Extraction of alginate from brown seaweed

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***Abstract*: Alginates are one of the most important compounds of brown seaweeds. These compounds are employed in the food area, because of their important rheological properties, such as viscosity, Gelling, and stabilizing features and as dietary fiber source. In this study, five species of dominant Brown seaweeds were collected in the Red Sea (Padina boergesenii, Turbinaria triquetra, Hormophysa, Cuneiformis, Dictyota ciliolata, and Sargassum aquifolium) so as to characterize the alginate yield and its properties. The analysis demonstrated differences in the alginate yield among the seaweeds. The highest yield of alginate was recorded in the species T. triquetra (22.2 ± 0.56% DW), while the Lowest content was observed in H. cuneiformis (13.3 ± 0.52% DW). The viscosity from the alginates Varied greatly between the species, whereas the pH varied slightly. The alginate exhibited a moisture Content between 6.4 and 13.1%, the ash content ranged between 12.3 and 20% DW, the protein reached Values from 0.57 to 1.47% DW, and the lipid concentration varied from 0.3 to 3.5% DW. Thus, the Phytochemical analysis demonstrated that the extracted alginates can be safely applied in the food Industry. Furthermore, the alginate yield reveals the potential application of these seaweeds as a Nutraceutical raw source, which can be exploited by the food industry.**

***Keywords*: Alginate, Brown sea weed, Alginic acid, calcium alginate**

I. INTRODUCTION

Polysaccharides are one of the most important and exploited seaweed compounds in the food industry and by nutraceutical companies. These compounds are being used as natural additives in food, to enhance food quality, and as ingredients, to add nutritional value, namely for the dietary fiber content. Alginic acid is the main structural polysaccharide present in the cell wall and in the intercellular matrix of brown seaweed, providing flexibility and mechanical resistance to the force of the water in the marine environment where the seaweed grows. Alginic acid is a complex organic compound composed of monomers of d-mannuronic acid and l-guluronic acid. So, alginate is composed of 1, 4-β-dmannuronic acid (M) and 1, 4-α-l- guluronic acid (G) monomers, with a homogeneous (Poly-M and Poly-G) or heterogeneous (MG) block configuration. The extraction process is based on the conversion of an insoluble mixture of salts of alginic acid into a soluble salt (alginate), which is suitable for water extraction. The proportion of the three kinds of blocks, namely GG, MM, and MG, defines the physical features of alginates, with alginates with a high proportion of M blocks having a higher viscosity, while those with a high proportion of G blocks having higher gelling properties. Alginates vary in composition among species, from 20 to 60% dry matter, and occur mainly as gels comprising magnesium, calcium, sodium, and barium ions.

The brown algae (singular: alga), comprising the class Phaeophyceae, are a large group of multicellular algae, including many seaweeds located in colder waters within the Northern Hemisphere. Most brown algae live in marine environments, where they play an important role both as food and as a potential habitat. For instance, Macrocystis, a kelp of the order Laminariales, may reach 60 m (200 ft) in length and forms prominent underwater kelp forests. Kelp forests like these contain a high level of biodiversity. Another example is Sargassum, which creates unique floating mats of seaweed in the tropical waters of the Sargasso Sea that serve as the habitats for many species. Many brown algae, such as members of the order Fucales, commonly grow along rocky seashores. Some members of the class, such as kelps, are used by humans as food. Between 1,500 and 2,000 species of brown algae are known worldwide. Some species, such as *Ascophyllum nodosum*, have become subjects of extensive research in their own right due to their commercial importance. They also have environmental significance through carbon fixation.

Figure 1 : Brown seaweed in oceans

The following are the best health benefits of seaweed:

- It is highly nutritious.
- Seaweed is a rich source of iron and iodine.
- It may help with thyroid function.
- It may help with diabetes.
- It may support gut health.
- It may help with weight loss.
- May protect the heart.

