according to treatment (F1, F2, F3, F4, and F5) until it reaches a temperature of 60 °C, then 5% gelatin is added to reach a temperature of 80 °C. Addition of sorbitol 3% and 1% sugar is done slowly to prevent clotting and cooked until it reaches a temperature of 90 °C and thickens for 10 minutes. The temperature is lowered to 70 °C to prevent evaporation and excess water loss. The solution is stirred until homogeneous, then add mint flavor and guava flavor to remove the seaweed aroma for 5 minutes. Candy solution is poured into Teflon 8 cm in diameter then stored for two days in cold temperatures in a room of 15 °C and packaged. Sensory testing was carried out to determine the best treatment of *Caulerpa* sp.

Parameter analysis of *Caulerpa* thin candy including proximate analysis, microbial analysis, sensory analysis, and physical analysis. Physical analysis was carried out namely water and color activities (15). Proximate analysis is carried out namely moisture content (16), ash content (17), and protein content (18). The product was also analyzed for reducing sugar content, total food fiber (19). Color testing is done objectively using a Colorimeter (*colorflex* EZ). Microbial analysis was performed by ALT analysis (Total Plate Figures), *E. coli* analysis (13), and *Coliform*, *Staphylococcus Aureus* (13). Salmonella (13), Mold/Yeast (13), and Mold (13). Metal analysis including Cu, Pb, Sn, Hg, and As was carried out based on SNI 3547.2-2008 (13). Microbial and metal analyzes were performed on the best products.

Sensory testing (20) is done by acceptance. Sensory tests to determine the sensory acceptance of this thin candy product were carried out two tests, namely the score test and the hedonic test. Sensory tests were carried out using 15 trained panelists. In the hedonic test of thin candy products, the hedonic scale used is 1- 5, the intended value is the number 5 = very like, 4 = like, 3 = neutral, 2 = dislike, 1 = very dislike. The data obtained were then analyzed statistically using Kruskal Wallis with further test *All pairwisetest*.

C. Data Analysis

Data obtained from this study include physical testing (water and color activity), chemical characteristics (water content, ash content, protein content, carbohydrate content, total food fiber, reducing sugar content) and sensory test (hedonic test and score test).

Analysis of the data used in this study was a Completely Randomized Design (CRD) with one factorial. The design of this experiment consisted of 5 treatment comparisons of water with *Caulerpa* sp. i.e. F1 (4: 0), F2 (3: 1) F3 (2: 2), F4 (1: 3), and F5 (0: 4). Session testing (score and hedonics) uses the *Kruskal-Wallis* method. The treatment was done three times.

III. RESULTS AND DISCUSSION

Sensory Characteristics of Thin Candy Seaweed *Caulerpa* sp.



Sensory test using the human senses as an instrument. Sensory testing is done by acceptance (20). Sensory or organoleptic testing is carried out using the sense of sight, smell, touch to measure the characteristics of a product. This test has an important role in early detection in assessing quality to determine changes and see the acceptability and likeness of panelists about seaweed thin candy products. Sensory testing is done by a score test and a hedonic test.

Test score

The score test based on (21) is a test in determining the level of quality based on a scale of numbers 1 (one) as the lowest value and 9 (nine) as the highest value using a validation sheet. Quality attributes used in this test are aroma, texture, taste, and adhesiveness. Sensory analysis of thin candy seaweed carried by panelists trained. The average value of the seaweed thin candy score test can be shown in Table 1.

Table 1. The average value of the test score of thin seaweed *Caulerpa* sp.

Comparison of Water and <i>Caulerpa</i> sp	Parameters			
	Flavour	Texture	Taste	Adhesiveness
F1	4,13 ^b	3,73 ^a	2,80 ^a	2,93 ^a
F2	3,87 ^{ab}	4,13 ^a	2,67 ^a	3,33 ^a
F3	4,13 ^b	4,27 ^a	2,53 ^a	3,53 ^a
F4	3,40 ^{ab}	4,00 ^a	2,40 ^a	3,00 ^a
F5	2,93 ^a	4,20 ^a	2,47 ^a	3,33 ^a

Note: Values with different letters (a, b, c) show statistically significant differences ($\alpha = 0.05$)

