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Review Article

A Compilation Of Sea Weed Carrageen

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ABSTRACT

Red sea algae and seaweeds, *Chondracanthus canaliculatus* and *Furcellaria fastigiata*, are primarily utilized for the extraction and manufacturing of carrageen. Seaweeds belonging to the Rhodophyceae class are the primary source of carrageen, a naturally occurring polysaccharide. It is utilized for complete medication release, food industries, pharmaceuticals, cosmetics, agriculture, and other industries as a potent viscous and jellying agent. Despite its numerous beneficial uses, carrageen still has a number of drawbacks and negative effects on human physiology. For this reason, it is modified to produce more accurate and efficient outcomes by combining its natural and semi-synthetic forms. This information explains the various sources and characteristics of carrageenan, as well as natural polymer-based carrageenan mixtures and ingredients and their uses in CDDS, wound healing (dressing), injuries, and tissue culturing. Their compatibility and degrading qualities allow them to be used in the food industry as gelling and other kinds of agents. utilized as moisturizing and emulsifying agents in the cosmetics industry. While carrageenan is made from "Eucheuma denticulate," carrageenan is typically extracted from the algae "Kappaphycus alvarezii." Carrageenan is derived from a variety of seaweeds, including *Chondrus crispus* and *Gigartina radula*. The majority of nations in Asia and the surrounding regions extract carrageen from weeds and algae, such as *K. alvarezii*, and other plants, such as *spinosum* and *sacol*. Given that it makes up half of their dry mass, carrageen is crucial to sea weeds. Carrageen's results primarily depend on a number of variables, including harvesting techniques, extraction times, distribution, and handling extraction techniques used, such as fungal treatment, cellulase-assisted extraction, and conventional boiling. The enzymes utilized in the extraction process are safe, affordable, and environmentally friendly. Similar to extraction, the cellulase-assisted method produces the highest yield (45%), followed by the conventional boiling method (37.5%) and the fungal treatment method (25%). The highest yield- generating techniques are often cellulase-assisted and traditional boiling; in some parts of the world, they may be substitutes for one another.

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(Gigartina radula, carrageen, rhodophyceae, and polysaccharide suspension agents).

INTRODUCTION

Any of the larger marine algae is generally referred to as a seaweed. Seaweeds are a diverse group of macroscopic, multicellular algae that thrive primarily in marine environments, though some species are also found in brackish or even freshwater habitats. Among the most prominent divisions that make up this group are Rhodophyta (red algae), Phaeophyta (brown algae), Charophyta, and Chlorophyta (green algae). Each of these divisions exhibits unique pigmentation, structural features, and ecological roles, making seaweeds an essential component of marine biodiversity.

The foundation of most marine food chains is built upon microscopic seaweeds known as phytoplankton. These tiny organisms drift freely in the water column, harnessing sunlight through photosynthesis and serving as the primary producers of the ocean. Despite their microscopic size, phytoplankton are responsible for generating a significant portion of the Earth's oxygen, while

also supporting the diet of zooplankton, small fish, and ultimately the largest marine animals, such as whales. In this way, the seemingly invisible phytoplankton form the base of an immense and complex web of marine life.

In contrast to these microscopic producers, some seaweeds reach impressive sizes. The most striking example is the giant kelp (*Macrocystis pyrifera*), which can grow in dense underwater forests that rival terrestrial redwood forests in scale and grandeur. Anchored to the seabed by strong root-like holdfasts, these kelp forests rise dramatically toward the ocean surface, creating a three-dimensional habitat that shelters thousands of marine species, from fish and invertebrates to sea otters and seals. These ecosystems not only provide food and shelter but also help stabilize the ocean floor and buffer coastal environments against wave action.

Dry Sea Weed

The majority are medium-sized, red, green, brown, and black, and they sporadically wash up on shorelines and beaches almost everywhere.



Fig 1: Dry Sea Weed

Process of carrageen obtained from seaweed

Carrageenan is a naturally occurring polysaccharide that is extracted from red algae, commonly referred to as seaweed. It possesses

several important biological properties and is widely used in the food industry, primarily as a stabilizing and thickening agent. Traditionally, it was first obtained from Irish moss (*Chondrus*

crispus), but today it is sourced from several red algae species.

