UNDERGRADUATE THESIS

ANALYSIS OF DIETARY FIBRE, VITAMIN C, AND TEXTURE PROPERTY OF SEAWEED JELLY WITH POMELO ALBEDO SUBSTITUTION

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ANALISIS SERAT PANGAN, VITAMIN C DAN TKSTUR JELLY RUMPUT LAUT DENGAN SUBSTITUSI KULIT JERUK PAMELO

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ABSTRAK

Latar Belakang: Pomelo adalah buah dengan nilai gizi tinggi, tetapi penggunaannya sebagai bahan makanan belum dioptimalkan. Rumput laut dapat kehilangan kandungan nutrisi karena berbagai perlakuan selama pengolahan. Pomelo albedo dikenal karena kandungan vitamin C, serat dan pektinnya, dan substitusinya dapat meningkatkan nilai gizi dalam makanan. **Tujuan**: Penelitian ini bertujuan untuk meningkatkan nilai gizi dalam produk jeli rumput laut oleh pomelo albedo sebagai substitusi dan pektinnya diharapkan dapat menggantikan penggunaan gelatin dalam pembuatan jeli. **Metode**: Penelitian ini merupakan penelitian eksperimental dengan metode Rancangan Acak Lengkap (RAL) dengan satu faktor, yaitu penambahan pomelo albedo. **Hasil**: Ada perbedaan yang signifikan dalam vitamin C dan kandungan serat makanan pada setiap kelompok perlakuan (p-value 0,000). Kandungan vitamin C dan serat makanan tertinggi ditemukan dalam sampel dengan substitusi 45% pomelo albedo dengan vitamin C 32,39% dan serat makanan 2,60%. Tekstur jeli menunjukkan perbedaan yang signifikan dengan p-value 0,041. **Kesimpulan**: Substitusi pomelo albedo memberikan perbedaan yang signifikan dalam peningkatan vitamin C dan kandungan serat dalam jeli rumput laut dan jumlah pomelo albedo yang tepat dapat digunakan sebagai pengganti gelatin.

Kata kunci: *serat makanan, pomelo albedo, rumput laut, tekstur, vitamin c*

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ABSTRACT

Background: Pomelo is a fruit with a high nutritional value. However Its use as food ingredients has not been optimized. Seaweed can lose its nutrients content due to various treatments in processing. Pomelo albedo was known for its vitamin C, fibre and pectin content. This substitution can increase nutritional value on food. **Objective:** This study aimed to increase the nutrient value in seaweed jelly product by pomelo albedo as a substitution and its pectin expected to replace the use of gelatin in jelly making. **Methods:** This research was an experimental study with a completely randomized design (CRD) method with one factor, specifically the addition of pomelo albedo. **Results:** There is a significant difference in vitamin C and dietary fibre content in each treatment group (p-value 0.000). The highest content of vitamin C and dietary fibre was found in samples by 45% pomelo albedo substitution with vitamin C 32.39% and dietary fibre 2.60%. The texture of jelly shows a significant difference with p-value 0.041. **Conclusion:** The substitution of pomelo albedo gave a significant difference in increasing vitamin C and dietary fibre content in seaweed jelly. In addition the right amount of pomelo albedo can be used as a substitute for gelatin.

Keywords: *dietary fibre, pomelo albedo, seaweed, texture, vitamin c*

STATEMENT OF ORIGINALITY

DECLARATION

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Ponorogo, April 2019

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STATEMENT OF ELIGIBILITY

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Praise be to Allah, the God of the universe. God who knows all things, God who teaches his servants, what was previously unknown

وَعَلَّمَ ءَادَمَ ٱلْأَسْمَآءَ كُلَّهَا ثُمَّ عَرَضَهُمْ عَلَى ٱلْمَلَٰٓئِكَةِ فَقَالَ أَنۢبِـُٔونِي بِأَسْمَآءِ هَٰٓؤُلَآءِ إِن كُنتُمْ صَٰدِقِينَ ٣١ قَالُوا۟ سُبْحَٰنَكَ لَا عِلْمَ لَنَآ إِلَّا مَا عَلَّمْتَنَآ ۖ إِنَّكَ أَنتَ ٱلْعَلِيمُ ٱلْحَكِيمُ (٣٢)

"And He taught Adam all the names, then presented them to the angels; then He said: Tell me the names of those if you are right. They said: Glory be to Thee! we have no knowledge but that which Thou hast taught us; surely Thou art the Knowing, the Wise".

Everything in the heavens and on earth is in the will of Allah, and with his will the author is still given the greatest favour in the form of faith, Islam, health and knowledge so that the writer can finish writing this thesis with the title: Analysis of Dietary Fibre, Vitamin C, and Texture Property of Seaweed Jelly With Pomelo Albedo Substitution. Prayers and greetings on the prophet Muhammad SAW. the prophet of the entire ummah until the end of time. In writing this thesis the author would like to express her sincere thanks to:

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The author realizes that humans are not free from mistakes, shortcomings and limitations, so in writing this thesis the author apologizes if there are various shortcomings.

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Siti Salamah

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CHAPTER I

INTRODUCTION

1.1. Background of Research

Indonesia was the second largest producer of seaweed carrageenan in the world after Philipines (Parenrengi & Sulaeman, 2007). Seaweed processing industry needs to be developed considering the potential of seaweed in Indonesia is quite large. The potential land or waters that are suitable for cultivation reached 2.1 million hectares (Putri, et al., 2015). Production volume of fisheries cultivation of seaweed was 1,944,800 tons or 55.07% of total fisheries product. The production was ranked first in total fisheries production of fish, shrimp and other commodities (Hamid & Kamisi, 2011).

Seaweed is one of the aquaculture commodities which is currently promoted by the government to increase foreign exchange. Generally, the diversity of seaweed species in Indonesian waters has been widely used by coastal communities as food and traditional medicine but did not contribute much to their economy. This is because the seaweed is less processed into products that have more value such as agar-agar, carrageenan and alginate, which more than 80% of local needs are still obtained from imports (Rosalita, et al., 2018).

Seaweed jelly is a product with a chewy texture. This texture is formed due to the presence of gel, which is gelatin added to the manufacturing process. Gelatin with its extensive use in the food and pharmaceutical industries has always been a becoming pivotal issue. Gelatin production in the world reaches 326,000 tons/year in detail. The production of gelatin that comes from pork skin is the highest (46%), followed by cows skin (29.4%), beef bone (23.1%) and other sources (1.5%) (Suptijah, et al., 2013).

Islam emphasizes the Moslem to earnestly pay attention to the foods and beverages that will be consumed. In addition to good quality, food must also be of the halal type. The use of gelatin in seaweed jelly still raises

concerns about its halal status, because of the possibility of using animal gelatin which is forbidden as a pork skin in the process of making jelly (Rismandari, et al., 2017). In a hadith, the Prophet Muhammad. said:

إِنَّ الْحَلَالَ بَيِّنٌ وَإِنَّ الْحَرَامَ بَيِّنٌ وَبَيْنَهُمَا أُمُورٌ مُشْتَبِهَاتٌ لَا يَعْلَمُهُنَّ كَثِيرٌ مِنْ النَّاسِ فَمَنْ اتَّقَى الشُّبُهَاتِ فَقَدْ اسْتَبْرَأَ لِدِينِهِ وَعِرْضِهِ وَمَنْ وَقَعَ فِي الشُّبُهَاتِ وَقَعَ فِي الْحَرَامِ كَالرَّاعِي يَرْعَى حَوْلَ الْحِمَى يُوشِكُ أَنْ يَرْتَعَ فِيهِ أَلَا وَإِنَّ لِكُلِّ مَلِكٍ حِمًى أَلَا وَإِنَّ حِمَى اللَّهِ مَحَارِمُهُ أَلَا وَإِنَّ فِي الْجَسَدِ مُضْغَةً إِذَا صَلَحَتْ صَلَحَ الْجَسَدُ كُلُّهُ وَإِذَا فَسَدَتْ فَسَدَ الْجَسَدُ كُلُّهُ أَلَا وَهِيَ الْقَلْبُ».

> Meaning: *"That which is lawful is clear and that which is unlawful is clear, and between the two of them are doubtful matters about which many people do not know. Thus he who avoids doubtful matters clears himself in regard to his religion and his honour, but he who falls into doubtful matters [eventually] falls into that which is unlawful, like the shepherd who pastures around a sanctuary, all but grazing therein. Truly every king has a sanctuary, and truly Allah's sanctuary is His prohibitions. Truly in the body, there is a morsel of flesh, which, if it is whole, all the body is whole, and which, if it is diseased, all of [the body] is diseased. Truly, it is the heart."* [Bukhari & Muslim]

Seaweed jelly is made with a method of boiling for quite a long time, the boiling process aims to inactivate the enzyme and reduce the number of microbes. In the other hand, this process can also affect the levels of fibre and vitamin C in seaweed. Vitamin C is easily degraded, either by temperature, light and surrounding air (Rahayu & Pribadi, 2012). Boiling seaweed with a temperature of 90^{O}C for 5 minutes, is known to reduce total dietary fibre by 3.8%, soluble food fibres by 5.0%, crude fibre by 0.85% (Chrystiawan, 2015). It also reduce levels of vitamin A 64.87%, vitamin B1 was 65.38% and vitamin E was 4.75% (Luthfiyah, 2015).

The anatomy of citrus fruit is consist of pulps, fruit peel and seeds. The part of citrus widely used is the fruit pulps, while the peel of this fruit is neglected and becomes waste. The production of pomelo in Indonesia

reaches 511 ton/ year, this production produced the amount of pomelo peel of 208 ton. During these, almost 50% of the pomelo peel has not been fully utilized, the amount of pomelo peel that is underutilized requires an effort to use it. Thus, it is necessary to handle pomelo peel waste which can later be utilized as a food ingredient, especially utilizing the compounds contained in pomelo peel which can be antioxidant (Rafsanjani, et al., 2015).

Pomelo albedo contains vitamin C and pectin quite high compared to other types of citrus. Pectin in the pomelo albedo has the ability to form a gel. The ability of gel formation from pectin due to acid addition and the heating treatment which help in forming elasticity in the resulting products (Octaviana, et al., 2013).

Seaweed jelly in this study is made from seaweed substituted with pomelo albedo as a source of pectin to replace gelatin which commonly used as a gel-forming material, the main source of concern about jelly halal status as an effort to provide the tranquillity of consumers in consuming jelly. The substitution of seaweed jelly with pomelo albedo is also expected to increase the nutritional value of the production of jelly so that foods with high nutritional value are obtained. Jelly with the substitution of pomelo albedo is also made as an alternative business of food products to increase the economic value of seaweed and pomelo albedo that can be made in home-level production and in this experiment will be analyzed dietary fibre, vitamin C and texture property of the product.