Flavour

Panelist acceptance of flavour ranged from 2.93–4.13 which shows that seaweed candy has a slightly smelling aroma to seaweed. Statistical analysis results show that the ratio of water with *Caulerpa* sp. significant effect ($\alpha < 0.05$) on the aroma of seaweed candy. The highest value given by the panelists was in the F1 and F3 treatments amounted to 4.13 which assessed that no foreign odor was detected in the thin candy caused by seaweed. This value is significantly different from the F5 treatment because of the ratio of water and *Caulerpa* 0: 4, so that the odor generated from seaweed is better smelled. The F1 and F3 treatments were also not significantly different from the F2 and F4 treatments which assessed the thin candy smelled a bit like seaweed. The lowest aroma value is the F5 treatment of 2.93 which shows the panelists smelled the seaweed. The resulting aroma is also influenced by the addition of guava and mint *essence* to remove the aroma from seaweed so that the aroma of seaweed does not smell. That is because the *essence* of guava and mint is added equally in each treatment by 2% and 5%. These results are not in accordance with the study of The difference in the addition of sea wine concentration does not affect the product's aroma(10). Sea grapes have a specific aroma of seaweed(22).

Texture

The texture in question is the level of plasticity of the thin seaweed candy produced. The sensory value of the texture of thin candy seaweed ranges from 3.73-4.27 which shows that the thin candy has a slightly clay to clay texture. The analysis

showed a comparison of water and *Caulerpa* sp. no significant effect ($\alpha > 0.05$) on the texture of seaweed thin candy. The highest value according to the panelists' assessment was F1 treatment with a value of 3.73 with somewhat clay characteristics. In general the texture of thin candy is influenced by the addition of gelatin. Gelatin added for all treatments amounted to the same. The addition of gelatin in industry aims to form gels, emulsion stabilizers, thickeners, water binders and coatings(23). Gelatin heated at 71°C will dissolve due to the breakdown of molecular aggregates and free liquid becomes trapped so that the solution will thicken. Gelatin gel starts to melt at 27-34°C. The addition of gelatin at the beginning of the treatment process and water that doubles the gelatin is sufficient to cause the dough to become elastic and clay(24). The texture of jelly candy is influenced by gelatin, water, and the heating process(25).

Taste

Taste is one of the factors that influences the value of product acceptance in consumer acceptance. Taste is a perception that is felt by the sense of taste which includes sweet, bitter, sour, and salty taste due to the dissolution of substances in the mouth(26). Sensory test results for seaweed thin candy ranged from 2.40-2.80 on a non-sweet scale(26). The results of the analysis showed that the ratio of water and *Caulerpa* sp. no significant effect ($\alpha > 0.05$) on the taste of seaweed candy. The highest score according to the panelists' assessment was the F1 treatment with a value of 2.80 with quite sweet characteristics. Research by (10) states that differences in the concentration of sea grapes do not affect the taste of thin seaweed candy made. The taste of sea wine is fresh, a bit spicy and salty. The addition of *essence* and sugar in making seaweed thin candy is very important in the final product taste.

Adhesiveness

Adhesiveness according to (26) is a force applied to remove or lift a sample from a given surface. The analysis showed a comparison of water and *Caulerpa* sp. no significant effect ($\alpha > 0.05$) on the adhesiveness of thin seaweed candy. Adhesiveness is illustrated easily or whether the sample is chewed, does not stick to the teeth and palate. Table 1 shows the average value of stickiness ranging from 2.93-3.53 which is on a sticky to slightly sticky scale. The results of the analysis showed that the ratio of water and *Caulerpa* sp. does not affect ($\alpha > 0.05$) adhesiveness to the thin seaweed candy. The highest value according to the panelists' assessment was the F3 treatment with an average value of 3.53 with rather sticky characteristics.

Hedonic Test

Hedonic test is a test to find out the likes or dislikes of a panelist on a product. The higher the value given by the panelists, the more panelists like thin candy products(27). The average value of the highest favorite level of thin candy with the addition of seaweed *Caulerpa* sp. in the F2 treatment for the aroma, texture, adhesiveness, and overall parameters, while for the taste parameter is the F3 treatment. The average value of a hedonic test can be seen in Table 2.

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Table 2. The value of hedonic test of thin candy seaweed *Caulerpa* sp.

