Extraction Of Seaweed Cargenanan (Kappaphycus Alvarezii) With The Addition Of Naoh (Sodium Hydroxide) Solution Concentration

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Abstract. Sebatik Island is well-known for its production of According to the Ministry of Maritime Affairs and Fisheries (KKP), seaweed commodities have a significant economic value, as evidenced by the volume of seaweed in the 2021 export market increasing to 225,612 tons with a value of USD 345.11 million. Seaweed productivity is increasing year after year, particularly in terms of seaweed export volume. Carrageenan is a type of galactan polymer discovered as an intercellular matrix material in red seaweed and marine algae of the Rhodophyta class. The purpose of this study is to determine the procedure of extracting carrageenan from Kappaphycus alvarezzi Seaweed, the water content and pH of the extracted carrageenan from seaweed (Kappaphycus alvarezzi), to determine the water content, and the pH value of the carrageenan. The experiment was carried out with NaOH concentrations of 1%, 5%, and 10% added to the treatment. The phases of the seaweed carrageenan (Kappaphycus alvarezii) extraction process include raw material preparation, soaking with NaOH, drying, and storage of seaweed carrageenan (Kappaphycus alvarezii). The water content obtained from the three treatments with 1%, 5%, and 10% NaOH solution addition was 1.35%, 21%, and 18.75%, respectively. The maximum water content was found in 5% NaoH solution, which was 21%, and the highest water content was found in the addition of 10% NaOH solution, which was 18.75%. The pH levels in the three treatments were 8, 7, and 7, respectively.

Keywords: Carrageenan, Seaweed, Kappaphycus alvarezzi

1. Introduction

Indonesia benefits tremendously from its location as an archipelagic country with a tropical climate, which results in a diverse biodiversity (Fathmawati et al 2014). One of the plants found in marine environments is seaweed. It is currently frequently grown by sailors and seaweed farmers in Indonesia. In Indonesia, the potential for seaweed is quite promising, and it can operate as a commodity for the movement of national economic advancement. According to data from the Ministry of Maritime Affairs and Fisheries (KKP), seaweed is an important fishery product in Indonesia, ranking first with a percentage of 69% (Sulistiyo 2018).bAside from shrimp, crab, and lobster, seaweed is a major export commodity. As a result, increasing the capacity of

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the seaweed cultivating community is important in order to expand production in the global market. This is due to the strong economic value of this commodity, as evidenced by the 2020 export volume of 195,574 tons with a value of USD 279.58 million. Seaweed productivity is increasing year after year, particularly in terms of seaweed export volume.

According to Ministry of Maritime Affairs and Fisheries figures, the volume of seaweed on the 2021 export market climbed to 225,612 tons with a value of USD 345.11 million. It's no surprise that Indonesia is the world's second largest producer of seaweed behind China.Because seaweed has been widely developed cultivation production techniques are generally simple and economical, with a minimal chance of crop failure, high output, and the ability to harvest every 45-60 days or more four times a year. The price of seaweed is also fairly high, which is one of the driving forces behind seaweed production and can absorb a considerable amount of labor, resulting in a large and broad economic multiplier effect (Salim & Ernawati, 2015).Nunukan Regency is located in North Kalimantan Province's northern portion and has a border with Malaysia. Nunukan Regency has a land size of 14,263.68 km2 and a sea area populated by around 3,000 farms with 1,000 - 5,000 spans of rope with a production capability of around 18 kg/kg rope. Seaweed agriculture is also practiced on the island of Sebatik, which is next to Malaysia. There are around 1,000 seaweed farms dispersed over numerous shores, with each farm capable of spreading 100-500 ropes.