1.2. Formulation of Research Problems

Based on the background stated, the problem can be formulated as follows:

a. Does the addition of pomelo albedo (*Citrus maxima*) affect the level of dietary fibre in seaweed jelly (*Eucheuma cottonii*)?
b. Does the addition of pomelo albedo (*Citrus maxima*) affect the level of vitamin C in seaweed jelly (*Eucheuma cottonii*)?
c. Does the addition of pomelo albedo (*Citrus maxima*) affect the level of texture property in seaweed jelly (*Eucheuma cottonii*)?

1.3. Objective of Research

1.3.1. General Objective

The general objective of this study was to analyze dietary fibre content, vitamin C and the texture property of seaweed jelly (*Eucheuma cottonii*) with pomelo albedo (*Citrus maxima*) substitution.

1.3.2. Specific Objective

The specific objective of this research is:

a. To analyze the levels of dietary fibre in seaweed jelly (*Eucheuma cottonii*) with pomelo albedo (*Citrus maxima*) substitution.
b. To analyze the levels of vitamin C in seaweed jelly (*Eucheuma cottonii*) with pomelo albedo (*Citrus maxima*) substitution.
c. To analyze the texture property of seaweed jelly (*Eucheuma cottonii*) with pomelo albedo (*Citrus maxima*) substitution.

1.4. Benefits of Research

1.4.1. Benefits For Society

This research is expected to contribute for people to increase their knowledge about the variation in the processing of seaweed and pomelo albedo into jelly as a food with a high nutritional and economic value.

1.4.2. Benefits For Institutions

The results of this research are expected to contribute knowledge about the variation in the processing of seaweed and analysis of dietary fibre, vitamin C and texture property of seaweed jelly (*Eucheuma cottonii*) with pomelo albedo (*Citrus maxima*) substitution.

1.4.3. Benefits For Researchers

This research is expected to provide additional insight or information and experience for a researcher in the variation of seaweed processing and analysis of dietary fibre, vitamin C and texture property

of seaweed jelly (*Eucheuma cottonii*) with pomelo albedo substitutions (*Citrus maxima*).

1.5. Authenticity and Formers Research

Research that discussed the variation of seaweed jelly with the substitution of pomelo albedo is still not available. Previous research was a study that discusses the manufacture of seaweed jelly or jelly pomelo albedo separately. This research is a compliment and previous research continuation listed in *Table 1* :

Table 1. Authenticity and Formers Research

No	Title	Variable and design	Result	Difference
1	The effect of immersion with orange acid and rice water to organoleptic quality of seaweed pudding (*Eucheuma cottonii*) (Rosalita, Husain Syam, & Ratnawaty Fadhilah. 2018).	Dependent variable: Organoleptic quality of seaweed pudding. Independent variable: moisture content, ammonia, proteins, carbohydrates, and ash levels content contained in seaweed pudding. Design: Randomized Complete Design (RAL).	The colour, taste, aroma, texture most preferred by panellists with was long immersion 36 hours, with the value of each of the colour of 5.56%, 5.59% aroma, flavour 5.56% and texture 5.86%. Treatment was long immersion 36 hours with orange acid has ammonia content 0.003%, water content 84.4%, protein content 0.111%, carbohydrate content 13.063% and ash content 9.62%.	The research only uses seaweed to make jelly without substitution with other ingredients and this study is using seaweed jelly with a substitution of pomelo albedo. The independent variable does not discuss texture, micronutrients and fibre but this study discusses fibre content, vitamin c content and the texture of the seaweed jelly with pomelo albedo substitution.

No	Title	Variable and design	Result	Difference
2	Quality of Grapefruit Albedo (*Citrus grandis L. Osbeck*) and Roselle (*Hibiscus sabdariffa* L.) Jelly Candies with the Addition of Sorbitol (Putri Octaviana, Ekawati Purwijantiningsih & Sinung Pranata. 2013).	Dependent variable: jelly candy quality from *citrus grandis* albedo. Independent variable: proximate test, texture test, microbiological test and organoleptic test. Design: Randomized Complete Design (RAL).	The results obtained in this study is a product of roselle-orange albedo jelly candy made with a water content of 6.25%-6.84%, ash content 0.14% - 0.16%, reducing sugar content 21.17% - 23.65%, vitamin C 2.4053 – 3.4907 mg, texture 516.00 N / mm2 - 719.83 N / mm2, as well as microbiological tests which include calculation of numbers total plate (ALT) and yeast mold numbers that have met the SNI jelly candy standard. 120:80 combination provides the best quality in terms of chemical and organoleptic properties.	The research only uses a citrus albedo jelly and rosella without substitution with seaweed and this study is using seaweed jelly with a substitution of pomelo albedo. There is no treatment to remove the bitter taste of albedo in the formulation but this study is trying to remove the bitter taste. The variable does not discuss micronutrients and fibre and for this study is to discuss fibre content, vitamin c content and the texture of the seaweed jelly

3	The Influence Of Different Types Of Sugar Against The Quality Of Seaweed Jelly Candy (*Eucheuma cottonii*) (Marwita Sari Putri, Retty Ninsix & Aulia Gustina Sari. 2015).	Dependent variable: Effect of different types of sugar against the quality of seaweed jelly candy. Independent variable: Reduced sugar levels, water content, microbial total test, and organoleptic test. Design: Randomized Complete Design (RAL).	The best type of sugar in making seaweed jelly candy (*Eucheuma cottonii*) type sucrose sugar with a sweet and slight taste acidity, and clear pink and texture that is elastic and elastic with moisture content and sugar content high reduction and the number of microbes during storage of room t emperature doesnot exceed the specified SNI (2008) of a maximum of 5 × 104 cells/gram.	The research is using different types of sugar and this study just using the best type of sugar from the result. The research only uses a seaweed without substitution with other ingredients and this study is using seaweed jelly with a pomelo albedo substitution. The independent variable does not discuss micronutrients and fibre and for this study is to discuss fibre content, vitamin c content and the texture of the seaweed jelly.

4	The Chemical and Organoleptic Properties of Seaweed Jelly Candy (Angcivioletta Moniharapon. 2016).	Dependent variable: Chemical and organoleptic properties of seaweed jelly candy. Independent variable: Moisture content, ash content, reduced-sugar, sucrose content and heavy metals test. Design: Descriptive method.	The chemical properties of seaweed jelly candy that is treated with and without gelatin produce seaweed jelly candy that not meets the SNI standards of jelly candy.	The research only uses a seaweed without substitution with other ingredients and this study is using seaweed jelly with a pomelo albedo substitution. The variable does not discuss micronutrients and fibre and for this study is to discuss fibre content, vitamin c content and the texture of the seaweed jelly. The design used in this study is a descriptive method but this study id using the experimental method.

CHAPTER II

LITERATURE REVIEW

2.1. Jelly

Jelly is one of the food that is highly preferred by people, ranging from children to adults. This is indicated by the increasing number of jelly products with various new types that exist in the market. Jelly can be made from pectin, agar, carrageenan, gelatin or other hydrocolloid compounds by adding sugar, acid, and or without other food additives that are permitted (Standar Nasional Indonesia (SNI) 01-3552, 1994). Gelatin in the manufacture of jelly serves as a thickener, sugar as a sweetener and organic acid as a preservative and give a sour taste to the product (Octaviana, et al., 2013).

Jelly is a soft-textured sugar flower which is processed by adding hydrocolloid components such as agar, gum, pectin, starch, carrageenan, gelatin and others that are used for texture modification to produce chewy products, jelly must be set and processed ageing before packaging (SNI 3547-2, 2008). One of the factors that affect the quality of jelly is the presence of gel-forming materials. A strong gel and a thick texture on jelly can be produced by the addition of a gel-forming material. Thickener materials commonly used in jelly candy are carrageenan, pectin, gelatin, dextrin and carboxymethyl cellulose (Novitasari, et al., 2016).

Various studies that discuss the nutritional value of seaweed jelly showed results by Rosalita, et al., (2018) that seaweed jelly has the moisture content of 84.4%, protein content of 0.111%, carbohydrate content of 13.063% and ash content of 9.62%. Waryat and Faridah (2006) obtained fat content of 1.16%, crude fibre content of 3.806%, total sugar 35.915%, and pH 5.1 in seaweed jelly.

Jelly making requires other ingredients such as water and food additives. Water used as supporting material in food processing must meet the prerequisites for the quality of drinking water similarly with the use of food additives that may not exceed the limits of need (SNI 2802, 2015).

Table 2. Quality Requirements for Jelly

No	Test Criteria	Unit	Requirements
1	Circumstances		
1.1	Smell	-	Normal
1.2	Taste	-	Normal
2	Water content	%	Max. 20.0
3	Ash content	%	Max. 3.0
4	Reducing sugar (calculated as inversion sugar)	%	Max. 25.0
5	Saccharose	%	Min. 27.0
6	Metal contamination		
6.1	Lead (Pb)	mg/kg	Max. 2.0
6.2	Copper (Cu)	mg/kg	Max. 2.0
6.3	Tin (Sn)	mg/kg	Max. 40.0
6.4	Mercury (Hg)	mg/kg	Max. 0.03
7	Arsenic contamination	mg/kg	Max. 1.0
8	Microbial contamination		
8.1	Total plate number	coloni/g	Max $5x10^4$
8.2	Coliform bacteria	APM/g	Max. 20
8.3	*E. Coli*	APM/g	< 3
8.4	*Staphylococcus Aureus*	coloni/g	Max. $1x10^2$
8.5	*Salmonella*		Negative/25 g
8.6	Mold / yeast	coloni/g	Max.$1x10^2$

Note: APM: The most possible rate

Source: SNI 3547-2, 2008

2.2. Seaweed (*Eucheuma cottonii*)

Seaweed is classified as a low-level plant, generally grows attached to certain substrates, has no true roots, stems or leaves. However, it only has a stem called thallus. Seaweed grows in nature by attaching itself to corals, mud, sand, rocks and other hard objects (Hamid & Kamisi, 2011). The classification of *Eucheuma cottonii* is as follows (Deki, 2010):

Kingdom : Plantae
Division : Rhodophyta
Class : Rhodophyceae
Ordo : Gigartinales
Family : Solieiaceae
Genus : *Eucheuma*
Species : *Eucheuma cottonii* (*Kappaphycus alvarezii*)

The Indonesian Sea has around 8,500 species of fish, 555 species of seaweed and 950 species of coral reef biota. Fish resources in Indonesian sea cover 37% of the fish species in the world, where several types of them have high economic value, such as tuna, shrimp, lobster, reef fish, various types of ornamental fish, armour, and seaweed (Ministry of Maritime and Fisheries Affairs, 2016). Seaweed is one of the commodities obtained from the sea which has many benefits for the food industry and can be utilized for other industries. Allah says:

أُحِلَّ لَكُمْ صَيْدُ ٱلْبَحْرِ وَطَعَامُهُۥ مَتَٰعًا لَّكُمْ

Meaning: *Permitted for you to hunt the sea and food (which originates) from the sea as delicious food for you.*

In the 2014-2019 presidential era, seaweed cultivation was used as a program to improve the welfare of Indonesian coastal communities (Ministry of Maritime and Fisheries Affair. 2016). Seaweed is generally traded in the form dried seaweed, products that can be directly consumed, and hydrocolloid products (carrageenan, agar-agar, and alginate). About 65% of seaweed production is the type that can be consumed directly; 15% hydrocolloid material; and 20% as fertilizer, paper, biofuel (Salim & Ernawati. 2015). Seaweed is very popular in the world of trade which in the world of science is known as algae. Seaweed is one of the commodities of fisheries, and the main source of producing agar-agar, alginate, and carrageenan which is widely used in the food, cosmetics, pharmaceutical and other industries such as paper, textile, photography, pasta, and canned fish (Parenrengi & Sulaeman, 2007).