Sample	Parameters				
	Flavour	Texture	Taste	Adhesive ness	Overa ll
F1	3,93 ^a	3,67 ^a	3,8 ^a	3,47 ^a	3,8 ^a
F2	3,73 ^a	3,60 ^a	3,2 ^{ab}	3,33 ^a	3,4 ^{abc}
F3	3,67 ^a	3,00 ^a	3,3 ^{ab}	2,87 ^a	3,27 ^{abc}
F4	3,27 ^a	2,80 ^a	3,07 ^{ab}	2,67 ^a	2,67 ^{bc}
F5	3,07 ^a	3,20 ^a	2,67 ^b	3 ^a	2,6 ^c

Note: Values with different letters (a, b, c) show statistically significant differences ($\alpha = 0.05$)

Aroma

Sensory value of seaweed candy *Caulerpa* sp. range between 3.07-3.93 (neutral). The highest aroma value is found in thin candy without the addition of *Caulerpa* sp. (F1), while the lowest aroma value is found in F5 treatment. Test results show that the ratio of water and *Caulerpa* sp. significant effect ($\alpha < 0.05$) on the preference level of aroma parameters. The analysis showed that there were no significantly different treatments for the scent of thin seaweed candy. The aroma is produced from the addition of *essence* and the effect of the aroma of fresh seaweed.

Texture

Sensory value of thin candy *Caulerpa* sp. ranging from 2.8-3.67 (do not like to neutral). The highest texture value is found in thin candy without the addition of *Caulerpa* sp. (F1), while the lowest value is found in F4 treatment. Test results show that the ratio of water and *Caulerpa* sp. does not affect the liking level of the texture of the thin seaweed candy.

Taste

Taste is an important factor in determining the acceptance of a food product. The hedonic test results or taste level preference parameters in Table 2 the average value of seaweed thin candy ranges from 2.67-3.8 (dislike to neutral). The highest taste value is found in the treatment without the addition of *Caulerpa* sp. (F1), while the lowest value is found in treatment F5. Test results show that the ratio of water and *Caulerpa* sp. influence ($\alpha < 0.05$) on the level of taste preferences on thin seaweed candy. The results of the analysis showed that F1 treatment was significantly different from F5 for the taste of the thin seaweed candy produced. F1 treatment with F2, F3, and F4 were not significantly different from the taste produced.

Adhesiveness

The hedonic test results or parameter preference level of average stickiness of thin seaweed candy ranged from 2.67-3.87 (dislike to neutral). The highest average value was found in the treatment without the addition of *Caulerpa* sp. (F1), while the lowest value is found in F4 treatment. Statistical test results using the Kruskal-Wallis showed that the ratio of water and *Caulerpa* sp. does not affect the liking level of seaweed candy *Caulerpa* sp.

Overall

Overall represents the total panelist acceptance of thin candy products. The overall average value ranges from 2.6-3.8 (do not like to neutral). The highest overall average value was found in the treatment without the addition of *Caulerpa* sp. while the lowest mean value is F5 treatment. The results of statistical tests using the Kruskal-Wallis method show that the ratio of water and *Caulerpa* sp. significant effect ($\alpha < 0.05$) on the overall

preference level on seaweed thin candy. Significantly different treatments can be seen by conducting further tests all pairwise (Pairwise comparison). The analysis showed that F1 treatment was significantly different from F4 and F5 treatments to the overall parameters of seaweed thin candy.

Characteristics of *Caulerpa* Candy Colors

Color testing is intended to determine the color difference that occurs when seaweed *Caulerpa* sp. on thin candy, Colorimeter according (28) is a tool used to measure colors that have a sensitive nature to light that is measured by how much color is absorbed by an object or substance. This tool determines the color based on the red, blue and green components of the light absorbed by the sample. Color testing is done with 3 replications in different parts of the candy. The Colorimeter tool produces several values namely L* (brightness), a* (red-green), b* (yellow-blue). The average values of L*, a*, and b* can be seen in Table 3.

Table 3. Average color values (L*, a*, and b*) thin seaweed candy *Caulerpa* sp.

