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Effect of Extraction and Bleaching Process on the Chemical Characteristic of Alkali Treated Cottonii Chips (ATCC)

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ABSTRACT

Seaweed is one of the marine commodities with high economic value, because of its wide range of use, both in everyday life and in the industrial world, making the extraction process to test the physico-chemical properties of the quality of the extracted Euchema cottoni seaweed. This is an experimental research with a completely randomized design (CRD) factorial pattern consisting of 2 factors; the extraction process with 3 concentrations of KOH solution and the bleaching process with 3 concentrations of CaCO3 solution. This research aims to determine the effect of extraction and bleaching process on the physico-chemical characteristics of Alkali Treated Cottonii Chips (ATTC). The experiments were carried out by adding the concentration of KOH and CaCO3 solution in each treatment. The experiments showed that the concentration of KOH and CaCO3 solution in the processing process of Alkali Treated Cottonii Chips (ATTC) influenced the chemical physicochemical characteristics of Alkali Treated Cottonii Chips (ATTC). In this study, the lowest water content is treatment A3B1 obtained a value of 9.62% highest treatment AIB1 obtained a value of 11.77% where the maximum standard of ATTC water content is 12%, for the lowest pH is treatment A1B2 obtained a value of 9.06% highest treatment A3B2 obtained a value of 9.38% and the highest gel strength treatment A3B2 with a value of 193.10g lowest treatment A3B1 with a value of 66.50g while for the highest carrageenan treatment A1B2 with a value of 63.26% lowest treatment A3B3 with a value of 38.87%.

Keywords: *ATTC Physicochemical Characteristics, Bleaching, Eucheuma cottonii, Extraction*

INTRODUCTION

Indonesia is the largest archipelago in the world consisting of 17,508 islands with a coastline of 81,000 km and a marine area of approximately 3.1 million km² (Diani, 2021). Indonesia comprises 70% of the waters and 30% of the land, which are coastal areas with vast and diverse biological resources. Various biological resources are considered important development potentials as sources of emerging economic growth (Otero et al., 2020).

Seaweed is a relatively modest plant that has no roots, stems, and leaves (Agustang et al., 2021). Seaweed is one of the marine commodities with high economic value, because of its wide range of use, both in everyday life and in the industrial world, making the extraction process to test the physico-chemical properties of the quality of the extracted Euchema cottoni seaweed.

Seaweed is one of Indonesia's greatest biodiversity treasures. Indonesia is home to around 18,000 species of seaweed worldwide and 25 of them are of high economic value. Indonesia has 555 species of seaweed and 4 of them are well known as export commodities, such as Euchema sp., Gracilaria sp., Gelidium sp., and Sargasum sp. (Andrianto, 2020). Seaweed contains hydrocolloid compounds such as carrageenan, agar and alginate. Carrageenan and agar are produced by red seaweed or algae (Rodhophycae), while alginate is produced by brown algae (Phaeophycae) (Jayakody et al., 2022).

Seaweed containing carrageenan is from the Eucheuma clan. There are three varieties of carrageenan, which are iota carrageenan known as spinosum type, kappa carrageenan known as Cottonii type and lambda carrageenan. Iota carrageenan is a soft and flexible or soft jelly. Kappa carrageenan is a rigid jelly and is brittle and hard. While lambda carrageenan cannot form jellies, but is in the form of a viscous liquid. E. cottonii and E. spinosum is a seaweed that is widely traded, both for the purposes of industrial raw materials in the country and for export (Anggadireja & Tim, 2011). Types of seaweed that are widely cultivated in Indonesia are the types of Eucheuma cottonii and Gracilaria sp.

Considering that seaweed has become a national leading commodity and has clearly been able to drive the local, regional and national economy as well as being one of the business activities that is able to touch the role of community empowerment at large, the current seaweed industrialization policy has become an important issue and can improve the local economy in seaweed producing areas in particular and nationally in general by increasing added value up to the production of ATC Chips (Rimmer et al., 2021). Alkali Treated Cottoni, or ATC, is a process of preserving carrageenan-producing seaweed using alkaline liquids in both cold and hot alkaline applications. The form of the product is either in the form of chips or flour with considerable added value.

Extraction is a process of separating the content of chemical compounds from plant or animal tissues using certain solvents. Extract is a concentrated preparation

obtained by extracting active substances using a suitable solvent, whereupon all or nearly all of the solvent is evaporated and the remaining mass or powder is treated in such a way as to meet the specified standards (Paramita et al., 2022). In general, extraction is carried out using solvents based on the solubility of components to other components in the mixture, usually water and others organic solvents. The material to be extracted is typically a dry material that has been crushed, usually in the form of powder or simplisia (Syukri, 2023).