Seaweed is the largest part of marine plants and one of the potential export commodities to be developed. There are four types of seaweed which have high economic value in Indonesia as an export commodity and also for domestic consumption, namely *Eucheuma* sp., *Gracillaria* sp., *Gelidium* sp., *Sargassum* sp. and *Hypnea* sp. *Eucheuma cottonii* and *Eucheuma spinosum* species are red algae species which are carrageenan producers and are the largest part of Indonesia›s export volume (Moniharapon, 2016).

Figure 1. Seaweed (Eucheuma cottonii)

Source: Author Documentation

The parts of seaweed generally consist of a holdfast as the basic part of seaweed which functions to stick to the substrate and thallus which are forms of seaweed growth that resemble branching. Seaweed growth dependent on oceanographic factors (physics, chemistry, and movement or dynamics of seawater), seaweed takes nutrients from its surroundings diffusion and osmosis through thallus walls (Surni, 2014).

Table 3. The Chemical Composition of Fresh Seaweed in Units of Dry Weight.

Nutrient	**Value per 100 g**
Ash content (%)	29.97
Protein (%)	5.91
Fat (%)	0.28
Carbohydrate (%)	63.84
Insoluble fibre (%)	55.05
Soluble fibre (%)	23.89
Total fibre (%)	78.94
Iodium (µg/g)	282.93

Source: Astawan et al., 2004

Seaweed is famous for its fibre content, fibre content (dietary fibre) in seaweed provides satiety and facilitates the body's metabolic processes. The dietary fibre and nutritional content of seaweed are useful as an antioxidant, antimutagenic, anti-coagulant, anti-tumour, and lipid metabolism. Seaweed is one of the best sources of natural iodine (Moniharapon, 2016).

Seaweed is one of Indonesia's potential fishery commodities. Seaweed processing industry does need to be developed considering the potential of seaweed in Indonesia is quite large with the potential land or waters that are suitable for cultivation reached 2.1 million hectares. One way to use *Eucheuma cottonii* seaweed is to make it into jelly (Putri, et al., 2015). Seaweed cultivation should also be followed with the development of the processing industry, due to the added value of seaweed is largely in its processing industry. The fact showed that the processing of the seaweed industry from raw materials into semi-finished materials or materials so haven't so much (Moniharapon, 2016).

A type of seaweed that dominates exports in Indonesia that usually processed into food is *Eucheuma cottonii* (Rosalita, et al., 2018). *Eucheuma cottonii* has important economic value because it is a raw material for agar, alginate and carrageenan producer (Satriani, et al., 2018). *Eucheuma cottonii* has several derivative products, such as; bread, sauce, ice cream, jelly, candy, ice mix, cheese, pudding, jam, beer, wine, coffee and chocolate. This is due to the fact that *Eucheuma cottonii* seaweed functions as food adhesives material, emulsion maker, thickener, filling material, and gel-making material (Rosalita, et al., 2018).

2.3. Pomelo Albedo (*Citrus maxima*)

Pomelo (*Citrus maxima*) comes from Southeast Asia. It has been introduced to China. Pomelo (*Citrus maxima*) is a synonym of *Citrus grandis (L) Osbeck* who belongs on a subfamily Rutaceae family and Aurantioideae (Kalsum, 2015). The classification of the types of Pomelo is as follows (Dyaningratri, 2011):

Kingdom	: Plantae
Division	: Spermatophyta
Sub-Division	: Angiosperms
Class	: Dicotylendonae
Sub-Class	: Choripetalae
Ordo	: Geraniales
Family	: Rutaceae
Genus	: *Citrus*
Species	: *Citrus maxima*

The characteristic of pomelo fruit is large and thick skinned, it is resistant to being stored and transported over long distances. The fruit is round, which looks pressed and have a slightly thick peel, containing 11-16 segments. Pomelos display a greenish yellow to an orange tint, similar to grapefruit. The pulps of the pomelo are typically white, it can also be a light pink. The membranous material around the segments is typically discarded it is bitter and considered inedible. The pulps of the fruit have a hard to a soft texture, the sweetness will be slightly sour and slightly seedy (Dyaningratri, 2011).

Figure 2. Pomelo (Citrus maxima)

Source: Endarto & Martini (2016)

Citrus is one of the plantation commodities that has good quality prospects. Citrus is also one of the fruits that contain a lot of vitamin C, it

is useful for endurance, have high efficacy and are beneficial to humans where use is not only in its pulps, but the peel can also be used. Citrus fruit peel has a constituent component of various compounds including citric acid, amino acids, essential oils (Sarofa, et al., 2018). Most of the components of the pomelo are located on the peel, including alkaloid compounds, flavonoids, lycopene, vitamin C, and the most dominant are pectin and tannins (Rafsanjani & Putri, 2015). The content of pomelo peel is the same as the part of the fruit, such as lycopene which functions to prevent various cancers. Citrus peel also believed to contain active substances that can cleanse old red blood cells in the body and normalize the level of hematocrit. Pomelo and its peel contain vitamin C which is very good as a source of antioxidants (Dyaningratri, 2011).

Table 4. Chemical Composition of Pomelo Albedo

Nutrient	Value per 100 g
Water content (%)	17.36
Pectin level (%)	2.94
Ash content (%)	0.62
Vitamin C (mg)	13.35
pH	6

Source: Octaviana, et al., 2013

Basically, pomelo albedo has a bitter taste, but with right processing such as boiling, washing process or soaking in water, the bitter taste can be removed so that it will produce good quality products that can be accepted by consumers (Kalsum, 2015). Citrus pulps in processed are usually made jelly, but citrus fruit waste, which is citrus peel, which weighs nearly 36% of the weight of the fruit has not been widely used (Octaviana, et al., 2013).

2.4. Dietary Fibre

Dietary fibre is a part of plants that can be consumed and composed of carbohydrates which have resistance to digestion and absorption in the human intestine and fermented in the large intestine. Dietary fibre is the part of a plant cell that is not hydrolyzed or digested by human digestive enzymes

which include hemicellulose, cellulose, lignin, oligosaccharides, pectin, gum, and wax layers (Fairudz & Nisa, 2015). Dietary fibre can be divided into the soluble fibre and insoluble fibre in water. Water-soluble fibre has positive properties because it can reduce total blood cholesterol levels from low-density lipoprotein (LDL). One component of water-soluble fibre is pectin which is widely found in fruit (Soesilawaty, 2008).

Fibre is an important food component, especially in maintaining the health and balance of the digestive system function. Dietary fibre is known to have important health value, especially in reducing blood cholesterol, improving glucose absorption for people with diabetes, preventing colon cancer, and helping to lose weight. Several studies showed that seaweed is a potential material as a source of food fibre with several advantages compared to food from soil plants. When compared to production, the consumption of seaweed in the Indonesian community is still very low. The consumption of food fibre in the Indonesian people is still dominated by materials from soil plants (Dwiyitno, 2011).

Dietary fibre has the potential to reduce cholesterol levels, with a mechanism to bind fat in the small intestine, bind bile acids and increase excretion to faeces. The liver will increase plasma cholesterol uptake to be synthesized again into bile acid, it will reduce cholesterol levels in blood plasma (Rizma, 2017). Dietary fibre has been used. This is recommended to keep a normal blood cholesterol level. Consumption of dietary fibre is an effort to reduce cholesterol levels in the blood because dietary fibres can inhibit the absorption of cholesterol in the small intestine and eventually reduce cholesterol in the plasma, it increases cholesterol synthesis by the liver, bile synthesis, and cholesterol excretion through faeces (Nashriana, et al., 2015).

Seaweed is famous for its fibre content. Insoluble fibre in seaweed is generally in the form of cellulose, uronic acid, and neutral sugars such as mucosa, rhamnose, arabinose, galactose, anhydrogalactose, methylgalactose, xylose, mannose, and glucose. The content of water-soluble fibre *Eucheuma*

cottonii is much higher (18.3%) compared to its insoluble fibre (6.8%). (Dwiyitno, 2011). *Eucheuma sp.* contains carbohydrates 35-40%, cellulose component of 16-20%, hemicellulose 18-22%, lignin 7-8% and crude fibre 2.5-5% (Apriani & Zulfahmi, 2017)

Citrus peel can produce a valuable fibre. Pomelo albedo might be potentially used in producing functional fibres for its fibre components such as cellulose, hemicellulose, cellulose nanocrystal, lignin and pectin (Zain, et al., 2013). Pectin is mostly found in the grapefruit peel compared to other citrus peels. The percentage of purity of pectin in pomelo peel is 69.69% (Dewi, et al., 2013). And research from Octaviana, et al., (2013) shown in *Table 4* showed the pectin content in albedo pomelo at 2.94%.

2.5. Vitamin C

Vitamins are organic substances containing carbon which bind to hydrogen. These substances are needed by the body in small amounts for various physiological functions. Vitamins as micronutrients cannot be synthesized by the body so they must be obtained from food. Vitamins are often grouped according to their solubility, fat-soluble vitamins and water-soluble vitamins. Fat-soluble vitamins include vitamins A, D, E, and K, while vitamins that are water-soluble are vitamins B and vitamin C (Hardinsyah & Supariasa, 2017).

Vitamin C or ascorbic acid is one of the substances that play a role in the protection mechanism with exogenous antioxidants which can prevent oxidant formation and lipid peroxidation due to free radical attacks. The role of vitamin C in reducing cholesterol is to increase the conversion of cholesterol into bile salts. The bile acids in the liver excrete into the intestine. It excreted with faeces (Hapsari & Kusumastuti, 2014). In the other side, vitamin C also reduce the reabsorption of bile acids and their conversion to cholesterol. The role of antioxidants prevent the occurrence of lipid peroxidation (Inayah, et al., 2012).