Red algae (Rhodophyceae) extracts include carrageenan, which is the latex of the seaweed Kappaphycus alvarezii. The next step in separating carrageenan from the solvent is water or an alkaline solution. According to Chapman et al. (1980), carrageenan is a linear polysaccharide with macromolecules made up of more than 1000 galactose residues that are hydrogenated galactose and 3,6 galactose copolymers, potassium, sodium, and potassium sulfate esters. While carrageenan does not form a gel in water, it interacts well with proteins, making one type of carrageenan suitable for use in food production. Carrageenan is divided into three types: kappa, iota, and lambda. The three types are distinguished from one another based on differences in the strongest gel properties. Kappa carrageenan is produced by Kappaphycus Alvarezzi and dissolves in hot water. A hydrocolloid substance called carrageenan is obtained from a particular kind of red seaweed called Kappaphycus alvarezzi. Carrageenan is a thickener, emulsifier, and stabilizer. Because it contains negatively charged sulfates along the polymer chain and is hydrophilic, or able to bind water or other hydroxyl groups, carrageenan functions as a stabilizer (Suryaningrum et al., 2002).

The need for carrageenan, which is growing annually to fulfill domestic needs, and the lack of domestic carrageenan production were the driving forces for this study. Carrageenan is another processed seaweed product with great economic value, costing 10 to 20 times as much as seaweed itself (Ma'rup.F., 2003). Additionally, it is anticipated that this research will give the local people the means to easily transform seaweed into the highly valuable carrageenan. The straightforward procedure employed in this study is to extract Kappaphycus alvarezzi into carrageenan, and the ultimate goal is to develop it to satisfy domestic needs—some of which are still imported—and to add value to seaweed, which is a source of carrageenan production.

2. Literature Reviews

2.1. Seaweed

One of the aquatic plants without actual roots, stems, or leaves is seaweed. Despite the fact that seaweeds are actually different, they are referred to as bacteria because of their similar body composition. This plant survives by adhering to the substrate of the seafloor or other items in the tidal zone. demonstrating that seaweed has been extensively grown by seaweed farmers since it has economic value and significant potential for development into a variety of goods, one of which is cosmetics (Yanuarti, et al., 2017). In Indonesia, seaweed production is estimated to be 10.2 million tons, or can triple from 2014. Production of seaweed was only 3.9 tons in 2010. However, KKP statistics for 2018 show that seaweed output is still rising by 11.92%. Even though the production of algae has increased, the state only processes 20% of it (Maghfiroh, 2016). The remainder of the seaweed that hasn't been converted into raw materials will typically be exported as wet and dry raw materials. This is a result of inadequate technology and a lack of attention to the possibilities of seaweed. Thus, seaweed farmers suffer financial losses. (Herliany, et al., 2014) Quality and price are fixed.

2.2. Seaweed Classification

Out of the 8,642 seaweed species that are known to exist worldwide, about 555 are found in Indonesia. Red seaweed (Rhodophyceae), green seaweed (Chlorophyceae), and brown seaweed (Phaeophyceae) are the three main classifications of seaweed or algae. Based on the primary dyes that are present, this classification was made (Merdekawati and Susanto, 2009). One of the 6000 or so different species of seaweed in the world, red seaweed is one of the most prevalent forms. The red sea is typically described as having a thallus that is cylindrical or flattened spherical, alternately branching, uneven in structure, and covered in bumps and spines. According to Merdekawati et al. (2009), red seaweed features thallus that are dark brown, light brown (blonde), purple, dark red, pink, and green. The pigment components of the thallus, which include chlorophyll a, chlorophyll d, and phycobiliprotein dyes including R-Phycocyanin, Allophycocyanin, and Phycoerythrin, are what give it its many colors. Raw red seaweed is frequently utilized in the production of agar and carrageenan products. Red seaweeds such as Eucheuma, Glacier, Glaycophylles, and Glycophyllum, Hypnea, and Rodymenia are the most often utilized varieties (Kadi, 2014).

2.3. Benefits of Seaweed

Seaweed is a plant with a wide range of uses, including in agriculture, industry, medicine, livestock, and human health. The majority of the nutrients required by the human body are present in seaweed, including water, protein, carbs, fat, fiber, and ash. In addition to nutrients, seaweed also contains vital minerals such iron, iodine, sulfur, salt, manganese, silicon, aluminum, magnesium, phosphorus, calcium, and others (Priyono, 2013). It also includes multivitamins (A, B, C, D, E, and K), pigments, enzymes, nucleic acids, amino acids, and colors. In addition to Halianti et al.'s (2016) addition that seaweed is an alternative energy source that can be used as biofuel, including bioethanol, Senger et al. (2018) reported that seaweed also contains active biological compounds such as antioxidants, antibacterial agents, and anthelmintics, as well as anti-cholesterol, anti-diabetic, anti-cancer, analgesic, and anti-inflammatory substances. This is so that ethanol can be produced from the polysaccharides (cellulose and alginate) and monosaccharides (glucose, fructose, and xylose) found in seaweed.