The purpose of extracting natural materials is to attract chemical components contained in natural materials. In this research, the heating method was carried out in the extraction process, the presence of heat will automatically accelerate the extraction process. In order to achieve a proper extraction process, the solvent used must meet the criteria of high ability to dissolve the solute component in the mixture, the solvent and the solution to be extracted should not easily mix, not easily react with the substance to be extracted, not corrode the tool, not flammable, non-toxic and relatively cheap (Pratiwi, 2021).

The advantage of extraction is that solid materials with coarse texture and resistant to direct heating can be extracted using this method, because it has a low boiling point making it easy to evaporate. The weakness of this method is that it requires a large amount of solvent, the length of extraction time will produce more extract, because the contact between the solute and the solvent is longer (Zhang et al., 2018). Based on the description previously described, this research aims to analyze the effect of KOH and CaCO3 in the extraction and bleaching process on the physico-chemical characteristics of Alkali Treated Cottoni Chips (ATCC). In this research, the following hypothesis can be derived:

H_0 = There is no effect of extraction and bleaching process on the physico-chemical characteristics of Alkali Treated Cottoni Chips (ATCC).
H_1 = There is an effect of extraction and bleaching on the physico-chemical characteristics of Alkali Treated Cottoni Chips (ATCC).

LITERATURE REVIEW

Eucheuma cottonii

Eucheuma cottonii is a type of seaweed belonging to the red algae group (Rhodophyceae) that produces carrageenan. Carrageenan is an important hydrocolloid as it has a very wide use in food and non-food industries. This type of seaweed was developed due to having good prospects in addition to good profits and various benefits. In the world of industry and trade, carrageenan has the same benefits as agar and alginate. Carrageenan can be used as a raw material for the pharmaceutical, cosmetic, food and other industries. The uses of carrageenan include product stability regulator, thickener, gelling agent and emulsifier (Błaszak et al., 2018).

Figure 1. Eucheuma cottonii
Source: Google Images

The following is a taxonomic classification of Eucheuma cottonii according to Anggadireja & Tim (2011):

1. Kingdom : Plantae
2. Division : Rhodophyta
3. Class : Rhodophyceae
4. Order : Gigartinales
5. Family : Solieracea
6. Genus : Eucheuma
7. Species : Eucheuma cottoni (Kappaphycus alvarezii)

Seaweed is in fact a low-level plant that does not have distinct structures such as roots, stems, and leaves. Although it appears to have differences, the actual shape is the seaweed thallus, which can be shaped round such as tubes, flat, sprawl, round like a pouch, and so on. According to Anggadireja & Tim (2011), Eucheuma cottonii is classified as Eucheuma with general characteristics of red, red-brown, green-yellow; has cylindrical or flat round thalli; gelatinous and/or cartilagenous thalli; and has bumps and spines. The gel characteristics of kappa-carrageenan are characterized by a stronger and brittle gel type with high syneresis and has a significant synergistic effect with locust bean gum. The basic organic ingredients in algae are complex nitrogen compounds, carbohydrates, fats, and pigments, with the content and composition of each compound depending on the species, growth stage, and growth conditions of the algae.

Seaweed Extraction

Seaweed extraction produces two types of carrageenan, semi-refined carrageenan (SRC) and refined carrageenan (pure carrageenan). According to Rizal et al. (2016) semi-refined carrageenan is a carrageenan with a low level of purity, because it still contains a small amount of cellulose that settles with carrageenan, while pure carrageenan is a carrageenan that is free of cellulose through the precipitation process (Ega et al., 2016). Semi-refined carrageenan is often utilized

in the non-food industry as a gelation ingredient in canned pet food, air freshener, shampoo, body wash, and dental coatings (Heriyanto et al., 2018).

Seaweed Bleaching

Bleaching is a whitening process using chemicals used by humans to remove stains and dirt attached to colored materials. The use of bleaching materials has been widely known to many by the use of chlorine (potassium hypochlorite). Currently, the use of bleaching has been developed in factories or industries such as rayon, paper, cardboard and others.

Alkali Treated Cottoni Chips (ATCC)

Alkali Treated Cottoni Chips (ATCC) is a process of preserving carrageenan-producing seaweed using alkaline solutions both cold and hot alkaline applications. The product form is chips/cuts or flour with considerable added value.

