FT-IR analysis of various kappaphycus alvarezii from Semporna and Natuna Island

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ABSTRACT – Seaweeds are interesting source of micronutrients and bioactive molecules for the health and cosmetic industry. Different origin of seaweeds might present different important chemical features of seaweeds even from the same variety. The present study aims to identify the chemical properties of brown algae *Kappaphycus alvarezii*. Two different varieties of *Kappaphycus alvarezii* seaweeds were collected from Semporna, Sabah and Natuna Island. The dried seaweeds were washed thoroughly with distilled water before shed and oven-dried. Subsequently, the different *Kappaphycus alvarezii* were subjected to Fourier transform infrared spectroscopy for the analysis of functional groups. The chemical analysis revealed the presence of aliphatic constituents containing carbon, ketones, alkyl halides and hydroxyl groups. It also showed high values in terms of important kappa carrageenan structures for skin and body health. Therefore, the present study suggests the collected *Kappaphycus alvarezii* can be used for health and cosmetics industry.

1. INTRODUCTION

Seaweeds are very significant natural marine resources that are utilized as nutritional foods and animal feeds in their entire form, as well as sources of valuable dietary fiber, polysaccharides (mainly alginates, carrageenans and agar), carotenoids, lipids, vitamins, minerals, and amino acids for health and cosmetics industry [1]. Biologically active substances from seaweeds have the potential to act as nutritional supplements, pharmaceuticals, cosmeceuticals, cosmetics, fine chemicals, and enzymes [2]. Their application in cosmetics was revealed due to their skin care advantages including skin moisture source, blood circulation promoter, cell renewal and the metabolism activator, sebaceous gland function regulator, anti-inflammatory effect, and skin's resistance properties [3]. Generally, seaweeds are aquatic photosynthetic organisms belonging to the Eukaryota domain and to the Plantae (green and red algae) and Chromista (brown algae) kingdoms, respectively. Referring to Pereira [2], seaweeds can be classified as: (a) red algae are included in the Rhodophyta phylum, and their photosynthetic pigments are chlorophyll a, phycobilins (r-phycocyanin and r-phycoerythrin), and carotenoids (lutein, zeaxanthin, β-carotene) [4]; (b) green algae are included in the Chlorophyta phylum and their pigmentation is identical to that of land plants (chlorophyll a, b, and carotenoids) [3]; and (c) brown algae are included in the Ochrophyta (or Heterokontophyta) phylum, Phaeophyceae class, and their pigments include chlorophylls a, c, and carotenoids (fucoxanthin). Brown seaweeds has tyrosinase inhibitory effects which helps to reduce or control skin pigmentation, possesses anti-inflammatory effect and also, assists in preventing natural aging of the skin by supporting the formation of collagen (a structural protein which tends to disperse with age). Furthermore, the pigment moisturizes the skin and keeps the skin cells working efficiently [5]. Brown *Kappaphycus alvarezii* was reported earlier to contain vitamin C, vitamin E and bioactive compounds (alkaloids, terpenoids, steroids, flavonoids, saponins, and tannins), which give them antioxidant and tyrosinase enzyme inhibitory activities [6]. Moreover, brown seaweed is said to produce hydrocolloid alginate which can be used as a stabilizer, thickener, gel maker, emulsifier and water binder in the cosmetics field. Thus, this research aims to study the chemical properties of brown *Kappaphycus alvarezii* seaweed from different origins of Semporna, Sabah and Natuna Island.

2. METHODOLOGY

The marine brown *Kappaphycus alvarezii* was collected from the sea coast of Semporna, Sabah and Natuna Island (Figure 1). The dried thallus of *Kappaphycus alvarezii* were first washed thoroughly with tap water, followed by distilled water before cut into pieces, and left under shed-dried for 5 days, followed by oven-dried for 2 hours (60°C). The samples were analyzed using FT-IR via ATR technique. IR spectra region 4000-400 cm-1 were recorded at room temperature on a Perkin Elmer Fourier transform spectrometer.

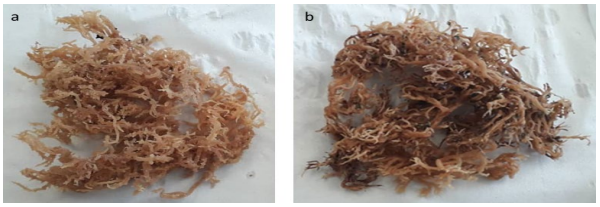

Figure 1 Marine brown *Kappaphycus alvarezii* collected from the sea coast of a) Natuna Island and b) Semporna, Sabah.