2.4. Carrageenan

A substance called carrageenan is made by extracting red seaweed (Rhodophyceae). This group of polymers, which dissolve in water and can result in liquid gels, includes carrageenan. A carrageenan structure is created when galactose units and 3,6 anhydrogalactose D are arranged in an increasing order and bound to silicon sugars a-1,3 and b-1,4 (Kumayanjati et al., 2018). Carrageenan functions generally as a thickening, suspending, and emulsifying agent. Because it has negatively charged sulfate groups along the polymer chain that can bind water or other hydroxyl groups, carrageenan also serves as a stabilizing agent. Thus, hot water or alkaline solutions like NaOH, Ca(OH)2, or KOH can be used in the seaweed extraction process to create carrageenan (Supriyanti, et al. 2017).

2.5. Types of carrageenan

Carrageenan is composed of macromolecules that are arranged in a linear chain of potassium, sodium, and potassium sulfate esters, which can be created when galactose is added. Different characteristics of each carrageenan can be used to categorize them. The species of algae, similarities in gel characteristics, and groups connected to the carrageenan structure are typically used to distinguish between different forms of carrageenan. The three varieties of carrageenan are kappa, iota, and lamda (Fardhyanti and Julianur, 2015).

Beta (1,4)3,6 Anhydro-D-galactose 6-sulfate, alpha (1,3)D-galactose-4-sulfate, and 3,6-Anyydro-D-galactose-2-sulfate make up kappa carrageenan. Because the kappa carrageenan group has a sulfate group that may be entirely removed, the homogeneity of the molecule becomes uniform, and the glass power rises, giving it a higher gel strength than the iota and lambda carrageenan groups. Iota carrageenan is distinguished by the presence of 2 sulfates per 3,6-anhydro-D-galactose group and 4 sulfates on each glucose residue. 2 The lack of molecular homogeneity in small amounts of carrageenan is caused by the fact that the sulfate groups in iota carrageenan cannot be eliminated by alkaline treatment procedures like kappa carrageenan. In addition, lamba carrageenan contains a remnant of 1,4-d-galactose disulfide. As opposed to kappa and iota carrageenan, which consistently include a 4 ester sulfate group (Ningsih, 2014).

2.6. Extraction of carrageenan

Red seaweed (Rhodophyceae), such as Eucheuma, Glacieria, Licorice, Sargassum, Hypnea sp. seaweed, and E.spinosum, can be used to make carrageenan. Alkaline solvents like KOH and NaOH are two examples that are utilized to extract seaweed (Asikin and Kusuma Ningrum, 2019). Several variables, including alkali content, extraction temperature and time, type of algae, and precipitation, affect the extraction of carrageenan from seaweed. High yields can be attained at high alkaline concentrations. The age at which seaweed was harvested also has a significant impact on the carrageenan's quality. (2018) Panggabean et al.

A wet solution added will lead to a greater Extraction. This can aid in the production of 3,6-galactose dehydration more quickly during the extraction process, leading to improvements (Nasruddin, Asikin, & Kusumaningrum, 2016).

2.7. Factors Affecting Carrageenan Quality

A substance made from seaweed called carrageenan provides seaweed farmers with a living, particularly in Indonesia. The quality qualities of the carrageenan, however, have an impact on the selling prices of high and low carrageenan. The quality of the seaweed, how it is processed, and the water's environmental conditions all have an impact on the quality of the carrageenan.

a. The carrageenan produced depends on the caliber of the seaweed. Whereas seaweed that grows wild is of lower quality than seaweed that is produced.
b. One of the elements influencing the quality of carrageenan extracted from seaweed is carrageenan processing. The extraction procedure, extraction time, temperature accuracy, solution concentration, chemical solution to seaweed ratio, washing, drying, and sorting processes are all part of the technological process of processing carrageenan.
c. The environmental aspects of the water are all significant and provide ideal circumstances for the growth of seaweed. Current speed, temperature, salinity, pH, the availability of nutrients, transparency level, and the quality of the seaweed seed itself are examples of environmental influences. The elements in seaweed are also influenced by the age at which it is harvested (Ningsih, 2014).