Vitamin C is important in improving body health. The biochemical functions of vitamin C include stimulating several enzymes, collagen biosynthesis, hormonal activation, antioxidants, histamine detoxification, phagocytosis leukocytes, the formation of nitrosamines, and proline hydroxylation (Setiawati, et al., 2017). Vitamin C has an ability to resist reactive oxidation in plasma which can significantly reduce lipid peroxide. It will inhibit oxidative modification of LDL. This protection is able to maintain LDL to be recognized by LDL receptors so as to accelerate the clearance of LDL in the blood through the LDL catabolism pathway (Inayah, et al., 2012).

Citrus has a wide range of antioxidants such beta-carotene, ascorbic acid, terpenoids, alkaloids, beta-sitosterol, carotene, polyphenols such as flavonoids and flavone glycosides which can be a major source of natural or phytochemical antioxidants (Tan & Zarina, 2013). The components of the pomelo are located on the peel including alkaloid compounds, flavonoids, lycopene and vitamin C. The most dominant substances are pectin and tannins (Rafsanjani & Putri, 2015). Pomelo and its peel contain vitamin C which is very good as a source of antioxidants (Dyaningratri, 2011). The content and capacity of antioxidant in pomelo peels are higher compared to their pulps to protect antioxidants in the fruit from oxidation (Toh, et al., 2013). Research by Octaviana, et al., (2013) showed vitamin C values in pomelo albedo by 13.35% (*Table 4*)

2.6. Texture Property

Physical properties test is an important part of seeing the quality of a food product (Negara, et al., 2016). Food product quality is food quality that can be accepted by consumers such as size, shape, colour, consistency, texture and taste (Adinugraha & Michael, 2015). Texture greatly affects the food that can be felt by pressure and movement of receptors on mouth (Irmayanti, et al., 2017).

Every food product has different texture. The texture is one of the important aspects in determining the quality of food. There are various

types of texture parameters that are often used, such as hardness, elasticity, adhesiveness, crispness. Fragility can be identified by the human senses. The texture of food is related to the consistency that can be felt, such as: hard or soft, crisp or not, smooth or thick, can flow or clot. The texture can be felt when the food is stirred, poured, pumped, pulled, and eaten (Aryanti, 2016). Texture analysis can be done organoleptically. However, it cannot provide accurate data because panellist assessment can be influenced by many factors such as gender, age, physical condition, and other factors. Texture measurements with texture analyzer are considered more accurate because they are not influenced by these factors (Aryanti, 2016).

Gel strength is a parameter to determine the physical quality of a gelatin product (Said, et al., 2014). Gel strength is the main physical property of carrageenan because gel strength shows the ability of carrageenan in forming a gel (Zainuddin, 2012). The strength of gel depends on the hydrogen bonds between water molecules with the free hydroxyl group of amino acid groups, the size of the protein chain, the concentration and distribution of collagen molecular weight (Said, et al., 2014). Gel Strength (Kg/gr) is by the maximum pressure that the gel can hold to maintain its structure after being extruded (Afriani, et al., 2012). Gel strength can be affected by water content. The higher the water content will reduce the gel strength (Afandi, et al., 2015)

2.7. Theoretical Framework

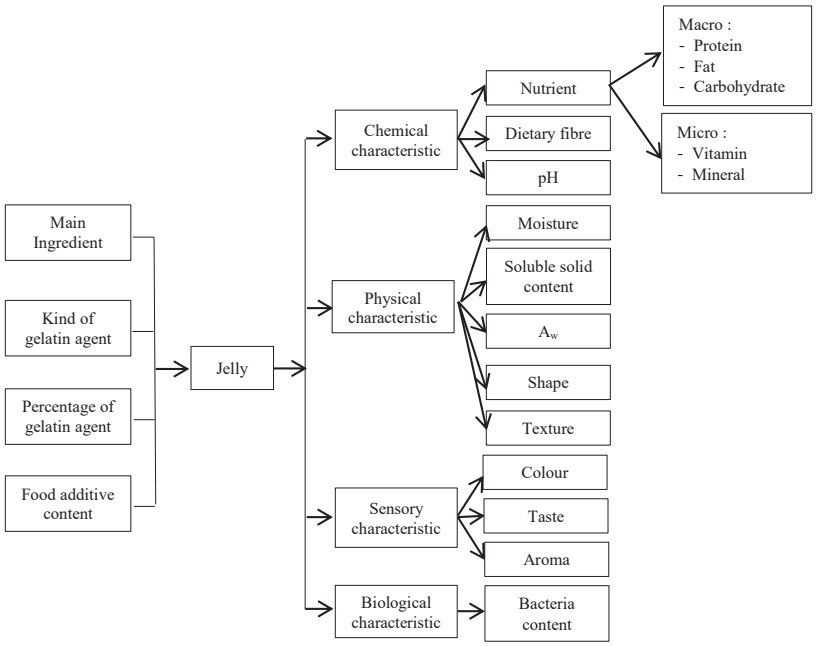


Figure 3. Theoretical Framework

Modification framework from Adinugraha & Michael (2015), Aryanti (2016), Hardinsyah & Supariasa (2017), Novitasari, et al., (2016), Octaviana, et al., (2013), SNI 01-3552 (1994).

2.8. Conceptual Framework

Based on the theoretical framework that underlies the researcher in carrying out the research, a conceptual framework will be examined by researchers as shown in the following figure :

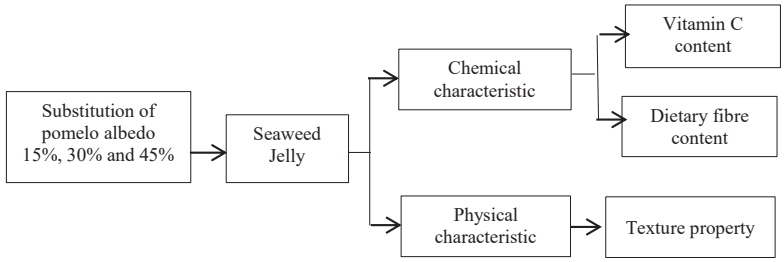


Figure 4. Conceptual Framework

2.9. Research Hypothesis

2.9.1. Major Hypothesis

The substitution of pomelo albedo in seaweed jelly is affected the nutrition value and the texture property of the jelly product.

2.9.2. Minor Hypothesis

1. The substitution of pomelo albedo affected the dietary fibre content of seaweed jelly.
2. The substitution of pomelo albedo affected the vitamin C content of seaweed jelly.
3. The substitution of pomelo albedo affected the texture property of seaweed jelly.

CHAPTER III

RESEARCH METHOD

3.1. Research Design

The type of research used in this study is an experimental study in the food and nutrition technology laboratory. In this study, a completely randomized design (CRD) method was used with one factor. That is the addition of pomelo albedo with 4 analysis treatments by 2 replications of samples, each of which fibre content, vitamin C and texture property were analyzed. The data obtained was analyzed by ANOVA test which if there is a difference, the analysis is continued using the Post hoc test.

The experiment sample consisted of four substitution formulations, there are three experimental groups and one control group. Then, the control group with no substitution was given a C code which was a comparison to the group given experimental treatment. Samples with 15% substitution were given code SJ 1, substitution of 30% was given code SJ 2, and 45% were coded SJ 3. Experiments in this study were carried out two repetitions, which meant making seaweed jelly with pomelo albedo substitution was repeated twice with the same basic ingredients.

The following is an experimental design scheme in making seaweed jelly with the substitution of pomelo albedo:

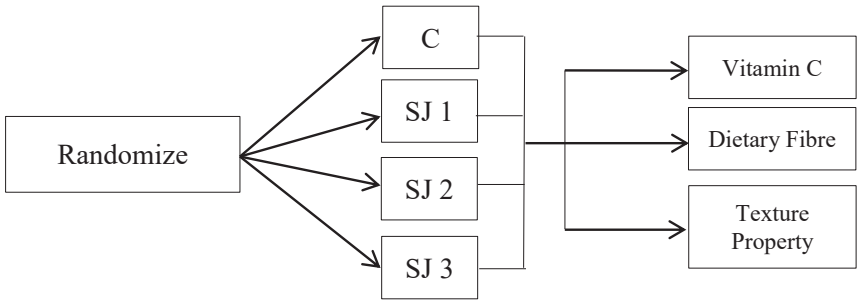


Figure 5. Research Design

3.2. Time and Place of Research

This research was conducted in December 2018 until February 2019. The production of seaweed jelly was carried out at laboratory of the Faculty of Science and Technology, University of Darussalam Gontor. Analysis of dietary fibre, vitamin C and texture property were carried out at the CV Chem-Mix Pratama Yogyakarta Laboratory.

3.3. Research Instrument

The instrument used in making seaweed jelly includes spoons, knives, basins, blenders, stoves, pans, moulds and scales. The instrument used in the analysis of the content of seaweed jelly are:

a. Dietary fibre analysis: Analytical scales, water purifiers, Erlenmeyer glasses, ovens, incubators, filter paper, and desiccators.
b. Analysis of vitamin C content: Analytical scales, gooc crucible, volumetric flask, drop pipette, and Erlenmeyer glass.
c. Texture analysis: Texture analyzer

3.4. Research Material

The ingredients used in making seaweed jelly includes seaweed (*Eucheuma cottonii*), granulated sugar, citric acid, vanilla, NaCl, pomelo albedo and whiting. Comparison of materials used in this study is listed in *Table 5*. as follows:

Table 5. Formulation of Seaweed Jelly

Ingredients	Formulation C	Formulation SJ 1	Formulation SJ 2	Formulation SJ 3
Seaweed (g)	200	170	140	110
Pomelo albedo (g)	0	30	60	90
Sugar (g)	50	50	50	50
Citric acid (g)	0.4	0.4	0.4	0.4
Vanilla (g)	1	1	1	1
NaCl (g)	0.4	0.4	0.4	0.4
Gelatin (g)	1	0	0	0
Water (ml)	200	200	200	200

Source: Yuliati, et al., 2016

The material used in the analysis of seaweed jelly content is:

a. Analysis of dietary fibre: buffer phosphate ph 7, alpha amylase enzyme, distilled water, 1 N HCl, 1% pepsin enzyme, 1N NaOH, beta amylase enzyme, ethanol, acetone.
b. Analysis of vitamin C levels: aquades, starch solution, iodine standard

3.5. Operational Definition

Table 6. Operational Definition

No	Variable	Definition	Unit	Scale
1	Jelly	The procedure for making jelly in this study was a modification of the formulation and procedure for processing seaweed jelly by Yuliati, et al., (2016). Jelly was prepared in four different formulations, one used by control and three with seaweed and pomelo albedo substitution.	Gram	Nominal
2	Seaweed	Dried seaweed *Eucheuma cottonii* were used as the main ingredient in making jelly. The seaweed soaked about 3 days until the seaweed blooms before use.	Gram	Ratio
3	Pomelo albedo	Pomelo part which used is inner peel or pomelo albedo (*Citrus maxima*), the part with white colour and sponge texture, soaked in water with whiting and used as the substitution in jelly by percentage: 15%, 30% and 45%.	Gram	Ratio
4	Dietary fibre	Total dietary fibre of seaweed jelly with a substitution of pomelo albedo was determined by a multi-enzymatic method	Gram	Ratio
5	Vitamin C	Vitamin C content in seaweed jelly with a substitution of pomelo albedo was determined by iodometry method	mg/g	Ratio
6	Texture	Seaweed jelly with a substitution of pomelo albedo texture analyzed by using a texture analyzer by placing a sample on the object table.	kg/mm	Ratio

3.6. Research Procedure

This study was divided into 4 stages, the first step was determining the percentage of pomelo albedo substitution. The percentage of pomelo albedo substitution determined at this stage was 15%, 30% and 45%. Pomelo albedo added during the cooking process of seaweed jelly.