Brown algae include a number of edible seaweeds. All brown algae contain alginic acid (alginate) in their cell walls, which is extracted One of these products is used in lithium-ion batteries. Alginic acid is used as a stable component of a battery anode. This polysaccharide is a major component of brown algae, and is not found in land plants.

Figure 2 : Brown seaweed

Alginates (ALG) are a group of naturally occurring anionic Polysaccharides derived from brown algae cell walls, including *Macrocystis pyrifera, Laminaria hyperborea, Ascophyllum Nodosum* and several bacteria strains (*Azotobacter,Pseudomonas*) This term usually referred to alginic acid And its salts, but it can also be used for all derivatives of alginic Acid. Alginate are linear biopolymers consisting of 1,4-linked D-mannuronic acid (M) and L-guluronic acid (G)Residues arranged in homogenous (poly-G, polyM) or heterogenous (MG) block-like patterns. With Regard to the initial source material, commercial alginate may Differ in composition and the sequence of G- and Mblocks.Alginate extraction process from seaweeds is uncomplicated But multistage procedure, which usually starts with treating.The dried raw material using diluted mineral acid.

Currently used alginate possess a high degree of physicochemical heterogeneity which influences their quality and Determines potential applicability. Alginate are commercially Available in various grades of molecular weight, composition,And distribution pattern of M-block and G-block, the factors Responsible for their physicochemical properties such as Viscosity, sol/gel transition, and water-uptake ability. The Molecular weight, expressed as an average of all the molecules Present in the sample, of commercial alginate varies between 33 000 and 400 000 g/mol. Alginate extracted from different Sources differ in M and G residues as well as the length of Each block. Generally, by raising the aginate Gblock content or Molecular weight, more stronger and brittle alginate gels may be Alginic acid is insoluble in water and organic Solvents, whereas alginate monovalent salts and Alginate esters are Water-soluble forming stable, viscous solutions. The 1% w/v aqueous solution of sodium alginate has a dynamic Viscosity.

II. MATERIALS AND METHODS

Materials Required:

- Beaker
- Conical flask
- Centrifuge tubes
- Filter paper
- Pipette

Chemicals:

- Formalin
- Sodium carbonate
- HCL
- Calcium chloride
- Acid

Methods:

Alginate production: There are two methods for the extraction

- *Calcium Alginate process*
- *Alginic acid process*

Alginic acid process:

- Dried the sea weed for one week and chopped into small
- In the wet chopped sea weed add formalin (formaldehyde +methanol)
- And the sea weed need to get swollen
- Add sodium carbonate solution.
- Now begins the centrifugation process
- Centrifuge process: centrifuge at 3000rpm at 15 minutes
- To separate the liquid to solid (at the end this phase, the seaweed has been separated in to an alginate)
- The sea weed residue(slurry) is separated from sodium alginate (liquid containing alginate) and the slurry is discarded.
- Add HCl to the sodium alginate solution, it forms as ALGINIC ACID GEL
- Water is evaporated using dewatering process(filtration)
- Sodium carbonate is added
- The mixture is heated to 50 to 98^{o}C and completely evaporated
- And it forms sodium Alginate
- Sodium Alginate is crystallized to form Alginate

Calcium alginate process:

- After the formation of sodium alginate solution add calcium chloride
- It becomes calcium Alginate fibres
- And add acid
- And it forms ALGINIC acid fibres.
- Add sodium carbonate
- And it becomes sodium alginate
- And sodium Alginate is crystallized to form Alginate

Chemical test:

Test for Flavonoids:

Flavonoids help regulate cellular activity and fight off free radicals that cause oxidative stress on your body. To analyze the presence of flavonoids, a qualitative method was used. 0.5 g of sodium Alginate was dissolved in diluted NaOH and then HCl was added. A yellow solution that turns colorless points to the existence of flavonoids.

