International Journal of Education and Life Sciences (IJELS)
Vol. 3, No. 7, 2025: 2367-2374

Analysis of Hydrocolloid Types and Fourier Transform Infrared Spectroscopy (FTIR) Spectra of Red Seaweed (Rhodophyceae) During the Dry Season in Oenaek Waters, Kupang Regency

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ARTICLE INFO
Keywords: FTIR, Hydrocolloid Types (carrageenan and agar), Red Seaweed.

Received : 15, May
Revised : 20, June
Accepted: 17, July

ABSTRACT
Red seaweed (Rhodophyceae) is a natural hydrocolloid source that has great potential to be developed in Indonesia. Hydrocolloids such as agar, carrageenan, and alginate can be used in various industries, including food, pharmaceuticals, and cosmetics. However, the utilization of seaweed in Indonesia is still not optimal, as most of it is exported in dried form. This study aims to determine the type of hydrocolloid and FTIR spectra of red seaweed in the dry season in Oenaek waters, Kupang Regency. This study used two methods: laboratory research and descriptive research. The descriptive method was used to describe and explain the observed phenomena. The parameters studied in this research include hydrocolloid content and infrared spectroscopy (Fourier Transform Infrared) testing, which was conducted at the Laboratory of Advanced Technology and Multidisciplinary, Airlangga University Campus C, Mulyorejo, Surabaya. The results showed that the types of hydrocolloids obtained in this study were carrageenan and agar. The carrageenan content obtained from red seaweed ranged from 30.2% to 40.8%, while the agar content obtained from red seaweed ranged from 29.6% to 33.2%. The results of infrared spectroscopy (Fourier Transform Infrared) analysis showed that the absorption peaks obtained were characteristic of the chemical composition of red seaweed.

DOI: https://doi.org/10.59890/ijels.v3i7.91
https://ntlmultitechpublisher.my.id/index.php/ijels

INTRODUCTION

Red seaweed*(Rhodophyceae)*is one of the main sources of natural hydrocolloids, namely polysaccharide compounds that have the ability to form gels, thicken, and stabilize solutions in the food and non-food industries. Among the important types of red seaweed in hydrocolloid production are*Gracillaria* And *Gigartina*. The types of Indonesian seaweed that have important economic value are*Rhodophyceae*(red algae) and seaweed are producers of agar-agar and carrageenan (Ulfah, 2009). The types of seaweed that produce carrageenan are*Gracilaria* And *Gellidium*, while the seaweed that produces carrageenan is*Chondrus crispus, Gigartina, Eucheuma and Halymenia*(Suparmi and Sahri, 2009). The utilization of seaweed in Indonesia is still not optimal because most of the seaweed is exported in dried form and only about 20% can be processed by domestic industry (Desiana and Hendrawati, 2015).

Indonesia has not been optimal in processing seaweed raw materials into value-added products, so there is a risk that this commodity will be exploited by other countries (Salam and Larasati, 2014). Hydrocolloids are polysaccharide compounds that can form gels or increase viscosity in solution. Hydrocolloids from red seaweed generally consist of agar, carrageenan, alginate. Carrageenan and agar are widely extracted from red seaweed (Williaams and Phillips, 2000), and alginate is widely extracted from brown seaweed (Williams and Phillips, 2000; Reyes-Tisnado, et al., 2005). These hydrocolloids can be used in various industrial fields, such as food, pharmaceuticals, and cosmetics, due to their diverse properties and functions.

The hydrocolloid content in red seaweed can vary depending on the species, habitat, and environmental conditions. The nature of hydrocolloids that have a negative charge on the hydroxyl group allows them to form hydrogen bonds that play an important role in the formation and characteristics of edible films (Riyanto et al., 2014).

FTIR (Fourier Transform InfraRed) spectral profile can be used to identify functional groups and molecular structures of hydrocolloids in red seaweed. By knowing the type of hydrocolloid and FTIR spectral profile, the nature and characteristics of red seaweed can be understood, so that it can be optimally utilized in various applications.

Therefore, it is necessary to conduct research on the analysis of the types of hydrocolloids contained in red seaweed and its FTIR spectra profile, so that it can provide useful information for the development of seaweed-based industries and sustainable management of marine resources.

RESEARCH METHODS

Place and time of research

This research was conducted in July-August 2024. Sampling was carried out in the waters of Oenaek Village, Kupang Regency, hydrocolloid content testing was carried out at the Laboratory of the Faculty of Animal Husbandry, Marine Affairs, and Fisheries at Nusa Cendana University, and FTIR Spectra

Analysis was carried out at the Laboratory of the Faculty of Advanced Technology and Multidisciplinary, Airlangga University.