Figure 2. Alkali Treated Cottoni Chips (ATCC)
Source: Google Images

ATCC Seaweed Processing Procedures

ATCC seaweed processing procedures are as follows. The dried seaweed was sorted from contaminants from the sea (such as paper, plastic, sand and salt). Then soaking seaweed as much as 250g is carried out for 14 hours with the addition of KOH solution concentrations of 1.48g, 1.85g and 2.22g per liter of water at pH 11-12 with a standard temperature of ± 28ºC. After the soaking process, extraction was carried out for 1 hour with the addition of KOH solution concentration of 1.48g 1.85g 2.22g per 2 liters of water at pH 11-12 and stirred every 15 minutes and the extraction temperature was between 60ºC-65ºC. Measure the pH value and water temperature at the beginning and end of the extraction process. After the extraction process, bleaching was carried out for 1 hour by adding $CaCo_3$ concentrations of 6.6g 8.3g and 9.9g per 2 liters of water at pH 11-12. Measure the pH value and water temperature at the beginning and end of the bleaching process. After the bleaching process, rinse with 2 liters of clean water, repeated 3 times to obtain better results. After rinsing, dried in the drying room stored on a tray for 3-4 days until

the water content is stable, which is 12g. After the seaweed is dry, chipping and packaging is carried out.

RESEARCH METHODOLOGY

The type of research to be carried out is experimental research with a completely randomized design (CRD) factorial pattern consisting of 2 factors. Factor A is the extraction process with 3 concentrations of KOH solution and factor B is the bleaching process with 3 concentrations of CaCO3 solution. Therefore, the number of treatments tested was 3 KOH × 3 CaCo3 × 3 replicates resulting in 27 experimental units.

The length of time for research starting from preparation to testing, began on September 21, 2020 to May 2021 with the experimental research method applied. ATCC processing was carried out at the Agricultural Technology Education Laboratory, Faculty of Engineering, Universitas Negeri Makassar and for the analysis of carrageenan and gel strength was carried out at the Water Quality Laboratory, Faculty of Fisheries and Marine, Universitas Hasanuddin. The population includes the place of seaweed sampling in Takalar Lama Village, Mappakasunggu Subdistrict, Takalar Regency. The sample in this research is Eucheuma cottoni seaweed. The data collection technique used in this research is the method of systematic observation and recording of the subject of research. Data were collected by conducting the following tests: testing of water content, carrageenan, gel strength, and pH/acidity degree.

RESULT AND DISCUSSION

Research Result

The results of the research include data presentation in the form of data description, analysis requirements test, and data analysis.

1. Descriptive Data

   This experiment was conducted to determine the extraction and bleaching process on the physico-chemical characteristics of ATTC produced by the observed parameters, which are chemical analysis (water content and pH), physical properties analysis (gel strength and carrageenan). The data of the research results are as follows:

   a. Water Content

      Water content is the amount of water contained in an object, such as soil (also called soil moisture), rocks, agricultural materials, and others.