3. RESULT AND DISCUSSION

Figure 2 shows the FT-IR spectra of brown *Kappaphycus alvarezii* seaweed from different origin of Semporna, Sabah and Natuna Island. The FT-IR analysis of both samples gives broad peaks at ~3350 cm^{-1}, which indicating the presence of OH stretching suggesting the presence of alcohols and phenols [6]. The absorption peak at ~2910 cm^{-1} and 1638 cm-1 are ascribed to stretching vibrations of C-H groups and polymer bound water respectively [6]. Next, the peak at 1410 cm^{-1} and 1361 cm^{-1} correspond to the sulphate stretching and methylene group bending correspondingly. FT-IR spectra also present dominant absorption bands at 1210 cm^{-1} and 1150 cm-1 that are associated with the O=S=O bond and S=O of the sulfate ester groups. The intense band in 1020 cm^{-1} is representing glycosidic linkage. Meanwhile, the main features of seaweed originated from Natuna island have strong band at 927 cm^{-1} and 836 cm^{-1} which are associated with C-O-C stretching vibration of 3, 6-anhydrogalactose bridges and C4-O-S stretching in β-D-galactose-4 sulphate respectively [6].

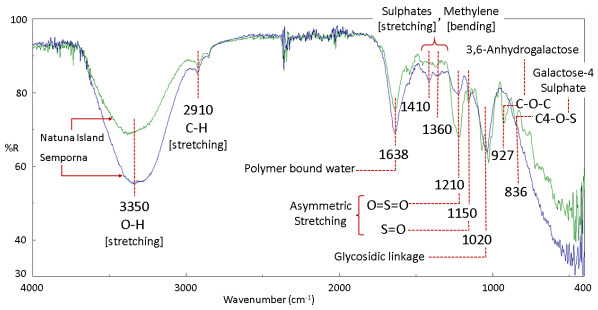

Figure 2 FT-IR spectrum of *Kappaphycus alvarezii* originated from Natuna Island compared to Semporna.

The sulfate ester stretching functional groups indicate the presence of carrageenan in *Kappaphycus alvarezii*. Hence, κ-carrageenan is the major polysaccharide component in seaweeds. Both functional groups of 3,6-anhydro-D-galactose and D-galactose-4-sulfate are the main compounds that provide the gelling ability and mechanical support to seaweed's structure [6]. However, this κ-carrageenan which comprises a family of linear water-soluble sulphated polysaccharides seaweeds is absent in seaweeds originated from Semporna. In contrast, many earlier studies reveal this significant polysaccharides features in seaweeds originated from the sea coast of Semporna, Sabah [7]. The observation might be due to post-harvest treatment process such as drying of this sample which result in main peak absence. Direct sun-drying of seaweeds might result in loss of certain nutrients like minerals and proteins.

4. CONCLUSIONS

Vibrational FT-IR-ATR spectroscopy is a useful tool in the food, pharmaceutical, and cosmetics industries for a preliminary identification of the main sulphated polysaccharides (namely carrageenan) produced by edible brown seaweeds, via a rapid and non-destructive method. This observation also verified the characteristic of both seaweeds *Kappaphycus alvarezii* from Semporna and Natuna Island. Both samples are sharing the same main features of seaweed *Kappaphycus alvarezii* even originated from different location. Absence of 3, 6-anhydrogalactose bridges and C4-O-S stretching in β-D-galactose-4 sulphate in *Kappaphycus alvarezii* collected from Semporna is suggested due to post-harvest treatment process.

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REFERENCES

[1] T. Rosemary, A. Arulkumar, S. Paramasivam, A. Mondragon-Portocarrero, and J. M. Miranda, Biochemical, micronutrient and physicochemical properties of the dried red seaweeds gracilaria edulis and gracilaria corticata, *Molecules*, vol. 24, no. 12, pp. 1–14, 2019.

[2] L. Pereira, Seaweeds as source of bioactive substances and skin care therapy-Cosmeceuticals, algotheraphy, and thalassotherapy, *Cosmetics*, vol. 5, no. 4, PP. 1-41, 2018.

[3] S. Joshi, K. Roshani, and V. N. Upasani, Applications of Algae in cosmetics: An overview, I*nt. J. Innov. Res. Sci.*, vol. 7, no. 2, pp. 1269-1278, 2018.

[4] R. Rossano, N. Ungaro, A. D'Ambrosio, G. Liuzz, and P. Riccio, Extracting and purifying R-phycoerythrin from Mediterranean red algae Corallina elongate Ellis & Solander, *J. Biotechnol.*, vol. 101, no. 3, pp. 289–93, 2003.

[5] H. Shimoda, J. Tanaka, S.-J. Shan, and T. Maoka, Anti-pigmentary activity of fucoxanthin and its influence on skin mRNA expression of melanogenic molecules, *J. Pharm. Pharmacol*., vol. 62, no. 9, pp. 1137–1145, 2010.

[6] M. T. Dolorosa, Nurjanah, S. Purwaningsih, and E. Anwar, Utilization of Kappaphycus alvarezii and Sargassum plagyophyllum from Banten as cosmetic creams, *IOP Conf. Ser. Earth Environ. Sci*., vol. 404, no. 1, pp. 1-10, 2019.

[7] A. P. S. A. Khalil, S. W. Yap, Y. Y. Tye, P. M. Tahir, S. Rizal, and M. R. Nurul Fazit, Effects of corn starch and Kappaphycus alvarezii seaweed blend concentration on the optical, mechanical, and water vapor barrier properties of composite films, *BioResources*, vol. 13, no. 1, pp. 1157–1173, 2018.