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# A REVIEW ON UTILIZATION OF CARRAGEENAN WASTE FROM SEAWEED INDUSTRY

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**ABSTRACT**

***Carrageenan is the result of extraction from red seaweed. Carrageenan has been widely used in the food and non-food industries. The carrageenan industry, apart from producing many benefits, also produces waste that can be detrimental to the environment. The purpose of this research is to analyze the source, handling of carrageenan waste, and utilization of carrageenan waste so that it becomes a value-added product. Heaps of decayed seaweed waste are usually overgrown with weeds. Carrageenan waste contains macro and micro nutrients which have the potential to be used as something of value. Carrageenan waste can be used as edible film, jelly-making material, organic fertilizer, fish and livestock feed, oyster mushroom growth media, paper industry, and particle board material. With the utilization of carrageenan waste, it is hoped that it can increase its added value and reduce environmental pollution.***

***Keyword: Seaweed, added value, waste handling, solid waste***

## 1. INTRODUCTION

Seaweed is classified as a low-level plant, generally grows attached to certain substrate, has no true roots, stems or leaves, but only resembles a stem called a thallus. The shape of the thallus varies, some are round like a tube, flat, round like a bag, or some are like hair. Seaweed grows in nature by attaching itself to coral, mud, sand, rocks and other hard objects. In addition to inanimate objects, seaweed can also attach to other plants epiphytically [1].

The increase in market demand has made seaweed cultivation more and more carried out by the community, this certainly has a positive impact on increasing production. However, on the other hand, the impact of waste appears.

The increase in seaweed cultivation includes variations in quality that cause products to be rejected by the industry, both from a non-uniform age or harvest period as well as from handling post-harvest hygiene. Cultivation systems, drying facilities and processes, packaging and transportation add to the amount of seaweed waste that is wasted and scattered in drying and storage areas. Currently most of the seaweed waste is always mixed with shellfish whose habitat is attached to seaweed. This waste is only used by the community as a material for landfilling roads or buildings. Even though shells with a sharp, sharp shape and scattered around are also very dangerous for the safety of road users.

Most of the seaweed cultivated by cultivators is seaweed Eucheuma cottonii and Gracilaria sp. [2]. Carrageenan, agar-agar and alginate are the results of extraction from seaweed which can be used as an excellent source of nutrition for food, animal feed, fertilizer and phycocolloid production [3]. Carrageenan is a polysaccharide extracted from the red seaweed class Rhodophyceae [4]. Carrageenan has been widely used in the food industry as a thickening agent, gelling agent, and as an excipient in the form of pills and tablets in the non-food industry [5].

The carrageenan industry, apart from producing many benefits, also produces waste that can be detrimental to the environment. Heaps of decayed seaweed waste usually grow weeds or a variety of plants. The solid waste (dregs) is thought to contain quite complete macro and micro nutrients [6]. With the presence of these nutrients, the carrageenan waste actually has the potential to be used as something that has added value. The purpose of this research is to analyze the source, handling of carrageenan waste, and utilization of carrageenan waste so that it becomes a value-added product.

## 2. SOURCES OF CARRAGEENAN WASTE

One of the products extracted from seaweed is carrageenan. Carrageenan is a product of seaweed which is extracted with water or an alkaline solution from a species of seaweed from the class Rhodophyceae (red algae). Carrageenan is obtained from the process of sedimentation of seaweed with the addition of alcohol, drying and flouring [7]. The results of red seaweed processing not only produce carrageenan with a yield of 23.8 – 28.5%, but also produce solid and liquid waste containing cellulose and other substances [8].

Production of Eucheuma seaweed as raw material for carrageenan reached 94,000 tons in 2007, while the proportion of waste in the carrageenan processing ranged from 65 – 70% so that the potential for carrageenan industrial waste reached more than 60,000 tons per year. The waste resulting from carrageenan extraction consists of two types, namely solid waste containing cellulose and liquid waste containing alkaline compounds, organic compounds and other impurities[9]. Processing results are not only in the form of carrageenan, but also produce residue or waste.

Heaps of decayed seaweed waste usually grow weeds or various plants. Carrageenan waste is a by-product of the processing of red seaweed class Rhodophyceae which has not been utilized. This carrageenan waste is thought to contain minerals that can be used as plant nutrition. Carrageenan waste which is rich in nutrients. The macro and micro elements are thought to have potential as fertilizer.