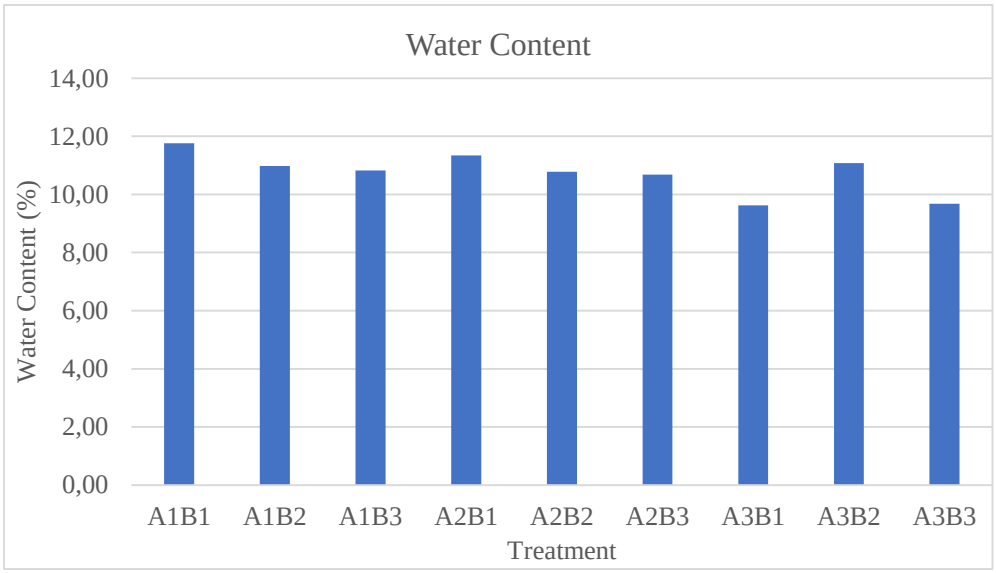

Chart 1. Water Content
Source: Processed Data by Researchers

According to the chart above, the results of chemical analysis (water content) on ATTC processing indicate that the highest average value of water content is obtained in the A1B1 treatment with the amount of water content reaching 11.77% while the lowest is obtained in the A3B1 treatment with the amount of water content of 9.62%. This indicates that the concentration of CaCo3 solution as much as 6.6 grams influenced the high value of water content and 1.48 grams of KOH solution concentration caused the high water content in ATTC.

b. pH Value

pH (power of hydrogen) is the degree of acidity used to indicate the acidity or basicity of a solution.

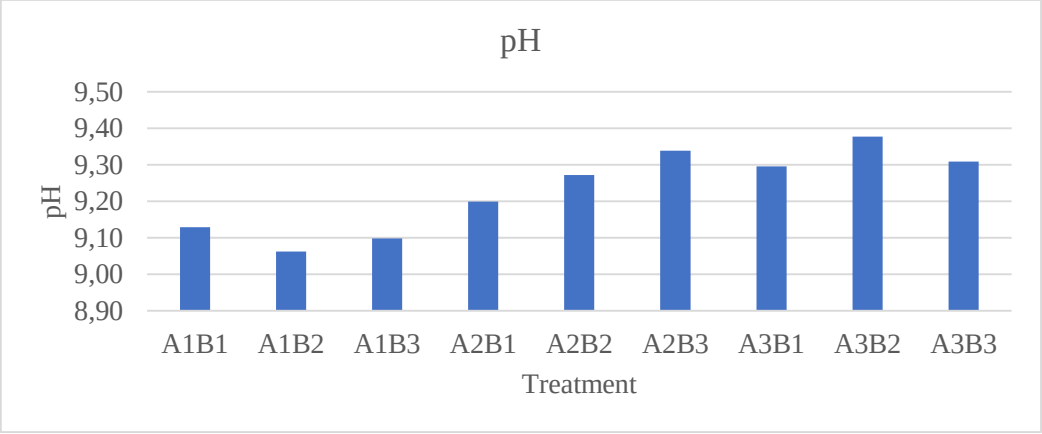

Chart 2. pH Value
Source: Processed Data by Researchers

The results of chemical analysis (pH) on ATTC processing showed that the highest average value of water content was obtained in the A3B2 treatment with the amount of water content reaching 9.38% while the lowest was obtained in the A1B2 treatment with the amount of water content of 9.6%. This indicates that the concentration of CaCo3 solution as much as 8.3 grams influenced the high value of water content and 2.22 grams of KOH solution concentration caused high water content in ATTC processing.

c. Gel Strength

Gel strength is an important physical property of gelatin as it indicates the ability of gelatin to form a gel, hence the wide use of gelatin in the food and non-food sectors (Charoenchokpanich et al., 2022).