Treatment	L*	a*	b*
F1	88.69±0.24 ^a	-2.19±0.11 ^a	8.64±1.14 ^a
F2	64.11±2.65 ^b	3.29±1.14 ^b	54.29±2.61 ^{cd}
F3	51.23±2.78 ^c	10.42±1.08 ^c	58.79±1.33 ^d
F4	36.42±4.89 ^d	12.28±0.46 ^{cd}	40.76±5.89 ^b
F5	31.70±5.89 ^d	12.96±0.30 ^d	42.63±7.57 ^{bc}

Note: Values with different letters (a-d) show statistically significant differences ($\alpha = 0.05$)

Table 5 shows that the average value of color values in the brightness (L*) is 31.70 - 88.69, the average at the level of red-green color (a*) is -2.19 - 12.96, and the average level of color on a yellow-blue (b*) is 8.64-58.79. Color testing using a standard white background with values L*, a*, and b* are 94.22, -1.08, and 2.55, respectively. The test results were compared using the green standard with the values of L*, a*, and b* respectively 53.16, -26.28, and 12.86. Statistical results show that the ratio of water and *Caulerpa* sp. affect the color produced.

F1 further test results were significantly different from the treatments of F2, F3, F4, and F5 with ($P < 0.05$). Brightness of seaweed thin candy obtained 88.69 values for F1 treatment, while the color values for the F2, F3, F4, and F5 treatments were 64.11, 51.23, 36.42, and 31.70. The results for the F1, F2, and F3 treatments are still categorized as bright colors, while the F4 and F5 treatments are categorized as dark. (29) states that the indication of the L* value with a low number (0-50) is the color darkness, while the L* value with a high number (51-100) is the color brightness. The brightness value in F1 treatment that was not added by *Caulerpa* sp. was lower because no *Caulerpa* seaweed was added. The greater *Caulerpa* sp. added will affect the brightness of the thin candy. Brightness is influenced by thin seaweed candy influenced by the chlorophyll content in *Caulerpa* sp. Seaweed and heating. (30) states that heating and drying make chlorophyll compounds degraded. Chlorophyll is unstable to heat. Research (31) also said the heating temperature of seaweed products could result in a pale green color.

The research of (29) states the effect of adding gelatin can also affect the level of brightness in the product because gelatin has yellowish brown characteristics. Another factor is the addition of sugar and during cooking the caramelization or brownish process occurs. The results of further tests showed a comparison of *Caulerpa* sp. and water has a significant effect ($p < 0.05$) on the color of a^* . The results of further tests conducted stated that the F1 treatment was significantly different from the F2, F3, F4, and F5 treatments with ($P < 0.05$).

The color of a^* negative value shows the sample is green, while the a^* positive color indicates the sample is reddish. The results of the F1 treatment color test have a value of -2.19 which means that the sample is slightly green when compared to the green standard value of a^* value of -26.28. while for the treatments F2, F3, F4, and F5 have positive a^* values of 3.29, 10.42, 12.28, and 12.96 which show the reddish color of the sample. Lestari (2019) said the characteristics of chlorophyll in seaweed are sensitive to heat so that it is degraded. Research (32) thermal degradation of chlorophyll a and b at 70-100°C. Factors that influence other than the addition of *Caulerpa* sp. is the addition of gelatin that you experience. The addition of gelatin to pemean can cause a brownish color due to the Maillard reaction, which is a non-enzymatic browning reaction involving amino acids and carboxyl groups especially reducing sugars.

The results of further tests conducted stated that the comparison of *Caulerpa* sp. and the water in the candy has an effect on the value of b^* ($p < 0.05$). The positive b^* color indicates the sample is yellow. The results of the F1 treatment color test have a value of 8.64, while for the treatments F2, F3, F4, and F5 are 54.29, 58.79, 40.76, 42.63. Sustainable Research (2019) states the yellowish color of cendol comes from chlorophyll b. The yellowish color of cendol derived from chlorophyll b is easily degraded due to processing at 100°C and drying at 50°C. (33) said *Caulerpa serrulate* has an Rf value of chlorophyll b of 0.44, and an Rf value of carotene (yellow) of 0.98. The yellow color can also be influenced by the addition of gelatin because the gelatin used is beef gelatin which has a yellowish color and has a distinctive aroma of gelatin.

Chemical Characteristics

Characteristics kimia in thin candy seaweed *Caulerpa* sp. done with several tests. Chemical characteristics include water content, ash content, protein content, reducing sugars and food fiber. Chemical content that is in thin candy seaweed *Caulerpa* sp. also refers to based on (13) concerning making soft candies. (13) states that the chemical characteristics that exist in confectionery or candy are only the water content and ash content. Chemical characteristics aim to determine whether the product is suitable for consumption or not that can affect product quality. The results of the chemical characteristics of seaweed thin candy products can be seen in Table 4.