2.8. Carrageenan Quality Standards

The Food and Agriculture Organization (FAO), the Food Chemical Codex (FCC), and the European Economic Community (EEC) have all established carrageenan quality standards that are used and recognized by the global market, as shown in table 1.

Tabel 1. Carrageenan Quality Standards

Quality Indicator	FAO	FCC	EEC
Yield (%)	>25	-	-
Ash content (%)	15-40	≤35	15-40

Water content (%)	≤12	≤12	≤12
Viscocity (cP)	≥5	-	-
Gel strength (g/cm²)	>500	-	-

Sumber: F ,EEC at Hakim *et al* (2011)dan FAO (2007)

2.9. Benefits of Carrageenan

Both the pagan and non-pagan commercial sectors can make use of carrageenan in many different applications. It has numerous applications in the culinary industry, including dairy, cheese, yoghurt, candy, ice cream, and chocolate goods. The solubility, viscosity, gel strength, reactivity with proteins, and non-curling polysaccharides in carrageenan are among of the characteristics that determine its usage in the pagan sector (Kumayanjati and Dwimayasanti, 2018). Carrageenan is a compound that is frequently utilized as an ingredient in industries and health care products outside the food business. Carrageenan is used in the manufacturing of printing paper, carpets, textiles, paints, air fresheners, and ceramic coatings in addition to other things. Carrageenan is a substance that is utilized in the health industry as an emulsifier and binder for medications, toothpaste, shampoo, and other products in the form of syrup or tablets (Ega et al., 2016). As an antioxidant, anticoagulant, antiviral, anti-cancer, and anti-inflammatory agent, carrageenan is currently being researched and developed in the biomedical sector, according to Masthora and Abdiani (2016).

3. Research Methods

This research conducted by using experiment.

1. Time and Place

From April to August 2023, this study will be conducted at the Nunukan State Polytechnic THP Laboratory, Jl. Ujang Dewa, Nunukan Regency, North Kalimantan.

2. Types and Sources of Data.

Both primary and secondary data were used to create this final project, and they are as follows:

a. Primary Data
   Primary data is information gathered by direct inquiry.
b. Secondary Data
   These auxiliary data were acquired inadvertently. data gathered for this final assignment from the press, books, and literature.

3. Data Collection Methods

Several data collection techniques were used in the development of this final project, namely:

a. Library Studies

The process of collecting data through literature study involves looking for information and data in books and other works of literature.

b. Experiment

Experiment is a technique for gathering data that involves a series of tasks and observations.

c. Documentation

Data can be gathered through documentation by using data sources like photographs and other data products.

4. Tools and Materials

a. Tools

The tools used in the manufacture of carrageenan are racks, beakers, digital scales, thermometers, scissors, panicles, stirring rods, spray bottles, ovens, mortars, litmus paper, desiccators, watch glasses, stoves.

b. Material

The materials used in this study were dried seaweed, 1% NaOH solution, 5% NaOH solution, 10% NaOH solution, 100 mL Isoprofil/Alcohol, and distille.

5. Work Procedures

3.5.1. Seaweed Extraction Manufacturing Process (Kappaphycus alvarezzi)

The phases of this study are adjustments to the research conducted by Panggabean et al. in 2018. The following is the working procedure for extracting carrageenan:

a. Raw Material Preparation

The raw materials are first soaked for 24 hours in rice water washing. The seaweed is then exposed to the sun for two days to dry. When the material grains on the dried seaweed no longer adhere, it is then numbed (Naufal et al., 2022).

b. Soaking with NaOH

The seaweed was then placed into a container and weighed using a digital scale up to 25 grams per piece. The seaweed had previously been rinsed with normal water and steeped for 30 minutes. Then, for 12 hours, a solution of various concentrations of NaOH (1%, 5%, 10%) was applied to each piece of seaweed. Seaweed and NaOH have a mass ratio of 1:20 (gr/ml). The seaweed is neutralized with plain water after soaking for 12 hours, bringing the pH level down to 7-9. The seaweed was then divided into pieces no larger than 2 cm (Naufal, et al., 2022).