Sources of Carrageenan

Carrageenan is a naturally occurring polysaccharide extracted from red algae, commonly referred to as seaweed. It is valued for its biological properties and is extensively used in the food industry as a stabilizing and thickening agent. Traditionally obtained from Irish moss (*Chondrus crispus*), which yields a mixture of lambda and kappa carrageenan, this compound is now derived from several other red algae as well. Marine algae of the genus *Eucheuma* in the Solieriaceae family serve as one of the main commercial sources, while species such as *Gigartina acicularis* and *Gigartina pistillata* provide lambda or iota types of carrageenan. Other contributors include *Gigartina radula* and *Eucheuma cottonii* along with

E. spinosum, both of which are rich in kappa-carrageenan and widely cultivated. Similarly, *Gymnogongrus furcellatus* supplies iota-type carrageenan, whereas *Furcellaria fastigiata* produces furcellaran, also known as “Danish agar,” which bears structural similarities that qualify it as part of the carrageenan family. Another species, *Hypnea musciformis*, yields kappa carrageenan, though it is no longer commonly used due to the difficulty of extraction. Together, these diverse sources highlight the wide range of red algae capable of producing carrageenan and emphasize its importance in both traditional and modern applications.

- ***Chondrus crispus* (Irish moss):** Produces a mixture of λ (lambda) and κ (kappa) carrageenan.
- **Genus *Eucheuma* (family Solieriaceae):** A major commercial source of carrageenan.

- ***Gigartina acicularis* and *Gigartina pistillata*:** Known for producing λ - or ι - (iota) type carrageenan.
- ***Gigartina radula*:** Another important carrageenan-yielding algae.
- ***Eucheuma cottonii* and *Eucheuma spinosum*:** Rich in κ -carrageenan and widely used for industrial extraction.
- ***Gymnogongrus furcellatus*:** Recognized as a source of ι -type carrageenan.
- ***Furcellaria fastigiata*:** Produces furcellaran, also known as "Danish agar," which shares structural similarities with carrageenan and is often classified within the carrageenan family.
- ***Hypnea musciformis*:** Yields κ -carrageenan, although it is rarely used today due to the difficulty of extraction.

Carrageenan is a naturally occurring polysaccharide extracted from red algae, commonly referred to as seaweed. It is valued for its biological properties and is extensively used in the food industry as a stabilizing and thickening agent. Traditionally obtained from Irish moss (*Chondrus crispus*), which yields a mixture of lambda and kappa carrageenan, this compound is now derived from several other red algae as well. Marine algae of the genus *Eucheuma* in the Solieriaceae family serve as one of the main commercial sources, while species such as *Gigartina acicularis* and *Gigartina pistillata* provide lambda or iota types of carrageenan. Other contributors include *Gigartina radula* and *Eucheuma cottonii* along with *E. spinosum*, both of which are rich in kappa-carrageenan and widely cultivated.



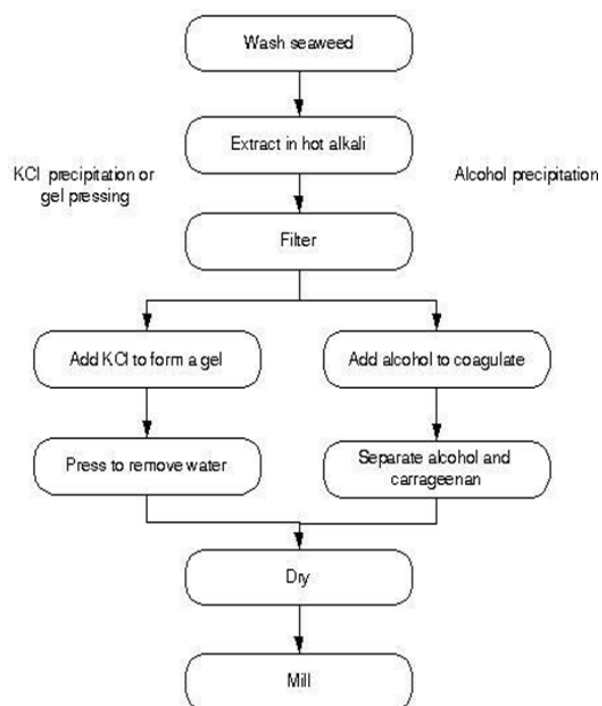


Fig 2: process of carrageen obtained from seaweed

Carrageenan is a naturally occurring sulfated polysaccharide extracted from red algae, commonly referred to as seaweed. It is composed of linear chains of galactose and anhydrogalactose units with varying degrees of sulfate substitution, which gives it unique functional properties. Widely recognized for its biological and industrial significance, carrageenan plays an essential role as a stabilizer, gelling agent, and thickener in numerous food and pharmaceutical formulations. Traditionally, it was first obtained from Irish moss (*Chondrus crispus*), which produces a mixture of lambda (λ) and kappa (κ) carrageenan. However, over time, several other species of red algae have been identified as significant sources of this compound. The genus *Eucheuma* (family Solieriaceae) has become one of the most commercially important producers of carrageenan, largely due to its ease of cultivation in tropical regions. Other notable sources include *Gigartina*