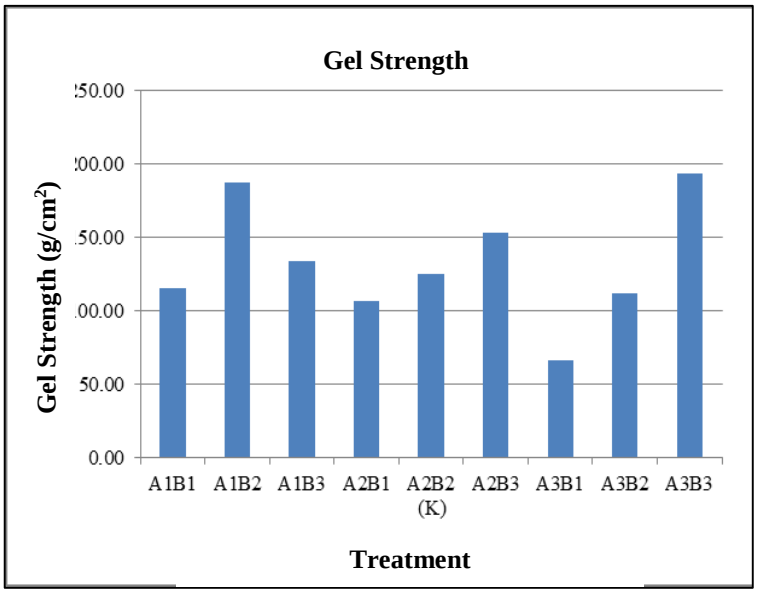

Chart 3. Gel Strength
Source: Processed Data by Researchers

The results of chemical analysis (gel strength) on ATTC processing indicated that the highest average gel strength was obtained in treatment A3B3 with the amount of gel strength reaching 193.10 grams while the lowest was obtained in treatment A3B1 with the amount of gel strength reaching 66.50 grams. This indicates that the concentration of KOH solution as much as 2.22 grams influenced the high value of gel strength and 9.9 grams of CaCo3 solution concentration caused the high value of gel strength in ATTC.

d. Carrageenan

Carrageenan is a fraction which can form a gel in water and is reversible, it melts when heated and gels again when cooled.

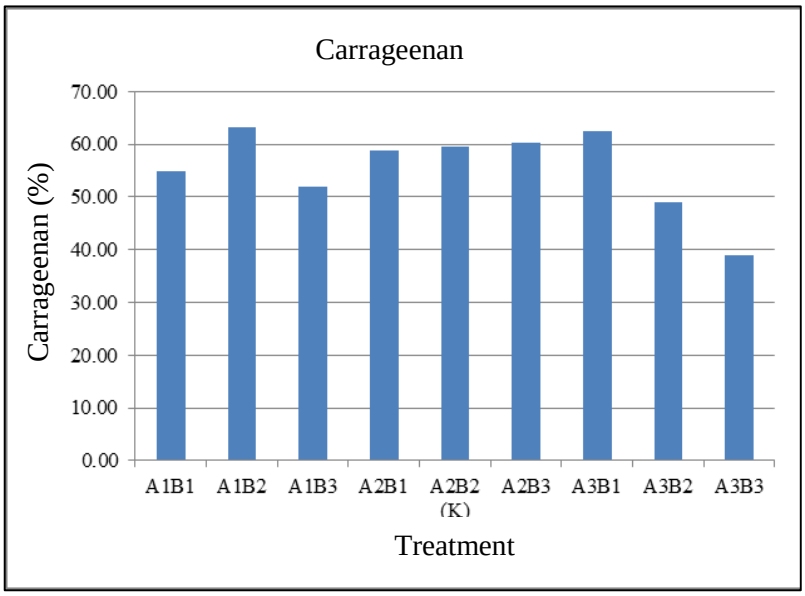

Chart 4. Carrageenan
Source: Processed Data by Researchers

The results of chemical analysis (carrageenan) on ATTC processing indicated that the highest average carrageenan was obtained in the A1B2 treatment with the amount of carrageenan reaching 63.26% while the lowest was obtained in the A3B3 treatment with the amount of carrageenan reaching 38.87%. This indicates that the concentration of CaCo3 solution as much as 8.3 grams and the concentration of KOH solution as much as 1.48 grams caused the high value of carrageenan in ATTC.

Research Discussion

Water Content

In ATTC processing, the greater the moisture content of ATTC obtained, the easier it will be contaminated by microbes, molds, and insects resulting in a short shelf life. The maximum standard moisture content of dry ATTC is 12%. In the research conducted from the results of the analysis of the physical characteristics of ATTC moisture content indicated that the average value of the highest and lowest moisture content obtained was 11.77%-9.62% with KOH formula 1.48 grams in the extraction process and CaCo3 formula 6.6 grams in the bleaching process, the results showed that the moisture content achieved was below 12%.

The measurement of moisture content is carried out because the water content of a food ingredient, especially fishery products, is directly related to the durability

of the product. Moisture content is also one of the most important characteristics of food, as water may affect the appearance, texture of the food (Fikriyah & Nasution, 2021).

Moisture content analysis aims to determine the number of water molecules both unbound (free water) and bound contained in a product. The principle of water content analysis is that water molecules are removed by heating with a vacuum oven at temperatures ranging from 95-100°C with air pressure of no more than 100 mmHg for 5 hours. Determination of water weight is calculated gravimetrically based on the difference in sample weight before and after the sample is dried. Moisture content is indicated as a percentage

pH Value

The degree of acidity in ATTC products has a value between pH 8-11. In order to obtain a standard value in accordance with market demands, in the production process a washing process is carried out which functions to reduce the pH value to match marketing standards.