c. Extraction of carrageenan from Kappaphycus alvarezii seaweed

The steam method is used to extract carrageenan from seaweed. Cut-up seaweed is added to an extraction vessel with raw material and NaOH solvent at a ratio of 1:20 (gr/ml), and the mixture is added to or extracted using steam at a temperature of 80–90 °C for 30 minutes. The sample was subsequently filtered with a filter cloth to create the filtrate. The filter was collected in a container, and then 100 ml of isoprofile was added and mixed. After that, it was abandoned for 15 minutes (Naufal et al., 2022).

d. Drying

Prior to being placed in the oven, the carrageenan that had been cleaned with distilled water was weighed. Additionally, the carrageenan was weighed and mashed after being placed in an oven heated to 100 °C (Naufal et al., 2022). However, after coming out of the oven, the carrageenan was placed in a desiccator for 30 minutes before being ground up.

e. Storage

To avoid contamination with additional components, the refined carrageenan is placed in a plastic bag.

3.5.2. Testing of water content

The Nunukan State Polytechnic Fisheries Product Technology Laboratory will test the water content of the product. The difference in sample weight before and after drying is used to determine the water content. The porcelain cup that will be used is first dried for 1 hour at 105°C in the oven, chilled for 30 minutes in a desiccator, and weighed until the weight stays constant (the weight of the cup). The sample, which weighs about 1 gram, is dried in a room-temperature oven. The cup containing the sample is heated to 105 °C for 5 hours, cooled in a desiccator for 30, and then weighed till the weight stays constant (result) (Nasrullah, 2019).Moisture content can be calculated using the formula:

$$\text{water content} = \frac{w_1 - w_2}{w_3} \text{ x } 100\ \%$$

Information:
A = empty cup weight + sample weight
B = weight of the cup after being in the oven
C = sample weight

3.5.3. PH testing

Following a 12-hour extraction process, samples of seaweed are neutralized with plain water, and the PH universal is used to determine the results. then the seaweed-containing container is filled with universal PH. The PH value is then recorded.

4. Result and Discussion

4.1. Results

4.1.1. Production of Carrageenan

Carrageenan is a hydrocolloid substance that is obtained from seaweed belonging to the Rhodophyceae family, such as Kappaphycus alvarezzi. It is made up of sulfated polyglycan chains with a molecular mass of more than 100,000. The amount of carrageenan produced from each treatment was 1% NaOH with a weight of 1.35 grams, 5% NaOH with a weight of 2 grams, and 10% NaOH with a weight of 1 gram, according to the results of the carrageenan-making process. Therefore, the optimum therapy among the three treatments—1% NaOH, 5% NaOH, and 10%—was 5% NaOH.

4.2. Discussion

4.1.2. Process of making carrageenan from seaweed (Kappaphycus alvarezzi)

The steps involved in creating carrageenan from seaweed (Kappaphycus alvarezzi) and sodium hydroxide (NaOH) are as follows:

a. Raw Material Preparation

The goal of this raw material preparation is to get the raw materials ready for extraction, which is the next step in processing. These raw materials must be prepared by weighing, soaking in rice water, drying, and cleaning. In a departure from earlier studies, the raw material is weighed up to 600 grams before being steeped in rice water for 24 hours. The seaweed is then dried for around two days in the sun. When the dried seaweed is finished drying, it is cleaned by shaking it vigorously until the material grains separate (Naufal et al., 2022).