acicularis and *Gigartina pistillata*, which yield lambda and iota (ι) types of carrageenan, as well as *Gigartina radula*, another important contributor. *Eucheuma cottonii* and *Eucheuma spinosum* are particularly valued for their κ -carrageenan content, making them central to large-scale production. In addition, *Gymnogongrus furcellatus* is recognized as a source of ι -type carrageenan, while *Furcellaria fastigiata* produces furcellaran, also called “Danish agar.” Furcellaran shares structural similarities with carrageenan and is therefore often considered part of the same family. Another species, *Hypnea musciformis*, is capable of yielding κ -carrageenan, although its use has declined in modern industry due to the complexity of extraction. Collectively, these diverse algal species highlight the adaptability and ecological range of carrageenan-producing organisms.

Properties:

Table 1: Properties Of Carrageen Obtained from Seaweed

Gel formation	λ carrageenan (no gel formation)
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	λ and ι carrageenan(forms gel -right handed) κ carrageenan(forms gel with potassium chloride) ι carrageenan (forms gel with calcium ions)
solubility	Insoluble In Organic Solvent, Oil or Fats. Soluble In Hot Water Above 60 Degree.
Viscosity	The viscosity of seaweed carrageenan extracts can range from 3.02 to 45.91 cp, depending on the temperature and the type of extracting solution
Properties	κ and λ carrageenan combine easily with milk protein to improve solubility and texture; also acts as emulsifier, stabilizer and thickening agent in food
Molecular weight	• Carrageenan: - 1. average molecular weight = 1.5×10^6 to 2×10^7 2. food-grade carrageenan reported as 100 000–800 000 or 200 000–400 000 3. degraded carrageenan (poligeenan) has average molecular weight of 20 000–30 000 furcellaran has average molecular weight 20 000–80 000

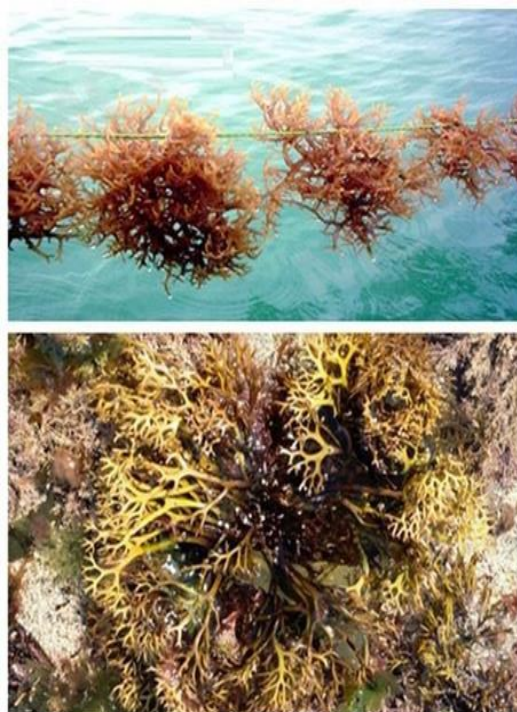


Fig 3: Carrageenan

Classification:

Main Carraggens Classification Are:

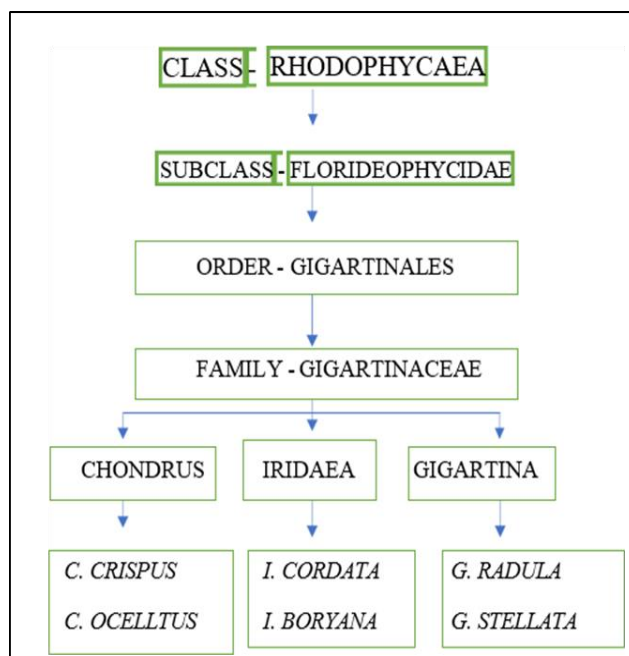


Fig 4: Classification Rhodophyta

Types of Carrageenan

Carrageenan is classified into three primary types—Kappa, Iota, and Lambda—each with distinct properties that determine their functional applications in food and industry. Below is a description of the three types:

1) Kappa Carrageenan

Kappa carrageenan forms strong gels primarily with potassium salts, followed by calcium salts. When combined with potassium, it produces a rigid and elastic gel, while calcium results in a stiff, glossy gel. Among all carrageenan types, kappa produces the strongest gels. However, these gels are also the most prone to syneresis (water separation or bleeding). This drawback can sometimes be minimized by blending with other carrageenan types.



Fig 5: Kappa Carrageenan

2) Iota Carrageenan

Iota carrageenan forms gels most effectively with calcium salts, followed by potassium salts, which is the reverse of kappa's reactivity. The resulting

calcium-based gels are soft, flexible, and resistant to syneresis (bleeding). These gels can also be reheated and reformed without losing integrity. Iota carrageenan gels exhibit thixotropic behavior—when stirred, they flow like a thick liquid, but once left undisturbed, they gradually reform into a gel.



Fig 6: Iota Carrageenan

Chemical composition:

- **Chemical Composition in Carrageen:**

Carrageenan is direct linkage of 1,3- linked β - D-galactophyranosyl arid 1,4- linked α - D-galactophyranosyl units having polymeric repeating structure, The 3- linked units looks like 2- and 4- sulphate units , while the 4- linked units looks like 2- sulphate unit, 2,6- disulphate unit, 3,6- anhydride unit, and 3,6- anhydride-2-sulphate unit.

- **Chemical Composition of Sub Type Of – Carrageen: crispus:**

In Chondrus crispus there are majorly 2 types of carrageen: Lambda and Kappa carrageen ,in which Kappa is extracted by adding potassium chloride and other substance which is left is Lambda carrageen. after studying about these substances, it indicates that Kappa has half of structure made up of sugar unit 3,6-anhydro-D-galactose. On the other hand, in lambda carrageen very little or no sugar present.

- **Gigartina species (G. chamissoi):**

Substance, was not recognised, but appears to be different from lambda carrageen structure. In this structure there is 1,3 linkages but lack substitution at C-6. And sugar unit without sulphated group at C-6 position cannot be transformed into anhydride form.

- **Eucheuma gelatinae:**

This type of sea weeds bears beta-carrageen having 1,3 linkage unit. Looks similar to kappa carrageen but lacks sulphate group at C-4. The prototype of beta carrageen is Gamma carrageen.

- **Furcellaria fastigate:**

This type of sea weeds contains 3-4 sugar units having one sulphate group after them in repeating sequence. In case of kappa carrageen only one sulphated group present for 2 sugar units

Production:

Methods of Production Seaweeds From Carrageen's:

1. **Ultrasound:** Dried seaweed is incubated in ethanol, filtered, and then treated with ultrasound. The ultrasound's mechanical energy ruptures the cell walls of the seaweed, releasing the carrageenan.
2. **Potassium hydroxide:** Seaweed is cooked in a hot potassium hydroxide solution, then soaked in fresh water to remove alkali. The product is dried and ground into a flour.
3. **Alcohol precipitation:** Carrageenan is extracted in an aqueous solution, then alcohol is added to force precipitation. The precipitate is dried and milled to create refined carrageenan.

4. **Bead mill:** Seaweed is washed, dried, crushed, and sieved.

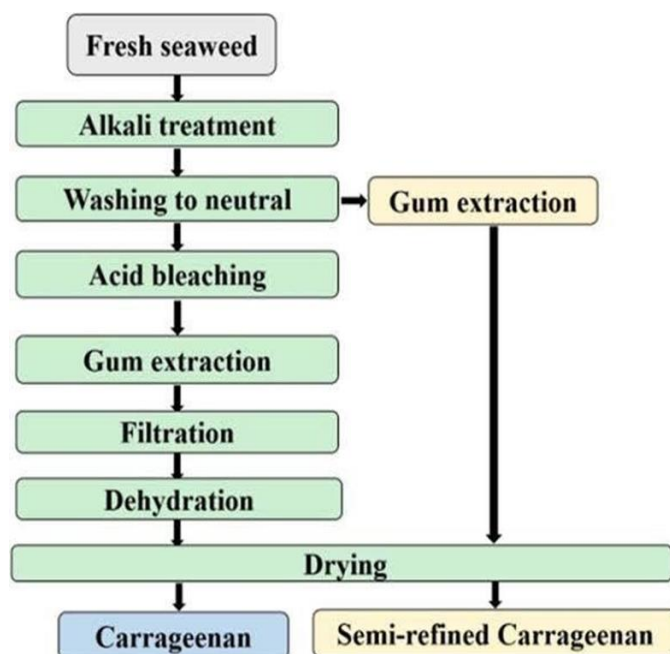


Fig.7: Production Process of Refined Carrageenan

Extraction Methods of Carrageen from Seaweeds:

The extraction of carrageenan from seaweeds generally begins with the careful selection of raw materials, ensuring that only high-quality algae with minimal contamination are used. Once selected, the seaweed undergoes impurity removal and a weak acid washing process to eliminate sand, salts, and other undesired particles. This is followed by mechanical treatments such as mincing and homogenization, which break down the algal tissue and allow easier release of the polysaccharides. To improve yield and purity, the material is then subjected to curing and sterilization under conditions of high temperature

and pressure, during which partial degradation of polysaccharide components may also occur. After the initial extraction, the carrageenan solution often requires further refinement to optimize its properties for industrial use. This involves pH adjustment to maintain stability and enhance gelling behavior, as well as probiotic fermentation to improve bioactivity and reduce impurities. In some advanced methods, alginate oligosaccharides are added to improve the functional properties of the extracted carrageenan. Together, these steps ensure that the final product meets the required standards for applications in food, pharmaceuticals, and biotechnology, making extraction a critical process in the value chain of seaweed-based hydrocolloids.

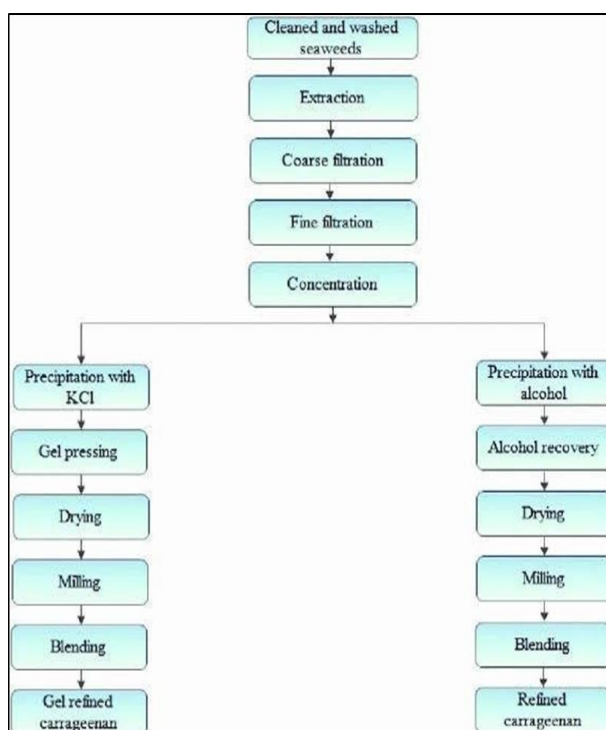


Fig.8: extraction methods of carrageen from seaweeds

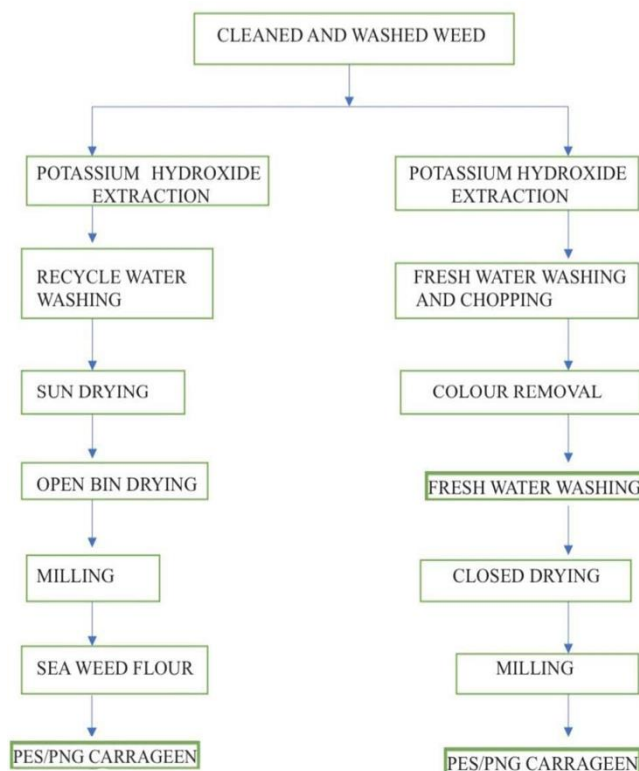


Fig.9: Classification Of Clean and Wash Weed

In different States of world like Europe, human uses both refined carrageen and PNG/PES carrageen as food, it contains different labels.