Tools and materials

Used are buckets, sample plastic, stationery, cameras, label paper, Erlenmeyer flasks, hot plates, petri dishes, scissors, analytical scales, blenders, basins, measuring cups, filter cloths, stirrers. The materials used in this study include red seaweed samples, distilled water, 4% NaOH solution, methanol solution.

Research procedures

Preparation of tools and materials to be used, Sample collection, then the samples found are washed clean and air dried. The dried samples are cut and then blended to obtain seaweed flour. Seaweed flour is weighed as much as 5 grams and then extracted. The extraction process of seaweed flour is put into an Elyemeyer flask, 200 ml of distilled water and 4% NaOH are added. Then boiled at a temperature of 70°-90°C until it becomes porridge. After becoming porridge, it is filtered into a petri dish containing 20 ml of ethanol, and continued with the sedimentation and drying process. FTIR analysis was carried out at the Laboratory of the Faculty of Advanced Technology and Multidisciplinary, Airlangga University.

Parameters Studied

The parameters observed in this study are as follows:

a. Carrageenan

Yield % = x 100%

b. So that

Yield % = x 100%

c. FTIR Spectra of Carrageenan and Agar

Identification of the type of hydrocolloid is carried out by infrared spectroscopy testing (*Fourier Transform Infrared*) which was carried out at the Laboratory of the Faculty of Advanced Technology and Multidisciplinary, Airlangga University Campus C, Mulyorejo, Surabaya.

Data analysis

The data obtained from the research results were then analyzed descriptively.

RESULTS AND DISCUSSION

Carrageenan

Carrageenan is a product extracted from red seaweed and can be used as an additive in various applications (Fardhyanti & Julianur, 2015). The measurement results showed that the carrageenan content in the samples ranged from 30.2% to 40.8%. Sample A2 had the highest content and sample A1 the lowest. The carrageenan yield value from Oenaek waters has met international standards. According to Syamsuar (2007), carrageenan contained in the cell walls

of seaweed is an important indicator of carrageenan quality. The higher the carrageenan content, the better the quality and economic value of the seaweed.
So that is a type of hydrocolloid contained in red seaweed, especially in the species*Ice* And *Gracillaria*. The results showed that the average agar content in the samples ranged from 29.6% to 33.2%. Sample B2 had the highest content of 33.2% and sample B1 had the lowest content of 29.6%. The agar yield from Oenaek waters meets the minimum standards set by FAO. The higher the agar content, the better the quality of the seaweed and the higher its economic value.

Alkaline solutions accelerate the formation of 3,6-anhydrogalactose bonds, increase gel strength, and allow reaction of the product with proteins that may be contained in the sample (Ega*et al*., 2016). According to Pumpente*et al*. (2019), increasing the concentration of alkali can increase the melting point of seaweed, thereby reducing the amount of extract that dissolves during heating. Another study by Ega*et al*. (2016) showed that the addition of alkali concentration affected the alkalization process and increased the pH of the extract. Nasruddin*et al*. (2016) also stated that high alkali concentrations can increase extraction capacity and accelerate the formation of carrageenan or 3,6 anhydrogalactose. This finding is supported by research by Ningsih (2014) & Arzani*et al*. (2020).

Extraction time and temperature also play an important role in determining the yield value of carrageenan, because it can affect the interaction of alkali solvents with polymer chains (Desiana*et al*., 2015;*et al*., 2018;*et al*., 2019). The environmental conditions where seaweed grows can also affect the yield value (Kreckhoff*et al*., 2015;*et al*., 2017; Happy *et al*., 2018). The right extraction time can accelerate the rate of diffusion of the extraction solution through the cell wall, thus affecting the final yield (Ega*et al*., 2015). The right extraction time can accelerate the rate of diffusion of the extraction solution through the cell wall, thus affecting the final yield (Ega*et al*., 2015). Based on the standards set by the Indonesian Ministry of Trade and Industry, which is a minimum of 25% carrageenan content (Syamsuar, 2006., Gunawan, 2008), samples A1 and A2 with values of 30.2% and 40.8% respectively meet these requirements.

c. FTIR spectra

According to Stuart (2004), FTIR is very effective in analyzing organic and inorganic compounds because it is able to detect functional groups with a high level of accuracy.

FTIR Spectra of Carrageenan

In the FTIR analysis of carrageenan, the FTIR spectra can show several characteristic peaks, including: OH absorption peak: Around 3400-3500 cm- 1, indicating the presence of hydroxyl groups (-OH). C-O absorption peak: Around 1200-1000 cm-1, indicating the presence of ether (C-O-C) and alcohol (C-OH) groups. Sulfate absorption peak: Around 1250-1220 cm-1 and 850-800 cm-1, indicating the presence of sulfate groups (-SO3) which are typical for carrageenan.