The second stage was the preparation. Before experiments were carried out, the instruments and materials used in this study need to be prepared. The preparation stage must be carried out carefully and thoroughly so that in the future the research process regarding the analysis of fibre content, vitamin C and the texture property of seaweed jelly with the substitution of pomelo albedo run smoothly without any obstacles. Material preparation also includes the selection of raw materials and additional materials to obtain good sample quality. The material used in this study is seaweed (*Eucheuma cottonii*) which will be processed into jelly with pomelo albedo (*Citrus maxima*) substitution by grouping samples into 4 sample groups, namely: C (control group), SJ 1 (15% substitution) , SJ 2 (30% substitution), and SJ 3 (45% substitution).

The third stage was making seaweed jelly with pomelo albedo substitution. The fourth stage of this research was the analysis of dietary fibre content, vitamin C levels and texture property in seaweed jelly with pomelo albedo substitution. The research procedure can be seen in *Figure 6*.

3.7. The Procedure for Making Jelly

The procedure for making jelly in this study was a modification of the formulation and procedure for processing seaweed jelly by Yuliati, et al., (2016) and the procedure scheme can be seen in *Figure 7*.

a. Making seaweed jelly begins with washing dried seaweed and soaking for 3 days with a 20:1 ratio of water:seaweed until the seaweed blooms with soaking water which is replaced every 12 hours.
b. Peel pomelo and separate the albedo with the green outer part. Wash pomelo albedo with running water then cut and soak using 2

litres of water with 31 g whiting for 12 hours and wash again.

c. Previously, prepare seaweed and albedo, then weighed according to the treatment group and smoothed using a blender and water.

d. The dough that has been smooth is then cooked until the solubility is evenly distributed with 30 minutes cooking time and then add the other ingredients.

e. Pour the cooked mixture into the mould and cooled.

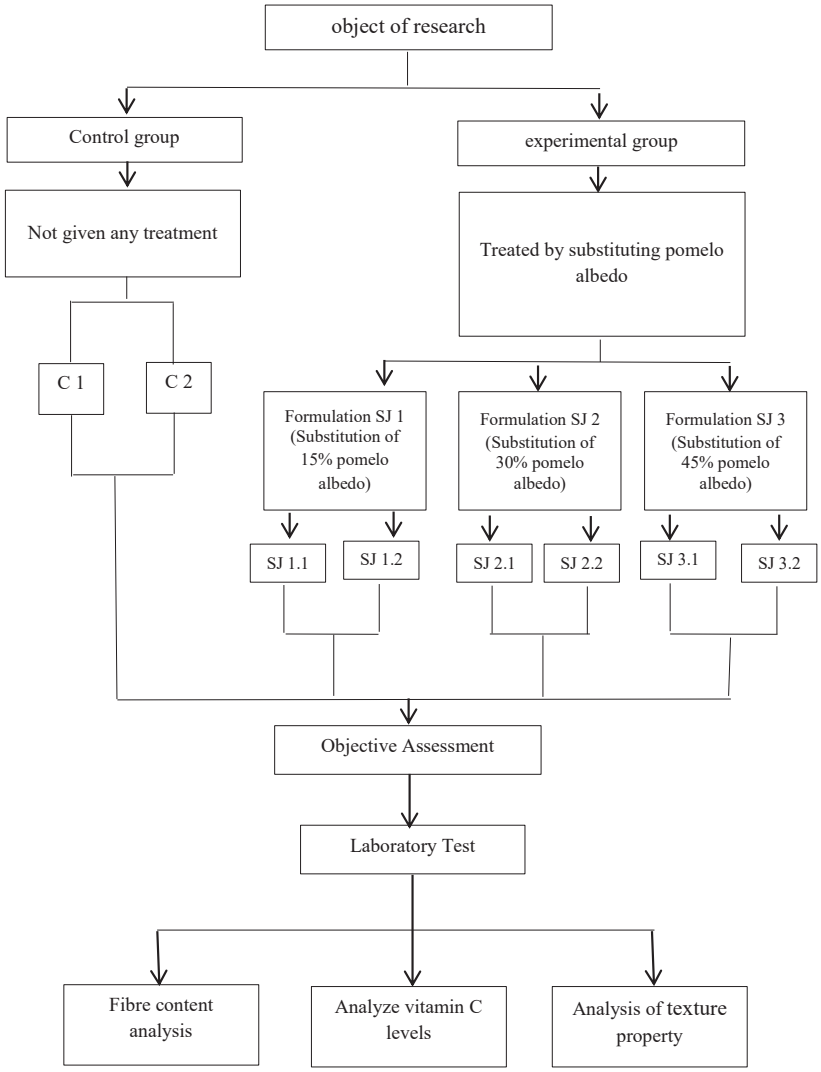


Figure 6. Research Procedure

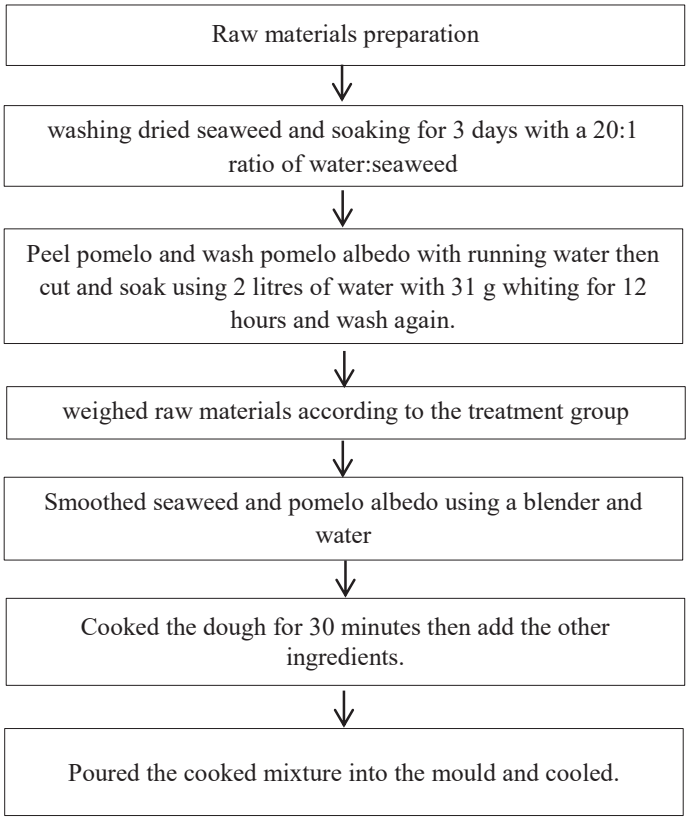


Figure 7. The Procedure for Making Jelly

3.8. Analysis Method

There are three analyzes that will be carried out: the analysis of the chemical content of seaweed jelly in the form of dietary fibre and vitamin C analysis and texture property test, like the gel strength of seaweed jelly substituted by pomelo albedo.

a. Chemical Analysis

1) Analysis of Dietary Fibre

The total dietary fibre tested in this study was all of the insoluble fibres and soluble fibres and will be carried out by multi-enzymatic methods. Procedure Analysis of fibre content can be seen in the following scheme:

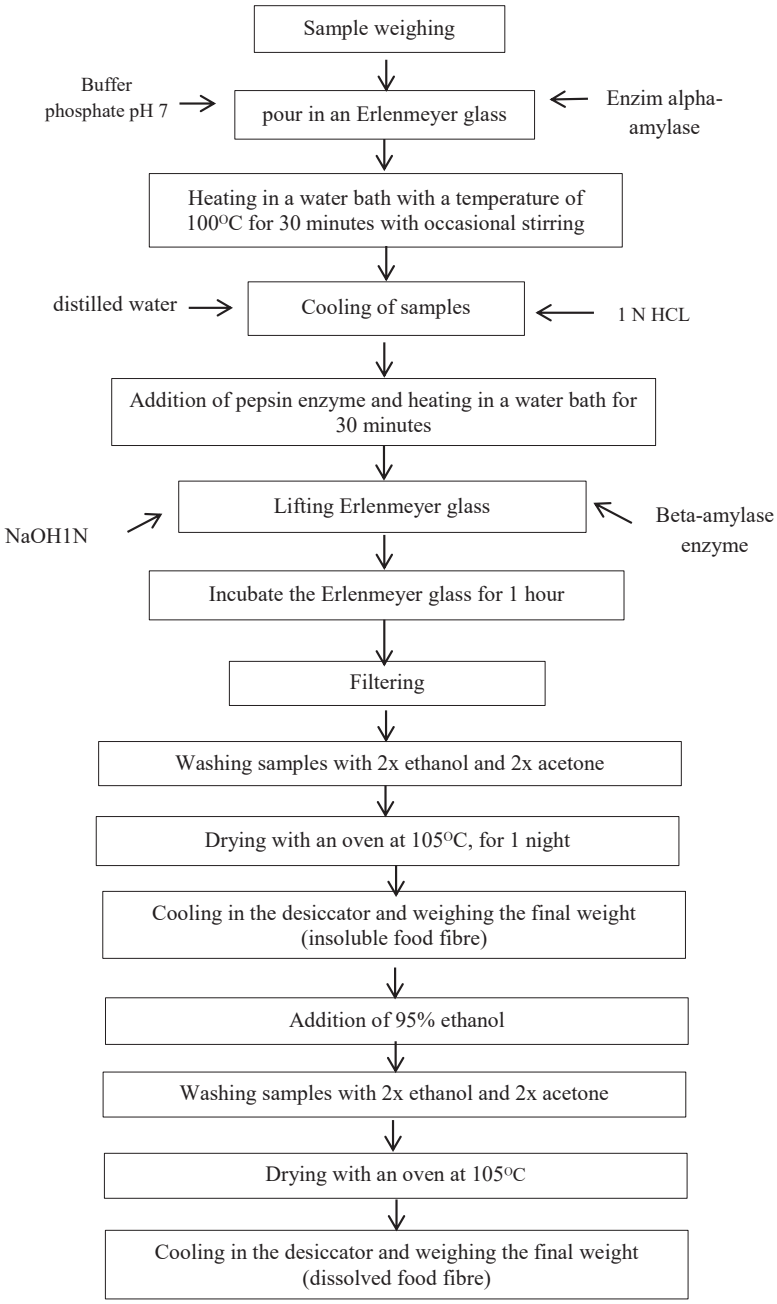


Figure 8. Multi-enzymatic Method

Calculation of total dietary fibre content

Total dietary fibre = insoluble food fibre + dissolved food fibre

2) Analysis of Vitamin C Levels

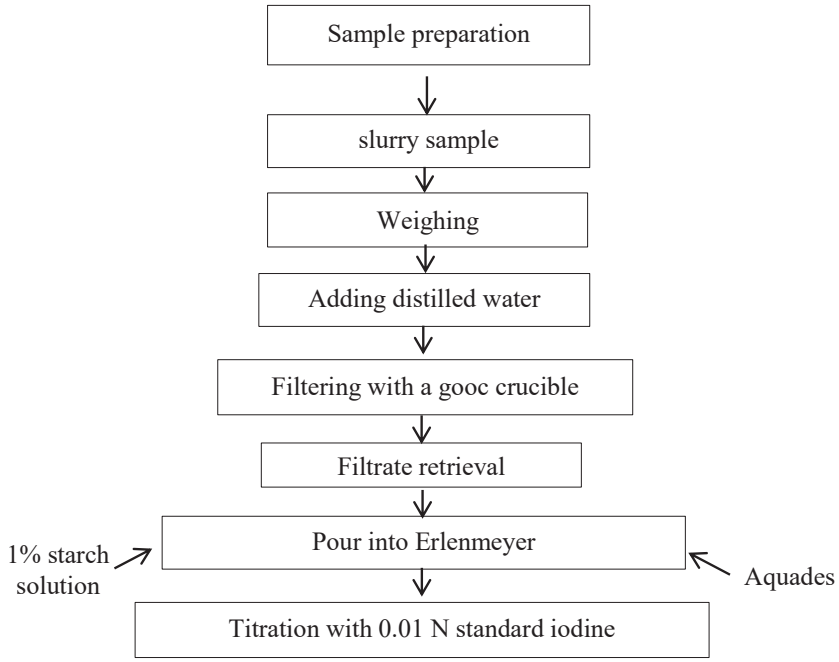


Figure 9. Iodometry Method

Calculation of vitamin C levels

$$\text{Vit.C (mg / 100g)} = \frac{(V\ I_2\ x\ 0.88\ x\ Fp)\ x\ 100}{Ws\ (gram)}$$

V I2 = Iodine Volume (mL)

0.88 = 0.88 mg ascorbic acid is equivalent to 1 mL of 0.01 N I2 solution

Fp = Dilution Factor

W = sample weight (gram)

b. Texture Analysis

Jelly texture analysis is done by using a texture analyzer by placing the sample on the object table. The probe on the device is lowered to touch the sample then the tool will run automatically.

3.9. Data Analysis

The data that has been obtained are presented in the table. It was analyzed by statistic data. Data analysis of dietary fibre content, vitamin C and texture was analyzed by one-way analysis of variance (ANOVA) to analyze the differences in fibre content, vitamin C and texture in each formulation group. If there is a significant difference in the ANOVA test which is indicated by the p-value < 0.05, the data analysis is continued using the Post hoc test which is used to see which formulation group has the most meaningful or the most influential difference. If the value of p-value is < 0.05, there are significant differences in the substitution effect between each group with different formulations, whereas if the p-value is > 0.05 then there is no significant effect between the groups given the different formulations.

3.10. Discussion Systematics

The experimental research was carried out starting with making seaweed jelly with 15%, 30% and 45% of pomelo albedo substitution and seaweed jelly with 0% of albedo as a control. The seaweed jelly produced then tested for fibre content using the multi-enzymatic methods, vitamin C levels with iodometry method and physical property using a texture analyzer. The results then compared between each group of samples with different variations of albedo substitution, so that the effect of pomelo albedo substitution on fibre content, vitamin C and the texture property of seaweed jelly was known.

CHAPTER IV

RESULTS AND DISCUSSION

4.1. Overview of Research

Seaweed jelly in this study was made by pomelo albedo substitution with the aimed of utilizing the pectin contained in albedo as a forming material for the texture of gelatin substitutes commonly used in making jelly. The study was conducted by comparing the levels of vitamin C, dietary fibre and the texture of seaweed jelly using gelatin as an additional food ingredient in the control group and seaweed jelly substituted by pomelo albedo as much as 15%, 30% and 45% as the comparison group to obtain the jelly formula has the highest vitamin C and fibre content and which formulation has a texture that resembles a control group and the effect of pomelo albedo substitution on seaweed jelly will be analyzed.

The raw materials used in this study were *Eucheuma cottonii*, pomelo albedo as substitutes and other additives such as sugar, citric acid, vanilla, NaCl, and water. *Eucheuma cottonii* used is a seaweed that has been through the drying process, the drying process can help to maintain the shelf life of seaweed so that the quality is more maintained and the pomelo albedo used is a type of fresh *Citrus maxima*. The material used in the study has not been damaged and has been cleaned and washed carefully to remove the dirt before entering the jelly product processing.

The research process begins by determining the percentage of pomelo albedo as a substitute for jelly ingredients, 15%, 30% and 45% is the percentage substitution used in this study. Making jelly begins with the selection of raw materials. The existing material is sorted according to predetermined criteria and cleaned before use, after sorting the next preparation is to soak seaweed for three days with clean water that is replaced every 12 hours so that the seaweed blooms and removes the dirt that sticks. Pomelo albedo used in this study was fresh albedo. The pomelo should be fresh peeled before processing. Peeled pomelo albedo was soaked in water

mixed with whiting for 12 hours then washed to reduce the bitter taste of albedo. The next step is to weigh and separate the ingredients according to the treatment group and cook them into jelly.

Jelly products are left in the jelly mould and form gel solids. Jelly products that have been finished are coded according to the treatment formulation, jelly gelatin products as controls are coded C, jelly products with 15% pomelo albedo substitution are given code SJ 1, 30% pomelo albedo substitution are given code SJ 2, and 45% pomelo albedo substitution are given code SJ 3. Analysis of vitamin C content in seaweed jelly products is done by iodometry titration method, analysis of fibre content of seaweed jelly is done by multi-enzymatic method while texture analysis is done by using a texture analyzer. Data obtained from the results of the analysis are processed computerized to determine whether or not there are significant differences between each treatment group and which groups have significant differences. It can be concluded the effect of the substance of pomelo albedo on the content of vitamin C, dietary fibre and seaweed jelly texture.

4.2. Results

4.2.1. Analysis of Pomelo Albedo Substitution Effect on Vitamin C Content in Seaweed Jelly

Analysis of vitamin C content in seaweed jelly shows that the addition of pomelo albedo substitution on seaweed jelly had significant results in increasing vitamin C content of the product. The results of ANOVA test can be seen in *Table 7*. ANOVA test shows that the addition of pomelo albedo substitution had a significant effect with a significance value of p-value 0.000.

Based on the results of the post hoc test of vitamin C levels in seaweed jelly presented in *Table 7*, it can be seen that the difference in the substitution formulations of pomelo albedo had a significant effect on vitamin C levels of each group. Vitamin C levels increase along with increased substitution of pomelo albedo. According to its

quantity, these results indicated that the best vitamin C content is found in seaweed jelly products with SJ 3 code or substitution of 45% pomelo albedo which was known to have a vitamin C content of 32.39% ± 2.070.

Table 7. Anova Test Results for Vitamin C (%) Contents

Group	Mean	±	SD	p-value
C	7.64	±	0.999[a]	0.000
SJ 1	15.50	±	1.576[b]	
SJ 2	18.62	±	1.004[c]	
SJ 3	32.39	±	2.070[d]	

Note: C = Substitution 0%, SJ 1 = Substitution 15%, SJ 2 = Substitution 30%, SJ 3 = Substitution45%
Sample with a different alphabet in one column shows a significant difference between group

4.2.2. Analysis of Pomelo Albedo Substitution Effect on Dietary Fibre Content in Seaweed Jelly.

Based on ANOVA test of dietary fibre content in the seaweed jelly, it could be concluded that different percentage of pomelo albedo substitution significantly affected the dietary fibre content with a significance value of p-value 0.000. ANOVA test results on dietary fibre content in seaweed jelly sample are shown in *Table 8*.

Table 8. Anova Test Results for Dietary Fibre (%) Contents

Group	Mean	±	SD	p-value
C	0.43	±	0.118[a]	0.000
SJ 1	1.10	±	0.212[b]	
SJ 2	1.64	±	0.169[c]	
SJ 3	2.60	±	0.285[d]	

Note: C = Substitution 0%, SJ 1 = Substitution 15%, SJ 2 = Substitution 30%, SJ 3 = Substitution45%
Sample with a different alphabet in one column shows a significant difference between group

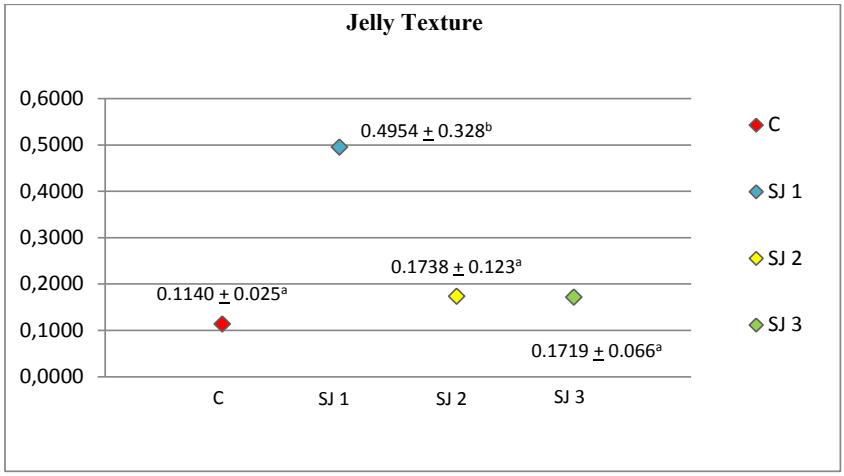
Analysis of dietary fibre in various seaweed jelly with pomelo albedo substitution shows the different percentage of fibres contained in each jelly formulation group. The analysis of fibre content in seaweed jelly with pomelo albedo substitution in Table 8 shows a significant effect on dietary fibre levels of each group. Dietary fibre content increase along with increased of pomelo albedo substitution. The analysis of dietary fibre content shows that the sample with the best dietary fibre content is a sample with code SJ 3 (2.60% ± 0.285) while the sample with the lowest dietary fibre content value is in the sample with code C (0.43% ± 0.118).