Table 4. Chemical characteristics of thin candy seaweed *Caulerpa* sp.

Sample	Chemical characteristic				
	Moisture (%)	Ash (%)	Protein (%)	Invert Sugar (%)	Dietary Fiber (%)
F1	13.27 ^a	0.51 ^e	38.13 ^b	4.14 ^{ab}	0.00 ^a
F2	14.43 ^a	1.15 ^d	37.61 ^b	2.39 ^b	3.02 ^b
F3	17.08 ^a	1.59 ^c	37.93 ^b	2.54 ^{ab}	2.81 ^b

F4	15.93 ^a	2.12 ^b	39.38 ^b	4.37 ^a	8.31 ^c
F5	11.75 ^a	2.77 ^a	34.32 ^a	4.06 ^{ab}	8.21 ^c

Note: Values with different letters (a-e) show statistically significant differences ($\alpha = 0.05$)

Table 4 shows the chemical composition produced from thin seaweed candy varies. The results of the average water content in sweets differ from 11.75-17.08%, the average ash content of sweets from 0.51-2.77%, the average protein content is from 34.32-39.38, the average reducing sugar of 2.39-4.37%, and food fiber from 0.00-8.31%.

The results of the analysis showed a comparison of seaweed *Caulerpa* sp. with water has no significant effect on the water content of sweets. Further test results on thin seaweed candy *Caulerpa* sp. states between treatments F1, F2, F3, F4, and F5 are not significantly different. The results of the water content in thin candy are not much different from the research of (34) which produces water content in seaweed jelly candy ranging from 13.7-15.1%. This value is in accordance with (13) which states the maximum water content in jelly candy is 20%. Moisture content is affected by the addition of gelatin to cooking, according to (35) gelatin has a reversible nature that when heated will form a sol and melt, if cooled the sol will turn into a gel and the gel will be solid. As much amount of gelatin is added, the amount of water in the gelatin molecule is greater than that of water that evaporates during cooking.

Statistical analysis showed that the comparison of *Caulerpa* sp. seaweed with water had an effect ($P < 0.05$). Statistical analysis states that the treatments F1, F2, F3, F4, and F5 are significantly different. The highest ash content was found in treatment F5 which was worth 2.77%. ash content in thin candy is still in accordance with (13) which states the maximum ash content is 3.0%. (10) says the ash content is higher because it is suspected that the sea grapes used have high mineral content. This statement is supported by research by (36) which means that the lower the ash content, the less mineral content in the material.

The results of the analysis on protein levels showed that the ratio of the addition of *Caulerpa* sp. and water affect the amount of protein contained in thin seaweed candy ($P < 0.05$). Protein levels in (37) with the highest value of 21.89%. The resulting protein level is affected by the addition of gelatin. (36) measured protein levels by the Kjehdal method include crude protein because what is measured is not only protein, but also other components that contain nitrogen. Research (38) cooking at high temperatures will cause gelatinization of gelatin molecules in water when heated to temperatures > 90 °C. The higher the rate of addition of water with the same cooking temperature on the mixing of gelatin ingredients into the material mixture, the lower the value of protein content in a product.

The results of the analysis of reducing sugar levels show that the ratio of the addition of *Caulerpa* sp. and water significantly affect the amount of reducing sugar found in seaweed candy (P value < 0.05). The amount of reducing sugar found in seaweed candy is still in accordance (13) which states the maximum amount of reducing sugar in jelly candy is 25%. (34) says reducing sugar levels are related to the process of inversion of sucrose into inverted sugar (glucose and fructose).

Characteristics of Thin Candy from Green Seaweed *Caulerpa* sp

The inversion process is influenced by the reaction of acid, heat and mineral content. heating causes disaccharide inversion processes such as sucrose into glucose and fructose. The basic ingredients in this research are seaweed which contains minerals. The mineral content is different, from the treatment suspected as a cofactor that can increase the inversion process. Reducing sugar levels according to (39) was also influenced by carbohydrate content in seaweed raw materials according to (5) which reported carbohydrate content of $18.27 \pm 0.08\%$.