In the research conducted from the results of the analysis of the physical characteristics of pH indicated that the highest and lowest average values obtained were 9.38%-9.6% with KOH formula 2.22 grams in the extraction process and CaCo3 formula 8.3gram in the ATTC processing bleaching process.

pH or degree of acidity is used to indicate the level of acidity or alkalinity possessed by a substance, solution or object. Normal pH has a value of 7 while if the pH value exceeds 7, it indicates that the substance has alkaline properties and pH value below 7 indicates acidity. pH indicates a high degree of acidity, and pH 14 indicates the highest degree of basicity. In general, a simple indicator used is litmus paper which turns red when acidity is high and blue when acidity is low.

The degree of acidity (pH) affects the fertility of the waters. Acidic waters will be less productive. At low pH (high acidity) the dissolved oxygen content will decrease, thus decreasing oxygen consumption. The majority of aquatic biota are sensitive to changes in pH and can live normally at a pH of around 7-8.5 Wang et al. (2016). According to Sulistiawati et al. (2020), the pH value for seaweed cultivation ranges from 7.3 to 8.2. The optimum pH range to support the survival of K. alvarezii is 7-8.5 (Kasnir et al., 2023).

Gel Strength

Based on the research conducted from the results of the analysis of the physical characteristics of ATTC gel strength, it indicates that the average value of gel strength from the highest and lowest obtained is 193.10g-66.50g with KOH formula 2.22 grams in the extraction process and CaCo3 formula 9.9 grams in the bleaching process.

The gel strength of carrageenan is strongly influenced by KOH concentration, pH, temperature and extraction time. The high gel strength of commercial

carrageenan is due to its lower sulfate content compared to Eucheuma cottonii carrageenan (Desiana & Hendrawati, 2015). The low gel strength value in this research may be influenced by the extraction time and the high sulfate content.

The higher the sulfate content, the lower the gel strength and the higher the viscosity (Fransiska & Reynaldi, 2020). Extraction time affects the strength of the resulting gel, in accordance with the increase in sulfate that occurs where the faster the extraction time, the greater the sulfate content, resulting in a low gel strength value (Basmal & Syarifudin, 2017; Desiana & Hendrawati, 2015).

Carrageenan

Based on the research conducted, the analysis of the physical characteristics of ATTC carrageenan indicated that the average value of carrageenan from the highest and lowest obtained was 63.26%-38.87% with a KOH formula of 1.48 grams in the extraction process and a CaCo3 formula of 8.3 grams in the bleaching process.

Carrageenan is a natural additive that is widely utilized in various industries, especially in food and cosmetic industries. Semi-refined carrageenan (SRC) is a carrageenan product with a lower purity level than refined carrageenan, as it still contains a small amount of cellulose that settles with the carrageenan. SRC is commercially produced from Eucheuma cottonii seaweed through an extraction process using an alkaline solution (Potassium hydroxide/KOH) (Rizal et al., 2016).

The solubility characteristics of carrageenan are also influenced by the salt form of the sulfate ester group. Sodium salts are generally more soluble, while potassium salts are less soluble. This makes kappa carrageenan in the form of potassium salt more difficult to dissolve in cold water and heat is required to convert it into solution, whereas in the form of sodium salt it is more soluble. Lambda carrageenan is soluble in water and is independent of the salt type (Rio et al., 2017).

CONCLUSION

Eucheuma cottonii seaweed affects the extraction and bleaching process on the physico-chemical characteristics of ATTC, which results in the lowest water content A3B1 obtained a value of 9.62% with a concentration of KOH solution of 2.22g in the extraction process and CaCO3 6.6g in the bleaching process, then produces the lowest pH A1B2 obtained a value of 9.06% with a concentration of KOH solution 1.48g in the extraction process and CaCO3 8.3g in the bleaching process, then produces the highest gel strength A3B3 obtained a value of 193.10g with a concentration of KOH solution 2.22g in the extraction process and CaCO3 8.3g in the bleaching process, then produces the highest pH A1B2 obtained a value of 9.06% with a concentration of KOH solution 1, 48g in the extraction process and CaCO3 8.3g in the bleaching process, then produced the highest gel strength A3B3 obtained a value of 193.10g with a concentration of KOH solution 2.22g in the extraction process and CaCO3 9.9g in the bleaching process and carrageenan

produced the highest value A1B2 obtained 63.26% with a concentration of KOH solution 1.48g in the extraction process and CaCO3 8.3g in the bleaching process.

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