b. Soaking with NaOH

Sodium hydroxide (NaOH) solution will be used to remove the seaweed during this immersion. This is consistent with earlier research that was done to extract seaweed carrageenan, specifically the extraction approach using potent alkaline solvents. Because the use of KOH during the extraction process can strengthen the carrageenan polymer chain ions that make up kappa carrageenan, the gel strength of kappa carrageenan is sensitive to K+ ions (Hakim et al., 2011). Carrageenan extraction is also impacted by sodium hydroxide solvent, where Na + ions play a different function in the characteristics of carrageenan gel (Azevedo, et al., 2013). When it comes to this study, the variation of the treatment consisted of adding NaOH solution at varying amounts, specifically 1%, 5%, and 10% NaOH solution. According to research Panggabean et al. (2018), the physico-chemical characterization of seaweed carrageenan from Kappaphycus alvarezii may be impacted by the carrageenan extraction process's use of various solvents. 10% NaOH and 14% KOH are the solvents used in the carrageenan extraction method. The yield is significantly impacted by the alkali concentration because higher alkali concentrations during the alkalization process result in high pH levels, which enhance alkali's ability to extract. The findings of the study indicate that NaOH solvent produces carrageenan of the highest quality.

c. Drying

Carrageenan is prepared as needed using an oven. Weighing was done on the collected seaweed. Once collected, the carrageenan was placed in a container and dried in a 100 °C oven. The material will next be mashed and reweighed (Naufal, et al., 2022). However, the acquired carrageenan was first placed in a desiccator for around 30 minutes in order to stabilize it before being ground up. This is consistent with the desiccator's role in removing moisture from a material, storing and maintaining dry materials that are prone to damp air, assisting in the cooling of highly heated objects, and being utilized in the analysis of figuring out moisture content.

d. Storage

Storage attempts to stop or guard against damage and contamination from other materials to the findings acquired, specifically carrageenan made from the seaweed Kappaphycus alvarezii. One of the crucial elements in ensuring product quality is storage. A smart storage procedure can prevent blunders like taking the wrong product and mixing up different products (Yulisa, M, 2022). To prevent them from being mixed up, a code is also provided when storing carrageenan. Transparent polypropylene (PP) type plastic is used to store carrageenan.

4.1.3. Moisture Content of Carrageenan

The results of the calculations for carrageenan water content achieved with 5% and 10% NaOH treatments, respectively, were 21% and 18.75%. The lowest water content, however, was 1.35 percent after treatment with 1% sodium hydroxide. Carrageenan quality requirements established by FAO (2007), which call for a water content of no more than 12%, are still not entirely met by the water content created in carrageenan.

The amount of water and volatile substances that are present in carrageenan are indicated by its water content. According to Desi (2015), the drying conditions, packing, and storing procedures typically dictate a product's moisture content. To find out how much water is in carrageenan, a water content test will be performed. Because it is so closely tied to the microbiological activity that takes place when the carrageenan is held, the water content of the substance has a significant impact on how long it can be stored.

4.1.4. PH (Acidity Degree) of Carrageenan

The 5% NaOH and 10% NaOH solution had the lowest pH value, which was 7, and the 1% NaOH solution had the highest pH value, which was 8. This is consistent with the research of Panggabean et al. (2018), who achieved a high pH to increase the alkali's ability to extract. The research of I G. A. G. Bawa, A. A. Bawa Putra, and Ida Ratu Laila (2012) is similar in that extraction at pH 7.5 (A) led to an average yield of carrageenan of 32.4%, pH 8.0 (B), by 33.5%, pH 8.5 (C), by 34.6%, and pH 9.0 (D), by 32.5%. An increase in pH up to 8.0 is probably what led to the outcomes of the extraction at pH. It's likely that the carrageenan structure was somewhat broken down to boost the supply of carrageenan.

5. CONCLUSION

Based on the tes t which already done in previous, it can be concluded that :

a. The stages of the seaweed carrageenan (Kappaphycus alvarezii) extraction process are raw material preparation, soaking with NaOH, drying, and storage of seaweed carrageenan (Kappaphycus alvarezii).

b. The water content obtained from the three treatments with 1%, 5%, and 10% NaOH solution addition was 1.35%, 21%, and 18.75%, respectively. The maximum water content was found in 5% NaoH solution, which was 21%, and the highest water content was found in the addition of 10% NaOH solution, which was 18.75%.

c. The pH levels in the three treatments were 8, 7, and 7, respectively. The lowest pH value is found in 5% NaOH and 10% NaOH solution with a total pH value of 7, and the highest pH value is found in 1% NaOH solution with a pH value of 8.

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