Refined carrageen name as 'carrageen' and E-407 and PNG/PES carrageen named as 'Recovered Eucheuma Seaweed' and E-407a. practically PNG

and PES are very similar carrageen. Only difference is that PNG contains 'cellulose' form original form, while PES contains 'cellulose' from refined process. Refined carrageen provides clear solution while PNG provides cloudy solution. In any case clarity not matters then PNG is suitable for extraction/uses. [2124].

Properties Of Carrageen: -

The properties of carrageen are given below: -

1. Antimicrobial Properties: -

Weeds from marine source have rich content as antimicrobial properties and also bears many application in various industries like food and pharmaceuticals, *K.alvarezii* seaweed contains carrageen like polysaccharides which acts like nutrient supplements, polymeric form of carrageen have many antibacterial functions against pathogens, bacillus subtilis, staphylococcus aureus, lactobacillus, E.coli, pseudomonas, vibrio cholera, etc. gram positive bacteria is more likely susceptible more than gram negative bacteria, difference is only in variation of structure and cell wall. *K.alvarezii* carrageen has properties of strong effectiveness for mycobacterium tuberculosis, shows antituberculosis. Scientist uses molecular

docking method to understand *k.alvarezii* mechanism on tuberculosis. Kappa carrageen inhibits enzymes present in both strains of tuberculosis bacteria, by inhibiting this enzyme harmful effects of bacteria are inhibited. Recent studies have focused on using biodegradable films on food surfaces to prevent the spread of preservatives into the food and to stop the growth of microbes on the surface. Organic acids like citric acid, such citric acid, lactic acid, and succinic anhydride have both bactericidal (killing bacteria) and bacteriostatic (inhibiting bacterial growth) effects against harmful strains. Citric acid, for example, was employed to create natural antimicrobial packaging materials at last this study aims to create flexible and bioactive film using kappa carrageen and its effective against against both gram-positive bacteria (*Staphylococcus aureus* and *Dickeya chrysanthemi*) and gram-negative bacteria (*Escherichia coli*, *Proteus mirabilis*, *Pseudomonas aeruginosa*).

Examples Of Antimicrobial Marketed Drugs:

1.Cephalexin Tablet (Caulerpin Drug)

Grisovin-FP Tablet (Fucoidan Drug)

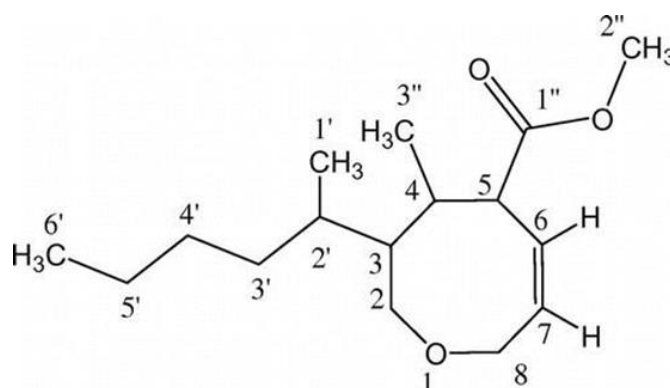


Fig.10: Cephalexin Tablet

2. Antiviral Properties: -

Carrageenan, extracted from red algae, has demonstrated antiviral properties against a broad range of viruses, both enveloped and non-

enveloped. Researchers have extensively studied marine algal sulphated carrageenan since the early 1900s for its ability to hinder various stages of the viral infection process, including attachment to host cells, internalization, uncoating, transcription, and replication. Among sulphated carrageenan, λ -carrageenan, with the highest sulphate content, shows superior antiviral effects compared to κ - and ι -carrageenan. To enhance their antiviral properties polysaccharides are often sulphated using methods like the chlorosulphonic acidpyridine approach or sulfuric acid treatment. Safety assessments, including intranasal administration of ι -carrageenan and exposure to

κ/λ -carrageenan in neonatal pigs, found no evidence of toxicity or adverse reactions. Studies on *Gigartina skottsbergii* carrageenan against murine herpes simplex virus showed no toxicity in mice. Recent reviews indicate that in vitro studies on carrageenan often show high cell viability (CC50 values exceeding 1000 $\mu\text{g/mL}$), suggesting potential safety concerns in vivo at such concentrations. However, λ -carrageenan, even at concentrations up to 300 $\mu\text{g/mL}$, did not exhibit toxicity to host cells. This carrageenan from marine red algae has demonstrated antiviral effects against influenza and severe acute respiratory syndrome coronavirus.