## 3. HANDLING OF CARRAGEENAN WASTE

Carrageenan can be extracted from seaweed protein and lignin and can be used in the food industry because of its characteristics which can form a gel, thicken and stabilize the main material. Carrageenan is inedible by humans and lacks the nutrients needed by the body. Carrageenan is only used in the food industry because of its characteristic function which can be used to control the water content in the main food ingredient, control texture, and stabilize food.

Carrageenan is produced from washed seaweed by being extracted using water in a ratio of 1:10 for 2-4 hours at 95-100°C. The extraction process is carried out to remove the gel contained in the seaweed. The results of the extraction process were filtered with a calico cloth to separate the filtrate and residue. This residue is called carrageenan waste. The carrageenan waste is then stored in a refrigerator so that it can be used further.

## 4. ALTERNATIVE UTILIZATION OF CARRAGEENAN WASTE

### *4.1 Utilization of Carrageenan Waste for Food Products*

a. Edible Film

Edible film is a thin layer made of edible material, formed to coat food (coating) or placed between food components (film) which acts as a barrier to mass transfer (moisture, oxygen, lipids, solutes) and or as a carrier additive as well as to improve the handling of a food [10].

Edible film has advantageous properties compared to ordinary packaging materials because it can increase the shelf life of food ingredients and can increase the nutritional value of packaged food ingredients, but further research is still needed because film that resulting product still has a large permeability value to water vapor and oxygen gas. The permeability value is greatly influenced by the chemical properties of the polymer, the basic structure of the polymer, and the properties of the components.

The higher the level of consumer concern for the environment, especially for plastic waste as a food product wrapper which is difficult to decompose and recycle and causes pollution problems, provides new challenges for food product processors to take advantage of edible film.

Edible film generated from edible biopolymer and food grade additives. Formation of film Biopolymers can be proteins, polysaccharides (carbohydrates and gums), or lipids [11]. Carrageenan is a compound that belongs to the galactose polysaccharide group extracted from seaweed. Most carrageenan contains sodium, magnesium, and calcium which can be bound to the sulfate ester group of galactose and 3,6-anhydro-galactose copolymer. Carrageenan is a potential hydrocolloid to be made edible film, because it is rigid and elastic, edible, and renewable [12]. Hydrocolloids have advantages, including good ability to protect products against oxygen, carbon dioxide and lipids as well as the required mechanical properties.

b. Jelly Candy Main Ingredients

Jelly candy is a food product that is very popular with people, especially children. Jelly candy is included in semi-moist food made from fruit juice and gel-forming materials, with a clear and transparent appearance, and has a certain texture and elasticity. Jelly candy with good quality has the following characteristics clear and transparent in appearance, springy in texture, elastic and sweet.

One of the factors that affect the quality of jelly candy is the presence of a gel-forming agent. Jelly candy is generally made with the addition of gelatin. Gelatin is generally produced from pork skin or bones. One of the gel-forming materials that can be used besides gelatin in the manufacture of jelly candy is carrageenan. The use of carrageenan in the manufacture of jelly candy will produce jelly candy with the characteristics of having a firm texture but easy to chew when eaten.

Carrageenan was chosen because it has the same role as gelatin, namely as a thickener and gelling agent. Carrageenan is obtained from red seaweed extract (Rhodophyceae) in hot alkaline solution for 10-30 hours then followed by precipitation using alcohol or potassium chloride and dried [7]. Carrageenan contains sodium, magnesium and calcium which can be bound to the sulfate ester group of galactose and 3,6-anhydro-galactose copolymer. The carrageenan used in the research is a type of kappa carrageenan which functions as gelling agent which can improve the texture of jelly candy.

### *4.2 Utilization for Non-Food*

a. Organic fertilizer

The use of carrageenan industrial waste as organic fertilizer is supported by the presence of hydrocolloid properties in the waste which can be used for water absorption [13]. Based on the content of minerals and growth regulators, as well as the production potential of Eucheuma type seaweed, this seaweed waste is expected to contribute to substituting the need for chemical fertilizers with organic fertilizers derived from carrageenan industrial waste.