4.2.3. Analysis of Pomelo Albedo Substitution Effect on Gel Strength of Seaweed Jelly.

Texture analysis performed on jelly samples can determine the gel strength values of the samples and express in Newton (N) units. *Figure 10* which is the result of ANOVA test on gel strength of seaweed jelly products shows a significance value of p-value 0.041. Significant values in ANOVA test shows that there were at least 2 groups with significantly different gel strength values. The post hoc test results showed that there was no significant difference between the group with the addition of pomelo albedo substitution to the value of seaweed jelly gel strength with the codes C, SJ 2 and SJ 3 while the sample with code SJ 1 had a noticeable difference compared to the other samples.

The average value of gel strength from the control group is 0.114 N ± 0.024 based on these data, it can be stated that the gel strength of the experimental group who approached the control group is a sample with formulation SJ 3 with a gel strength value of 0.172 N ± 0.066, and a sample that had a considerable distinction was sample of formulation SJ 1 with gel strength values of 0.495 N ± 0.328.

Figure 10. Anova Test Results for Texture (N) of Seaweed Jelly



Note: C = Substitution 0%, SJ 1 = Substitution 15%, SJ 2 = Substitution 30%, SJ 3 = Substitution45%
Sample with a different alphabet in one column shows a significant difference between group

4.3. Discussions

4.3.1. Pomelo Albedo Substitution Effect on Vitamin C Content in Seaweed Jelly.

Pomelo albedo was a product that has good lycopene and vitamin C as a source of antioxidants (Fadraersada, 2015). The substitution of pomelo albedo given to seaweed jelly can increase the vitamin C content in jelly products. Based on the test results of vitamin C content seen in *Table 7*, samples with C code or 0% pomelo albedo substitution have a vitamin C content of 7.64%, this number continues to increase with the increasing percentage of pomelo albedo substitution, in jelly with code SJ 1 or 15% pomelo albedo substitution found to have vitamin C content of 15.5%, 18.62% vitamin C content in jelly with code SJ 2 or 30% pomelo albedo substitution, and 32.39% vitamin C content in jelly with SJ 3 code or pomelo albedo substitution 45%.

Seaweed is a good source of vitamin C, but in its processing, vitamin C in seaweed or albedo can easily reduce, either by temperature,

light and surrounding air. Vitamin C content decreases compared to the raw material before processed due to an oxidation reaction when slicing using a knife and blending the raw material (Octaviana, et al., 2013). The substitution of pomelo albedo was carried out with the aim of increasing the vitamin C content in seaweed jelly products which were lost after processing. The results of a study by Nianti (2017) showed that the addition of citrus peel powder had a significant effect (p-value <0.05) on the brightness, suppleness, vitamin C content, and organoleptic properties of aroma, taste, colour, and preference of jelly product. The higher the concentration of citrus peel powder added, the higher the vitamin C content of jelly products. Research by Octaviana, et al., (2013) on the manufacture of pomelo albedo and rosella jelly shows that the more content of pomelo albedo, the more vitamin C content in jelly products.

4.3.2. Pomelo Albedo Substitution Effect on Dietary Fibre Content in Seaweed Jelly

The high fibre content of a product depend on the content and concentration of the ingredients used (Wintirani, 2016). Pomelo albedo is the white, spongy and cellulosic tissue as the principal citrus peel component and a functional product that can be used as food ingredients due to its high fibre content. Pomelo albedo is also expressed as a low-calorie food ingredient (Zain, et al., 2014). The dietary fibre content in jelly products is increased with increasing percentage of pomelo albedo substitution. Based on the analysis results of dietary fibre content shown in *Table 8*, it can be concluded that the highest content of dietary fibre is owned by the sample of seaweed jelly with code SJ 3 (2.60%) and the lowest content of dietary fibre found in jelly formulation coded C, which is 0.43%.

Pomelo albedo is a food that contains pectin. The pectin content in pomelo albedo is quite high compared to other types of citrus (Octaviana, et al., 2013). The addition of the percentage of pomelo

albedo in various formulations can increase the pectin content in jelly formulations depending on the number of pomelo albedo substituted. According to Dewi (2017), the results of fibre analysis showed that along with the addition of more pectin extracts in one sheet jam formula, the fibre content produced tends to increase.

4.3.3. Pomelo Albedo Substitution Effect on Gel Strength of Seaweed Jelly

The jelly candy texture is related to hard and soft or the elasticity of the product produced. The jelly candy texture produced was influenced by several factors, there are water content, sugar concentration, and pH. The high water content in the product will affect the texture to be soft (Octaviana, et al., 2013). Some things that can affect the texture of food are temperature and cooking time, this was because the higher the temperature and the longer time used when processing food causes the moisture content in the evaporating material to make the product hard. While high sugar levels will cause food to become hard (Nilasari, et al., 2017).

Pectin is widely used to modify texture, so the product has a chewy texture. Pectin cannot form a gel well without sugar and acid. Supporting materials that affect the elasticity of jelly candies are fructose syrup, sucrose, carrageenan and citric acid (Sahputra, et al., 2018). The pectin content found in pomelo albedo is quite high when compared to other types of citrus (Octaviana, et al., 2013). The content of pectin found in fruit pulps and the citrus peel will be very useful if processed as marmalade or jelly candy and the research from Nianti (2017) showed that the higher the concentration of adding citrus peel powder decreases the elasticity and brightness of jelly candy. Increasing the concentration of pectin can reduce water content (Syarifuddin & Yunianta, 2015).

Addition of pectin to food can improve the texture and make the texture of food more solids and compact. The process of cooking and

heating can affect the character and texture of food. Research by Dewi, et al., (2013) showed that the heating process made the consistency of the albedo jam rather fluid due to the heating of the albedo in the form of a sponge absorbing a lot of water so that the texture was destroyed and the jam produced by the texture became rather liquid. Texture product can depend on the content and concentration of the ingredients used. The raw material used in this study was albedo in fresh form and not albedo pectin extract. The results of this study indicate that the value of gel strength continues to decline with the addition of pomelo albedo substitution, pomelo albedo is a white raw material with spongy texture so that the decrease in gel strength of the sample is estimated because of the large amount of water absorbed by pomelo albedo during the cooking process resulting in gel strength continues to decrease with the addition of the percentage of pomelo albedo substitution.

The Qur'an describes the process of developing plants that start from seeds and then take root, then grow with a strong staple and then stem, leaf, and finally produce fruit that can be harvested. In the Qur'an, Allah SWT. has explained various kinds of food ingredients with various benefits to be studied and understood by humans. Repeatedly the Qur'an calls the role of plants as food and medicine for humans. In the Qur'an mentioned:

وَهُوَ ٱلَّذِيٓ أَنشَأَ جَنَّٰتٍ مَّعۡرُوشَٰتٍ وَغَيۡرَ مَعۡرُوشَٰتٖ وَٱلنَّخۡلَ وَٱلزَّرۡعَ مُخۡتَلِفًا أُكُلُهُۥ وَٱلزَّيۡتُونَ وَٱلرُّمَّانَ مُتَشَٰبِهٗا وَغَيۡرَ مُتَشَٰبِهٖۚ كُلُواْ مِن ثَمَرِهِۦٓ إِذَآ أَثۡمَرَ وَءَاتُواْ حَقَّهُۥ يَوۡمَ حَصَادِهِۦۖ وَلَا تُسۡرِفُوٓاْۚ إِنَّهُۥ لَا يُحِبُّ ٱلۡمُسۡرِفِينَ

Meaning: *And He is Who produces gardens (of vine), trellised and untrellised, and palms and seed-produce of which the fruits are of various sorts, and olives and pomegranates, like and unlike; eat of its fruit when it bears fruit, and pay the due of it on the day of its reaping, and do not act extravagantly; surely He does not love the extravagant.*

Plants have a very important role in human life. In the Qur›an, there are verses which state the role of plants, among them, as provisions for humans which are stated in the Surah Al-Mukminun verses 18-19. There are certain foods and beverages that are prohibited from being consumed, actually aiming to protect humans from food which has a negative effect on the body and humans should abandon what they have forbidden. In a hadith, the Prophet Muhammad. said:

إِنّ الْحَلَالَ بَيِّنٌ وَإِنّ الْحَرَامَ بَيِّنٌ وَبَيْنَهُمَا أُمُورٌ مُشْتَبِهَاتٌ لَا يَعْلَمُهُنّ كَثِيرٌ مِنْ النّاسِ

Meaning: *"That which is lawful is clear and that which is unlawful is clear, and between the two of them are doubtful matters about which many people do not know."*

Gelatin production in the world reaches 326,000 tons/year and 46% of it is gelatin made from pork skin. In this study, making seaweed jelly with the substitution of pomelo albedo included aims to replace the use of gelatin with natural pectin ingredients contained in pomelo albedo so that produced products that have a more guaranteed halal status and reduce concerns when consuming jelly.

CHAPTER V

CLOSING

5.1. Conclusions

1. The content of vitamin C in various sample groups has a significant difference (p-value 0.000). The best vitamin C content is found in seaweed jelly products with SJ 3 code or substitution of 45% pomelo albedo which is known to have a vitamin C content of 32.39%.
2. Jelly dietary fibre continues to increase with the increasing percentage of pomelo albedo substitution and shows significant differences between each formulation group (p-value 0.000) and the highest fibre content found in the sample with 45% of pomelo albedo substitution (2.60%).
3. The jelly texture shows a significant difference results with p-value 0.041. The difference shows in a sample with SJ 1 code, but samples SJ 2 and SJ 3 do not show a significant difference, so with the right amount, pectin in pomelo albedo can be used as a substitute for gelatin.