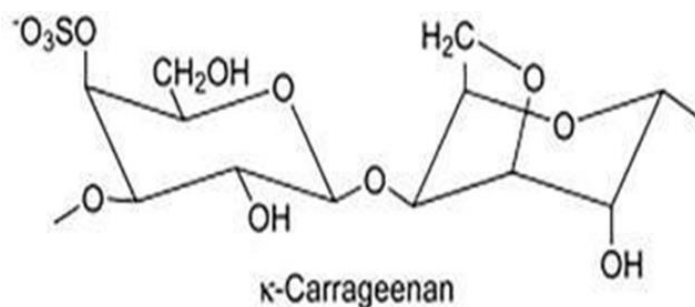


Fig. 11: Kappa Carrageen

Examples of Antiviral Drugs:

2. Olrest Tablet (Ulvan drug)

1. Galectin Tablet (Galectin drug)

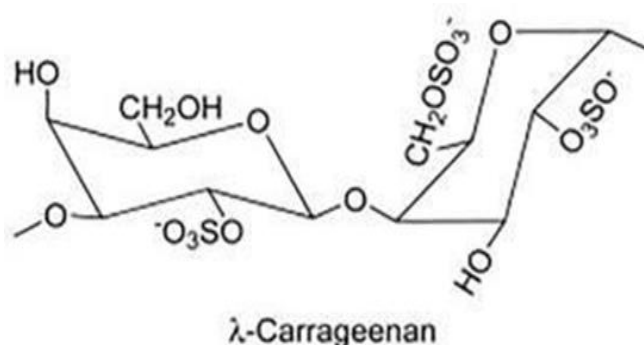


Fig. 12: Lambda Carrageen

3. Anticancer Properties: -

The scientist is researching on polysaccharides that are capable of fighting/stopping cancer cell growth. In research outside the body(in-vitro)

polysaccharides like carrageen, have found properties that are capable in destruction of cancer cell. In that study it is found these polysaccharides slow down and spread growth of cancer cell in human body. Scientist are still finding about its

anticancer property. These natural substance-like polysaccharides show anticancer activity they show positive side of stopping and slowing growth of cell. Actual mechanism explains that these polysaccharides bind with cell and dry them as like gamma rays bombarding. It happens by blocking connection between basal membrane and cell membrane. At last, it is concluded that carrageen is capable stopping cancer cell by disturbing their cell cycle. This tells us about carrageen impact on their cell division. And body defense mechanism

also helps carrageen for stopping cancer cell. This combination helps in boosting the immunity of body. Polysaccharides from seaweeds have ability to increase body immunity by affecting immune cell, researchers are studying on cell which are influenced by the carrageen's and developing method which can help in cancer treatment. Lambda carrageen was hinder growth of tumour in mice with B16- F10 and 4T1 tumour which are injected into body of mouse. [5-10].

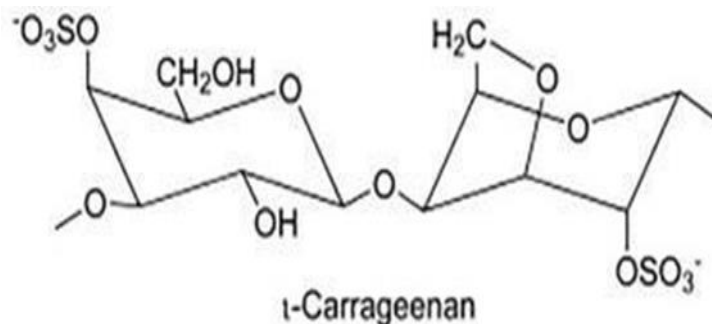


Fig. 13: Iotacarrageen

Examples Of Anticancer Drugs

1.Cubita HC Tablet (Caratenoid Drug)

2. Kombu Tablet (Fucoxanthin Drug) A

Application And Uses of Carrageen:

Seaweeds used as human and animal food _ It is used as foods from about thousand years in Asia and specific regions. Used in the form of powdered, salts, salad and ingredients ingredients in soups. In animal it is used as supplement for

reduce emissions of menthanes from grazing ruminants. Specially in aquaculture life beneficial for health of animal due to its high number of vitamins, minerals, and nutrients.

1 Kappa carrageen- forms gels most strongly with potassium salts, followed by calcium salts. Potassium gives a rigid(rough), elastic gel while calcium produces a stiff, shiny gel. Kappa gives the strongest gels of all carrageenan, but they're also the bones most likely to bleed (most subject to synaeresis). This liability can lessen in some parts of ways.