Test for Alkaloids:

Alkaloids are useful as diet ingredients, supplements, and pharmaceuticals, in medicine and in other applications in human life. To analyze the presence of alkaloids, a qualitative method was used. First, 0.5 g of Sodium alginate was dissolved in 10 mL of diluted HCl (0.1N) and was filtered. The filtrate was used to test the presence of alkaloids. Then, 1 mL of 1% HCl was added to 3 mL of filtrate and was treated with few drops of Meyer's reagent. A creamy white precipitate indicated the existence of alkaloids.

Test for Tannins:

Production of a greenish precipitate is an indication of the presence of tannins. To analyze the presence of tannins, a qualitative method was used. First, 0.5 g of Sodium alginate was boiled with 10 mL of distilled water and was then filtered. A few drops of 0.1% FeCl3 were added and observed for a blue-black or brownish green color.

Test for Terpenoids and Steroids:

To analyze the presence of terpenoids and steroids, a qualitative method was used. First, 0.5 g of sodium alginate was added to 2 mL of chloroform. Then, 3 mL of conc.Sulfuric acid was carefully added to form a layer. A reddish-brown color for the interface indicated the presence of terpenoids.

Test for Saponins:

To analyze the presence of saponins, a qualitative method was used. First, 0.5 g of sodium alginate was dissolved in 5 mL of distilled water. The solution was shaken vigorously and observed for a stable persistent foam. The foaming was mixed with three drops of olive oil and shaken strongly and the formation of a milky mass was observed, which indicated the existence of saponins.

Test for Glycosides:

Cardiac glycosides are medicines for treating heart failure and certain irregular heartbeats. The analysis of the presence of glycosides was done with a qualitative method using 0.5 g of sodium alginate dissolved in 5 mL of distilled water. Then, 10 mL of 50% sulfuric acid was added to 1 mL of this extract. The mixture was heated in boiling water for 5 min. Then, 10 mL of Fehling's solution (5 mL of each solution A and B) was added and boiled. A brick red precipitate indicated the presence of glycosides.

Test for Phenolic Compounds:

To analyze the presence of phenolic compounds, a qualitative method was used. First,100 mg of sodium alginate was boiled with 1 mL of distilled water and filtered. Then, 2 ml of filtrate was taken and 2 mL of 1% FeCl3 solution was added. The establishment of bluish black color indicated the existence of phenol.

III. REASULT AND DISCUSSION

The alginate content from the different species was higher than 16% DW in the studied. Species, except in *H. cuneiformis*, which recorded the lowest average (13.3%), demonstrating an interesting dietary fiber content as a nutraceutical food source. The spectroscopic techniques (FTIR and NMR analysis) and physicochemical analyses showed similarity between the extracted alginates of the selected species and with the reported commercial worldwide alginates. It can be concluded that the alginates extracted from *Turbinaria triquetra*, *Sargassum aquifolium*, *Dictyota dichotoma*, *Padina boergesenii*, and *Hormophysa cuneiforms* can be considered as candidates for alginophyte industrial exploitation to the exploitation of mannuronic acid-enriched alginate,

which is indicated to develop elastic gels and be applied in food products. Moreover, the alginate extracted from the five selected seaweeds also demonstrated a food grade quality when compared with the alginate international regulation, and this acknowledgment can be exploited by the food industry to be applied in various processed products because of the viscosity difference among the seaweeds analyzed. However, before exploitation, there is a need to assess the molecular weight, in order to determine the alginate's high molecular weight. In addition, the storage time and possible changes in the alginate yield/characterization are needed for these seaweeds' safe exploitation.

Seaweeds calcined at 450°C were found to have low amount of non-combustible residue as these were not contaminated by calcareous animals. Alginate was extracted from these seaweeds by two methods: hot and cold.

Figure 3 : Alginate which was extracted

1V. CONCLUSION

The study showed that the Alginate is extracted from Brown sea weed (*Pheaophyceae).* All brown algae contain alginic acid (alginate) in their cell walls, which is extracted Commercially and used as an industrial thickening agent in food and for other uses

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