5.2. Recommendations

1. A hedonic test is needed to determine which formulation is acceptable and preferred by consumers.
2. Tests are needed to determine the suitability of jelly formulations quality with jelly quality standards according to SNI.
3. **The jelly formula in this study is a basic formula in making jelly and can be developed to make other jelly formulations so that it can increase the variety of processed seaweed and pomelo albedo products.**

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APPENDIX

Appendix 1. The Outcome of Chemical Analysis

Vitamin C Content of Seaweed Jelly with Pomelo Albedo Substitution

Sample Code	1		2		Total	Average
	Test 1	Test 2	Test 1	Test 2		
C = Substitution 0%	6,9385	8,6731	6,6382	8,2978	30,5476	7,6369
SJ 1 = Substitution 15%	17,4326	15,6893	13,5931	15,2922	62,0072	15,5018
SJ 2 = Substitution 30%	19,6286	17,9929	19,3036	17,5487	74,4738	18,6185
SJ 3 = Substitution 45%	33,2955	29,9659	31,5763	34,7339	129,571	32,3929

Dietary Fibre Content of Seaweed Jelly with Pomelo Albedo Substitution

Sample Code	1		2		Total	Average
	Test 1	Test 2	Test 1	Test 2		
C = Substitution 0%	0,5866	0,4624	0,3399	0,3409	1,7298	0,4325
SJ 1 = Substitution 15%	1,3517	1,2066	0,9560	0,9008	4,4151	1,1038
SJ 2 = Substitution 30%	1,4538	1,5559	1,8233	1,7431	6,5761	1,6440
SJ 3 = Substitution 45%	2,4527	2,2674	2,8453	2,8267	10,3921	2,5980

Texture (Gel Strength) of Seaweed Jelly with Pomelo Albedo Substitution

Sample Code	1		2		Total	Average
	Test 1	Test 2	Test 1	Test 2		
C = Substitution 0%	0,0792	0,1206	0,1382	0,1180	0,4560	0,1140
SJ 1 = Substitution 15%	0,6857	0,8565	0,2605	0,1787	1,9814	0,4954
SJ 2 = Substitution 30%	0,2694	0,2905	0,0657	0,0695	0,6951	0,1738
SJ 3 = Substitution 45%	0,2385	0,2174	0,1083	0,1232	0,6874	0,1719

Appendix 2. Statistical Analysis of Vitamin C content in Seaweed Jelly

Case Processing Summary

	Sample	Cases					
		Valid		Missing		Total	
		N	Percent	N	Percent	N	Percent
Vitamin C (%)	C = Substitution 0%	4	100.0%	0	.0%	4	100.0%
	SJ 1 = Substitution 15%	4	100.0%	0	.0%	4	100.0%
	SJ 2 = Substitution 30%	4	100.0%	0	.0%	4	100.0%
	SJ 3 = Substitution 45%	4	100.0%	0	.0%	4	100.0%

Tests of Normality

	Sample	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Vitamin C (%)	C = Substitution 0%	.258	4	.	.881	4	.343
	SJ 1 = Substitution 15%	.203	4	.	.982	4	.914
	SJ 2 = Substitution 30%	.252	4	.	.897	4	.417
	SJ 3 = Substitution 45%	.169	4	.	.988	4	.945

a. Lilliefors Significance Correction

Descriptives

Vitamin C (%)	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min.	Max.
					Lower Bound	Upper Bound		
C = Substitution 0%	4	7.6369	.99928	.49964	6.0468	9.2270	6.64	8.67
SJ 1 = Substitution 15%	4	15.5018	1.57588	.78794	12.9942	18.0094	13.59	17.43
SJ 2 = Substitution 30%	4	18.6184	1.00424	.50212	17.0205	20.2164	17.55	19.63
SJ 3 = Substitution 45%	4	32.3929	2.06979	1.03490	29.0994	35.6864	29.97	34.73
Total	16	18.5375	9.33235	2.33309	13.5647	23.5104	6.64	34.73

Test of Homogeneity of Variances

Vitamin C (%)

Levene Statistic	df1	df2	Sig.
1.153	3	12	.368

ANOVA

Vitamin C (%)	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1280.069	3	426.690	194.513	.000
Within Groups	26.324	12	2.194		
Total	1306.392	15			

Multiple Comparisons

Vitamin C (%)
LSD

(I) Sample	(J) Sample	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
C = Substitution 0%	SJ 1 = Substitution 15%	-7.86490*	1.04729	.000	-10.1467	-5.5831
	SJ 2 = Substitution 30%	-10.98155*	1.04729	.000	-13.2634	-8.6997
	SJ 3= Substitution 45%	-24.75600*	1.04729	.000	-27.0378	-22.4742
SJ 1 = Substitution 15%	C = Substitution 0%	7.86490*	1.04729	.000	5.5831	10.1467
	SJ 2 = Substitution 30%	-3.11665*	1.04729	.012	-5.3985	-.8348
	SJ 3 = Substitution 45%	-16.89110*	1.04729	.000	-19.1729	-14.6093
SJ 2 = Substitution 30%	C = Substitution 0%	10.98155*	1.04729	.000	8.6997	13.2634
	SJ 1 = Substitution 15%	3.11665*	1.04729	.012	.8348	5.3985
	SJ 3 = Substitution 45%	-13.77445*	1.04729	.000	-16.0563	-11.4926
SJ 3 = Substitution 45%	C = Substitution 0%	24.75600*	1.04729	.000	22.4742	27.0378
	SJ 1 = Substitution 15%	16.89110*	1.04729	.000	14.6093	19.1729
	SJ 2 = Substitution 30%	13.77445*	1.04729	.000	11.4926	16.0563

*. The mean difference is significant at the 0.05 level.

Appendix 3. Statistical Analysis of Dietary Fibre Content in Seaweed Jelly

Case Processing Summary

	Sample	Cases					
		Valid		Missing		Total	
		N	Percent	N	Percent	N	Percent
Dietary Fibre (%)	C = Substitution 0%	4	100.0%	0	.0%	4	100.0%
	SJ 1 = Substitution 15%	4	100.0%	0	.0%	4	100.0%
	SJ 2 = Substitution 30%	4	100.0%	0	.0%	4	100.0%
	SJ 3 = Substitution 45%	4	100.0%	0	.0%	4	100.0%

Tests of Normality

	Sample	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Dietary Fibre (%)	C = Substitution 0%	.282	4	.	.865	4	.280
	SJ 1 = Substitution 15%	.257	4	.	.915	4	.510
	SJ 2 = Substitution 30%	.221	4	.	.946	4	.692
	SJ 3 = Substitution 45%	.289	4	.	.865	4	.280

a. Lilliefors Significance Correction

Descriptives

Dietary Fibre (%)	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min.	Max.
					Lower Bound	Upper Bound		
C = Substitution 0%	4	.43245	.117765	.058883	.24506	.61984	.340	.587
SJ 1 = Substitution 15%	4	1.10378	.212192	.106096	.76613	1.44142	.901	1.352
SJ 2 = Substitution 30%	4	1.64402	.169221	.084610	1.37476	1.91329	1.454	1.823
SJ 3 = Substitution 45%	4	2.59803	.285114	.142557	2.14435	3.05170	2.267	2.845
Total	16	1.44457	.838631	.209658	.99769	1.89144	.340	2.845

Test of Homogeneity of Variances

Dietary Fibre (%)

Levene Statistic	df1	df2	Sig.
3.993	3	12	.035

ANOVA

Dietary Fibre (%)	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10.043	3	3.348	79.320	.000
Within Groups	.506	12	.042		
Total	10.550	15			

Multiple Comparisons

Dietary Fibre (%)
Tamhane

(I) Sample	(J) Sample	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
C = Substitution 0%	SJ 1 = Substitution 15%	-.671325*	.121341	.019	-1.19934	-.14331
	SJ 2 = Substitution 30%	-1.211575*	.103083	.000	-1.62925	-.79390
	SJ 3 = Substitution 45%	-2.165575*	.154239	.001	-2.90998	-1.42117
SJ 1 = Substitution 15%	C = Substitution 0%	.671325*	.121341	.019	.14331	1.19934
	SJ 2 = Substitution 30%	-.540250*	.135703	.047	-1.07325	-.00725
	SJ 3 = Substitution 45%	-1.494250*	.177704	.001	-2.20229	-.78621
SJ 2 = Substitution 30%	C = Substitution 0%	1.211575*	.103083	.000	.79390	1.62925
	SJ 1 = Substitution 15%	.540250*	.135703	.047	.00725	1.07325
	SJ 3 = Substitution 45%	-.954000*	.165775	.014	-1.65906	-.24894
SJ 3 = Substitution 45%	C = Substitution 0%	2.165575*	.154239	.001	1.42117	2.90998
	SJ 1 = Substitution 15%	1.494250*	.177704	.001	.78621	2.20229
	SJ 2 = Substitution 30%	.954000*	.165775	.014	.24894	1.65906

*. The mean difference is significant at the 0.05 level.

Appendix 4. Statistical Analysis of Texture Property (Gel Strength) in Seaweed Jelly

Case Processing Summary

	Sample	Cases					
		Valid		Missing		Total	
		N	Percent	N	Percent	N	Percent
Tekstur (N)	C = Substitution 0%	4	100.0%	0	.0%	4	100.0%
	SJ 1 = Substitution 15%	4	100.0%	0	.0%	4	100.0%
	SJ 2 = Substitution 30%	4	100.0%	0	.0%	4	100.0%
	SJ 3 = Substitution 45%	4	100.0%	0	.0%	4	100.0%

Tests of Normality

	Sample	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Tekstur (N)	C = Substitution 0%	.314	4	.	.905	4	.455
	SJ 1 = Substitution 15%	.263	4	.	.894	4	.401
	SJ 2 = Substitution 30%	.302	4	.	.778	4	.068
	SJ 3 = Substitution 45%	.271	4	.	.856	4	.245

a. Lilliefors Significance Correction

Descriptives

Tekstur (N)	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min.	Max.
					Lower Bound	Upper Bound		
C = Substitution 0%	4	.11400	.024875	.012437	.07442	.15358	.079	.138
SJ 1 = Substitution 15%	4	.49535	.327660	.163830	-.02603	1.01673	.179	.856
SJ 2 = Substitution 30%	4	.17377	.122912	.061456	-.02181	.36936	.066	.290
SJ 3 = Substitution 45%	4	.17185	.065631	.032816	.06742	.27628	.108	.238
Total	16	.23874	.222501	.055625	.12018	.35731	.066	.856

Test of Homogeneity of Variances

Tekstur (N)

Levene Statistic	df1	df2	Sig.
32.524	3	12	.000

ANOVA

Tekstur (N)	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.360	3	.120	3.772	.041
Within Groups	.382	12	.032		
Total	.743	15			

Tekstur (N)

Duncan

Sample	N	Subset for alpha = 0.05	
		1	2
C = Substitution 0%	4	.11400	
SJ 3 = Substitution 45%	4	.17185	
SJ 2 = Substitution 30%	4	.17377	
SJ 1 = Substitution 15%	4		.49535
Sig.		.661	1.000

Means for groups in homogeneous subsets are displayed.

Appendix 5. Documentation

Raw Material for Making a Seaweed Jelly

Cooking Process

Formulation C

Formulation SJ 1

Formulation SJ 2

Formulation SJ 3

Jelly Product