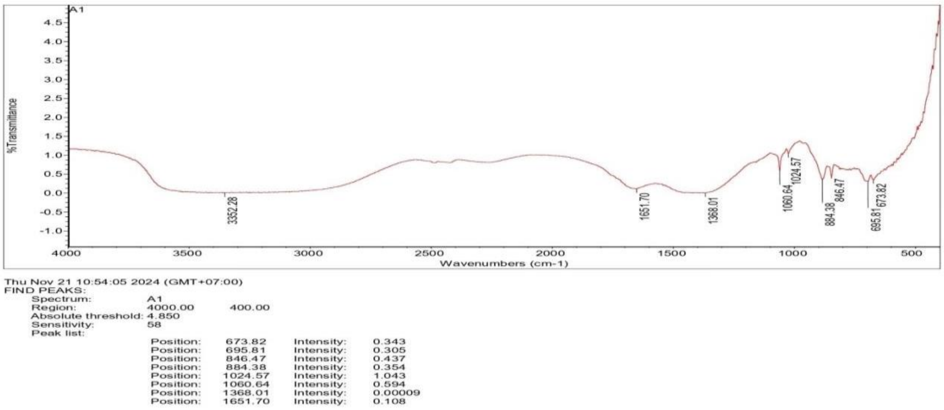


Figure 1. FTIR Spectra of Carrageenan A1

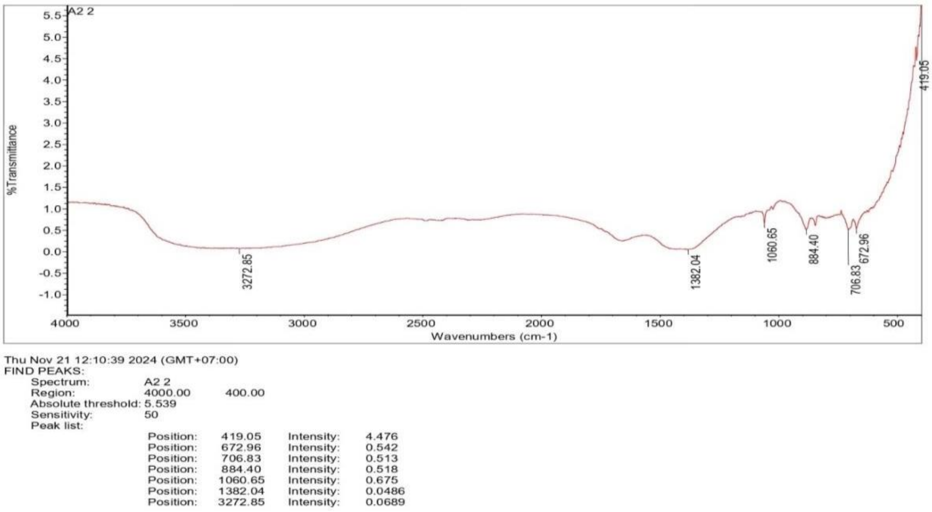


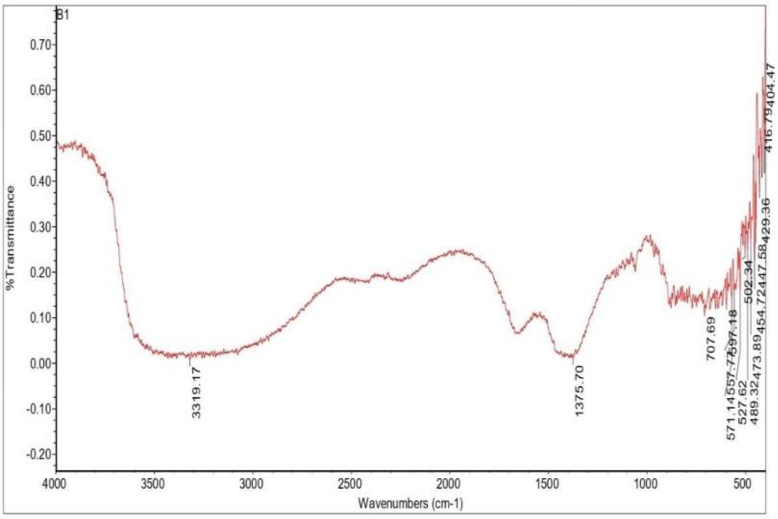
Figure 2. FTIR Spectra of Carrageenan A2