The results of the analysis of food fiber content showed that the ratio of the addition of *Caulerpa* sp. and water significantly affected the amount of protein contained in thin seaweed candy ($P < 0.05$). Total food source or rich fiber content is 3 grams per 100 grams in solid form (40). The increase in fiber content in jelly candy is due to the addition of seaweed filtrate addition formulation. Thin candy is in accordance with (40) so it can be said that the thin candy of seaweed *Caulerpa* sp. is a source of food fiber. Research by (14) said total dietary fiber content was $43.97 \pm 0.38\%$. Dietary fiber according to (8) is an edible part of plants with carbohydrates that are resistant to digestion and absorption in the fermented small intestine of humans. Dietary fiber includes polysaccharides, carbohydrates, oligosaccharides, lignin, and materials related to plant cell walls.

Microbial contamination

Thin candy seaweed *Caulerpa* sp. microbial contamination testing was carried out. Microbial contamination testing is carried out to ascertain whether the product produced contains microbial contamination that can endanger health in the body. Microbial contamination tested in the form of total plates, *Coliform* bacteria, *E. coli* bacteria, *Staphylococcus aureus*, *Salmonella*, and mold contamination. The results of microbial contamination testing can be seen in Table 5.

Table 5. Microbial contamination of thin seaweed *Caulerpa* sp.

Parameters	Unit	Sample
TPC	koloni/g	1.5×10^1
<i>Coliform</i>	APM/g	< 3.0
<i>E. coli</i>	APM/g	< 3.0
<i>Staphylococcus aureus</i>	koloni/g	Negatif
<i>Salmonella</i>	-	Negatif
Khamir	Koloni/g	20

Table 5 refers to the number of total plate number on thin candy seaweed *Caulerpa* sp. amounted to 1.5×10^1 , the number of *Coliform* bacteria and *E. coli* bacteria is less than three, *Staphylococcus aureus* bacteria were not found in the colony, *Salmonella* bacteria were not found in the colony, and the number of molds found was 2.0×10^1 .

Microbial contamination in the processing of seaweed candy can be influenced by various factors such as non-aseptic manufacture at the beginning of seaweed product collection until it becomes a product, processing during the cooking process, and water activity on the product. Contamination can come from workers or the container used. Seaweed candy products in the contamination of Total Plate Numbers (ALT) based on research by (41) was influenced by water activity contained in candy products. Moisture content can also affect physical

properties, chemical changes, and microbiological changes and enzymatic changes. Long storage of a product can also affect microbial contamination. ALT according to (42) can show the quality, shelf life, contamination and hygienic status in the production process. These results indicate that seaweed candy products *Caulerpa* sp. not dangerous for consumption. The small amount of bacteria can be affected by making aseptic candy and using high temperatures. The contamination of *E. coli* and Coliform on the product produced is in accordance with (13) so that the product is safe for consumption. The result is suspected because during the process of making seaweed candy using water or distilled water that is not contaminated with *E. coli* bacteria.

Pollution of *Salmonella* and *Staphylococcus aureus* bacteria on candy products is still below the standard of soft candy. *Salmonella* bacteria according to (42) can grow in aerobic and facultative anaerobic conditions at 15-41°C, but at 56°C and dry conditions will die. *Staphylococcus aureus* bacteria can be contaminated from the skin of the hands and can grow at room temperature. Mold bacteria that grow according to (43) states that these bacteria are mesophilic which means they can grow well at 0°C but some can grow at temperatures 35-37°C or higher. Molds can use food components from simple to complex. Mold can also produce hydrolytic enzymes such as amylase, pectinase, proteinase and lipase so that mold can grow on foods that have protein, starch, or pectin.

Bacteria in food according to (42), food poisoning by bacteria can be in the form of intoxication or infection. Intoxication is caused by the presence of bacterial toxins that form in food when bacteria multiply, whereas food poisoning in the form of infection is caused by the entry of bacteria into the body through contaminated food and the body reacts to these bacteria. Bacteria such as *E. coli* can also cause urinary tract infections and also other diseases such as pneumonia, meningitis and traveler's diarrhea if contaminated with food to be consumed. The growth of bacteria in food products can be influenced by several factors, namely the temperature during cooking, the handling of raw materials that are not hygienic, the equipment used is not hygienic, the cooking process is not appropriate, and the content of the ingredients used.

IV. CONCLUSION

Making thin candy based on seaweed *Caulerpa* sp. the best is the comparison of water and *Caulerpa* sp. 1: 3. The physical characteristics of the color of the thin candy, a best treatment is at a high brightness, redness and yellowness. Dietary fiber candy thin *Caulerpa* according to (40) already includes a source of dietary fiber that is equal to 3.02%.

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