Fertilizers derived from seaweed waste, including carrageenan industrial waste, are rich in nutrients Fe, B, Ca, Cu, Cl, K, Mg, and Mn. Seaweed waste also contains growth regulators (ZPT) such as auxins, cytokinins, giberilin, absicic acid, ethylene, P, S, Zn, and Boron (B) which are needed for plant growth. This is because seaweed grows in areas or media that are rich in minerals and accumulates in the tissues. The high nutrient elements are very beneficial for plants and soil [15].

b. Fish Feed (Flake)

Utilization of seaweed waste can create alternative feeds to reduce production costs for cultivator or breeder feed so as not to lose money and increase profits with nutritional content that is not much different from factory concentrate feed.

Feed formulated with seaweed flour produced a higher survival rate when compared to natural feed made from fresh seaweed or algae. [15] reported that the survival rate of abalones fed artificial feed was higher (77%-82%) compared to those fed fresh algae (62%-65%).Furthermore, with a high protein content and essential amino acid composition, seaweed flour can promote good growth. According to [16] reported that dry pelleted feed from a mixture of seaweed flour gave a good abalone growth response.

c. Animal feed

The increased consumption of rations is also the result of the fermentation process which produces glutamic acid which can increase appetite. Fermented products add aroma and produce flavors that are liked by livestock. According to [17]the fermentation process will increase ration consumption and body weight gain because the fermentation produces glutamic acid which can increase appetite.

d. Mushroom Growth Media

According to [18] have conducted research on making mushroom growth media by utilizing carrageenan processing waste as one of the media constituent materials. Cellulose contained in carrageenan industrial waste is a carbon source, where carbon is one of the nutrients needed by mushrooms[19]. Carbon is needed to produce energy and the formation of fungal cell structures. The carbon sources commonly used by fungi are polysaccharides, disaccharides, monosaccharide, organic acids, amino acids, certain alcohols, polycyclic components and other natural products such as lignin [20].

e. Paper

Paper is a product derived from wood. As is the case with boards, the existence of wood as a raw material is increasingly rare these days. Making paper from carrageenan industrial waste can be considered as an alternative. Several studies have shown that seaweed industrial waste, including carrageenan industrial waste, can be used as a raw material for making paper. This is based on the presence of fiber in seaweed [21]. The results of research conducted by [22] namely the manufacture of paper as a wrapper for processed fish products from seaweed with the addition of chitosan.

Some of the advantages of paper made from carrageenan industrial waste include: the paper production process from carrageenan industrial waste without using high concentrated alkali but only bleaching using chlorine bleach, the fiber length is uniform so that the surface is smoother, and the fiber density is very dense so it is not needed. Filler material between the fibers as in paper from wood.

## 5. CONCLUSION

Carrageenan is a processed product of seaweed which is extracted using water or an alkaline solution. Carrageenan functions in the food industry as a thickening agent and as an excipient in pill and tablet form in the non-food industry. Carrageenan production produces two types of waste, namely solid waste containing cellulose and liquid waste containing alkaline compounds. Organic compounds and other impurities have and the production of carrageenan also has a waste potential of around 65-70%, therefore proper handling processes are needed. Carrageenan waste can be used as edible film, jelly-making material, organic fertilizer, fish and livestock feed, oyster mushroom growth media and paper industry. With the utilization of carrageenan waste, it is hoped that it can increase its added value and reduce environmental pollution.

## REFERENCES

[1] Anggadiredja JT, Zatnika A, Purwanto H, Istini S. (2006). “Rumput Laut. [Seaweed]”. Penerbit Swadaya. Jakarta.

[2] Kementerian Kelautan dan Perikanan Indonesia. (2011). “Statistik Budidaya Laut”. http://statistik.kkp.go.id/index. php/statistik/c/7/0/0/ Statistik-BudidayaLaut/. Jakarta.

[3] Thirumaran G, Arumugam M, Arumugam R, Anantharaman P. (2009). “Effect of seaweed liquid fertilizer on growth and pigment concentration of Cyamopsis tetrogonolaba (L) Taub”. American-Eurasian Journal of Agronomy Vol. 2, Number 2, pp: 50-56.

[4] Sperisa D, Wiratni, Fahrurrozi M, Rochmadi. (2011). “Carrageenan properties extracted from Eucheuma cottonii Indonesia”. World Academy of Science Engineering and Technology. Vol. 78, pp: 738-742.