The FTIR spectrum of A1 carrageenan based on the absorption peak at the absorption peak number shows, Value 3352.28 cm^{-1}: which indicates the absorption of the hydroxyl group (-OH) which is typical for polysaccharides and indicates the presence of hydrogen bonds. Value 1651.70 cm^{-1}: Related to the vibration of the C=O bond of the carbonyl group in the carrageenan structure. Value 1368.01 cm^{-1}: Indicates the presence of a sulfate group (S=O) which is typical of carrageenan. Values 1024.57 cm^{-1} and 1060.64 cm^{-1}: Are characteristics of the sulfate group (C-O-S) in carrageenan. Values of 846.47 cm^{-1} and 884.38 cm^{-1}: Indicate the vibration of the sulfate group ($-OSO_3^-$) which distinguishes the type of carrageenan (kappa, iota, or lambda). Values of 695.81 cm^{-1} and 673.82 cm^{-1}: Indicate typical absorption for polysaccharide rings. While the FTIR spectrum of carrageenan A2 based on the absorption peak at the absorption peak number shows, Value 3272.85 cm^{-1}: Indicates the absorption of the hydroxyl group (-OH), which is typical for polysaccharides and is related to hydrogen bonds. Value 1382.04 cm^{-1}:

Related to the vibration of the sulfate group (S=O), which is the main characteristic of carrageenan. Value 1060.65 cm^{-1}: Indicates the presence of a sulfate group (C-O-S) in the carrageenan structure. Value 884.40 cm^{-1}: Indicates the presence of sulfate groups ($-OSO_3^-$) that distinguish the type of carrageenan (kappa, iota, or lambda). Values 706.83 cm^{-1} and 672.96 cm^{-1}: Show typical absorptions of the polysaccharide ring in the carrageenan structure. Value 419.05 cm^{-1}: Can be related to other bond vibrations in the polysaccharide.

FTIR Spectra of Agar

By analyzing the FTIR absorption peaks, we can understand the molecular structure of agar contained in the red seaweed sample. Some absorption peaks that may appear in the FTIR analysis results include Absorption peaks around 3400-3500 cm-1 (hydroxyl group -OH), Absorption peaks around 2900-3000 cm-1 (C-H group), Absorption peaks around 1200- 1000 cm-1 (ether group C-O-C), Absorption peaks around 930 cm-1 (3,6-anhydrogalactose structure).



Thu Nov 21 12:44:19 2024 (GMT+07:00)
FIND PEAKS:
Spectrum: B1
Region: 4000.00 400.00
Absolute threshold: 0.778
Sensitivity: 37
Peak list:

Position:	404.47	Intensity:	0.476
Position:	416.79	Intensity:	0.428
Position:	429.36	Intensity:	0.377
Position:	447.58	Intensity:	0.300
Position:	454.72	Intensity:	0.225
Position:	473.89	Intensity:	0.274
Position:	489.32	Intensity:	0.250
Position:	502.34	Intensity:	0.242

Figure 3. FTIR Spectra of Agar B1

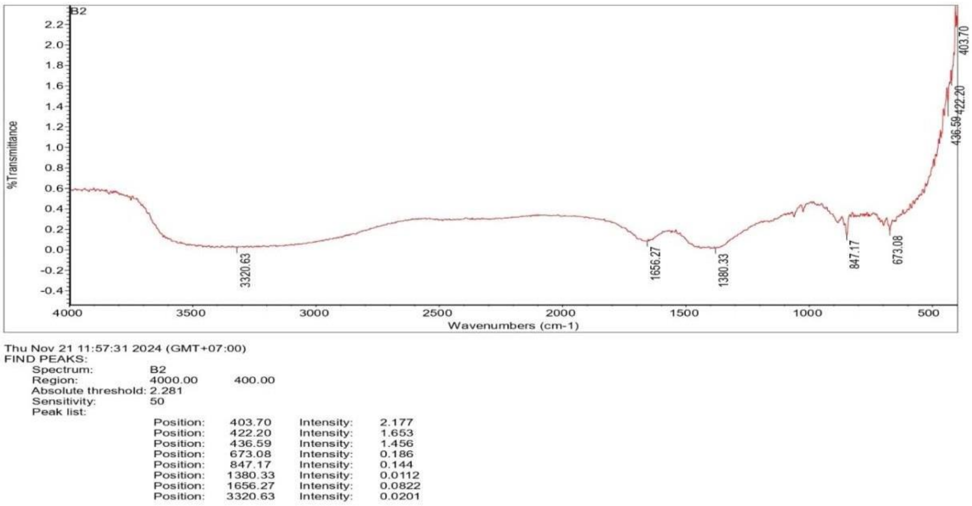


Figure 4. Spectra FTIR Agar B2

FTIR spectrum of agar (B1) based on the number of absorption peaks at the peak absorption as follows: value 3319.17 cm^{-1}: Indicates the absorption of hydroxyl groups (-OH), which is typical for polysaccharides and is related to hydrogen bonds. Value 1375.70 cm^{-1}: Related to the vibration of sulfate groups (S=O), which is the main characteristic of agar. Value 707.69 cm^{-1}: Indicates the presence of vibrations of polysaccharide rings in the agar structure. Value 571.14 cm^{-1} - 489.32 cm^{-1}: Indicates bond vibrations in the agar structure which may be related to sulfate groups and ionic interactions in the polymer matrix. Value 404.47 cm^{-1} - 502.34 cm^{-1}: Can be related to other bond vibrations in polysaccharides.

The FTIR spectrum of agar (B2) based on the absorption peak at the wave number shows the following values: value 3320.63 cm^{-1}: Indicates the stretching vibration (-OH) of the hydroxyl group, which indicates the presence of typical hydrogen interactions in polysaccharides. Value 1656.27 cm^{-1}: Related to the stretching vibration of the C=O or amide bond which may originate from protein contamination or complex polysaccharide structures. Value 1380.33 cm^{-1}: Related to the symmetric vibration of the sulfate group (S=O), which is a characteristic of agar. Value 847.17 cm^{-1}: Indicates the C-O- S vibration of the sulfate group, which is the main sign of the agar structure. Value 673.08 cm^{-1}: Typical vibrations related to the polysaccharide structure. Value 403.70 cm^{-1} - 436.59 cm^{-1}: Indicates the presence of vibrations of bonds in the agar structure related to molecular interactions.

Comparison Both spectra show strong absorption around 3320-3319 cm^{-1}, indicating hydroxyl groups. The spectrum of B2 has an additional absorption at 1656.27 cm^{-1}, which is not clearly seen in the spectrum of

B1, possibly due to contaminants or structural differences. The sulfate peaks in B2 are more pronounced at 1380.33 cm^{-1} and 847.17 cm^{-1}, while those in B1 are more dominant at 1375.70 cm^{-1} and around 707.69 cm^{-1}. The wavenumber range below 500 cm^{-1} shows a different pattern, which may be related to the variation in composition or substitution degree of sulfate groups in the samples.

CONCLUSION

Hydrocolloid analysis of red seaweed in the waters of Oenaek, Kupang Regency, shows that the species*Gigartina pistillata*contains carrageenan, while *Gracilaria gracillaris* containing . This study shows that hydrocolloids from red seaweed in Oenaek waters, Kupang Regency, not only meet the minimum content standard of 25%, but also have a distinctive chemical structure according to the results of FTIR analysis. Functional groups such as sulfate esters, glycosidic bonds, and galactose that were detected indicate the great potential of this hydrocolloid to be utilized in various industries. The results of the FTIR spectra analysis showed absorption peaks that were chemically characteristic of red seaweed, indicating the presence of hydrocolloids such as carrageenan and agar.

THANK-YOU NOTE

The author would like to thank theFaculty of Marine Animal Husbandry and Fisheries, Nusa Cendana University, Kupang.

BIBLIOGRAPHY

Arzani, H., (2020). Characteristics of semi-pure carrageenan from seaweed*Kappaphycus*striatum and*Kappaphycus alvarezii.*Journal of Industrial and Food Technology, 31(2),. https://journal.ipb.ac.id/index.ph p/jtip

Asikin, A. N., & Kusumaningrum, I. (2019). Physicochemical Characteristics of Carrageenan Based on Different Harvest Ages from Bontang Waters, East Kalimantan. Indonesian Journal of Fisheries Product Processing, 22(1), 136-142

Bunga, S.M, Montolalu, R.I, Harikedua, Montalalu, L, Watung, H, & Taher, N. (2013). Characteristics of the Physical and Chemical Properties *Kappaphycus alvarezi* At Various Harvest Ages Taken from the Waters of Arakan Village, South Minahasa Regency. Sam Ratulangi University. Journal of Fisheries Product Technology Media. Vol. 1 No. 2

Desiana, E., & Hendrawati, T. Y. (2015). Making Carrageenan From*Eucheuma Cottonii*With KOH Extraction Using Variable Extraction Time. Journal of Technology, 007, 1-7.

Ega, L., Cristina, C. G., & Meiyasa, F. (2016). Study of Carrageenan Quality of Eucheuma cottonii Seaweed Based on Physico- Chemical Properties at Different