[5] Campo VL, Kawano DF, Silva Júnior DB, Ivone CI. (2009). “Carrageenans: biological properties, chemical modifications and structural analysis”. Carbohydrate Polymers. Vol. 77, pp: 167-180.

[6] Wasis B, Suptijah P, Septembriani P. (2012). “Pemanfaatan Pasta Limbah Karagenan dari rumput laut Eucheuma sp. sebagai pupuk pada tanah terdegradasi. [Utilization of Carrageenan Waste Paste from Eucheuma sp. as Fertilizer on Degraded Soil]”. JPHPI. Vol. 15, Number 3, pp: 173-182.

[7] Winarno FG. (1996). “Teknologi Pengolahan Rumput Laut”. Pustaka Sinar Harapan, Jakarta. 112p.

[8] Uju. (2005). “Kajian Proses Pemurnian Dan Pengkonsentrasian Karaginan Dengan Membran Mikrofiltrasi”. Sekolah Pascasarjana, Institut Pertanian Bogor, Bogor. 114 p.

[9] Fithriani D, Sari RN, Sedayu BB. (2007). “Ekstraksi selulosa dari limbah pembuatan karaginan”. Jurnal Pascapanen dan Bioteknologi Kelautan dan Perikanan. Vol. 2, Number 2, pp: 91–97.

[10] Krochta JM, Baldwin EA, Nisperos-Carriedo MO. (1994). “Edible coatings and films to improve food quality”. Technomic Publication. Co. Inc. USA.

[11] Gennadios A, Hanna MA, Kurt LB. (1997). “Application of edible coatings on meats, poultry and seafoods, a review”. Lebsnm. Wiss.u.Technol. Vol. 30, Number 4, pp: 337-350.

[12] Carriedo MN. (1994). "Edible coating and film based on polysaccarides. Dalam: Edible coating and film to improve food quality". A Technomic Publishing Company Inc. Pensylvania. p. 305-335.

[13] Molloy FJ, Critchley AT, Kandjengo L, Mshigeni KE. (2003). "The use of the valuable oyster mushroom, Pleurotus sajor caju, for conversion of waste materi- als produced from seaweed and brewing industries: Preliminary investigations". J. Ambio. Vol. 32, Number 1, pp 76–78.

[14] Saputra DR. (2009). "Aplikasi Bioteknologi Pemanfaatan Limbah Rumput Laut". Rir Corp. Makassar. 58 pp.

[15] Daume S, Davidson M, Ryan S, & Parker F. (2007). "Comparisons on rearing systems based on algae or formulated feed for juvenile greenlip abalone (Haliotis leavigata)". J. Shellfish Research, Vol. 26, pp: 729-735.

[16] Giri NA, Marzuqi M, Astuti NWW, Andriyanto W, Rusdi I. Andamari R. (2015). "Evaluasi bahan baku pakan dan pengembangan pakan buatan untuk budidaya pembesaran abalon (Haliotis squamata)". J. Ris. Akuakultur, Vol. 10, Number 3, pp: 379-388.

[17] Widodo A.R., H. Setiawan, Sudiyono, Sudibya, Indreswari R. (2013). "Kecernaan nutrien dan performa puyuh (Coturnix japonica) jantan yang diberi ampas tahu fermentasi dalam ransum. Tropical animal husbandry". Vol 2, Number 1, pp: 52-58.

[18] Assadad L. (2009). "Pemanfaatan Limbah Industri Karaginan Untuk Menghasilkan Produk Bernilai Tambah". Jurnal Squalen. Vol. 4, Number 3, pp: 93-98.

[19] Kaul TN. (1997). "Introduction to Mushroom Science (Sys- tematics)". Science Publishers Inc., New Hampshire. 198 pp.

[20] Chang ST. and Miles PG. (2004). "Mushroom: Cultivation, Nutritional Value, Medicinal Effect And Environ- mental Impact". CRC Press, New York. 451 pp.

[21] Silaban I. (2008). "Rumput laut, alternatif bahan pembuat kertas". http://suarausu-online.com/web/index. php?option=com_content&task=view&id=126.

[22] Nugroho BS. (2007). "Chitosan-Seaweed Paper". Departemen Teknologi Hasil Perairan. Institut Pertanian Bogor, Bogor. 83 pp