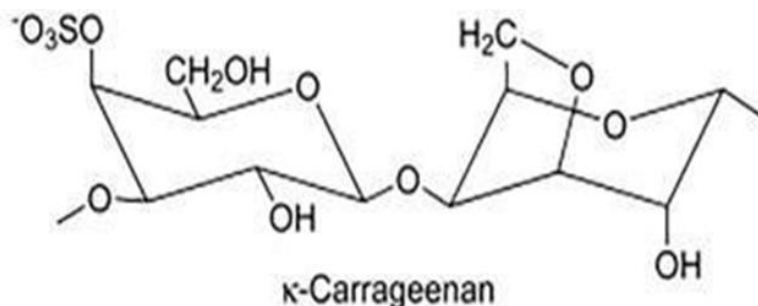


Fig. 14: Kappa Carrageen

1 Iota carrageen- forms gels most explosively with calcium mariners, followed by potassium salts the reverse of kappa reactivities. Calcium gels are soft and flexible and are nearly free of bleeding. They can be firmed and fused without

destroying the gel. They show an unusual property for a gel thixotropic inflow; this means the gel can be stirred and it'll flow like a thick liquid, but if left to stand it'll gradationally reform a gel.

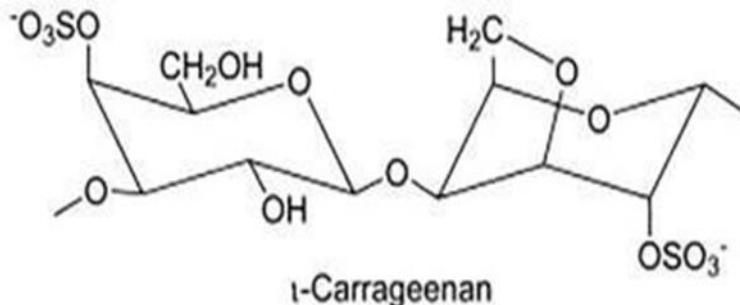


Fig. 15: Iota Carrageen

2 Lambda carrageen- Lambda carrageenan doesn't form gels but is extensively used as a density in numerous food operations. lambda carrageenan is blended in with the kappa,

bleeding can be reduced, so will also the rigidity and shining of the gel; still, the gel strength may also be lowered.

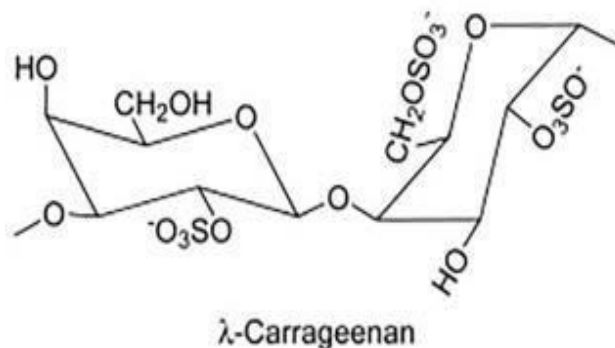


Fig. 16: Lambda Carrageen

Industrial Uses: -

Carrageenan acts as a support material for immobilisation of both enzymes and whole cell systems which is importance in the increasing of the stability and activity of the biocatalysts. This is proven by several applications in different industrial fields. The carrageenan also has been promoted as a food grade additive in the food industries. The mild immobilisation and reaction conditions of carrageenan in immobilization of whole cells as factor it apply and use in highly selective production processes for pharmaceutical

compounds. In food industries they are used as the food chemists' field, carrageenan is known well as stabilizer, emulsifier, gum or colloid. Many of products that people now take for granted such as dairy products, milks, soy milks, infant formulas and nutritional supplement are made, stored and packaged for long period of time with this carrageenan. Carrageenan is used to gel, suspend or thicken foods.

1. Pharmaceutical Applications: -

- **Capsule Formulation:** Carrageenan is used as a capsule shell material. It provides a stable and effective encapsulation for medications, facilitating controlled release and protecting the drug ingredients. (ex. Spirulina capsule)
- **Topical Pharmaceuticals:** Carrageenan is employed in topical pharmaceutical formulations such as gels and ointments. It contributes to the desired consistency and texture of these products. (ex. Cartigen ointment)
- **Suspension Stabilizer:** Carrageenan can act as a suspending agent, helping to maintain the uniform distribution of solid particles in liquid medications. This is crucial for ensuring consistent dosing. (ex. Gaviscon suspension)
- **Nasal Sprays:** In nasal spray formulations, carrageenan may be used to enhance viscosity, improving the adherence of the spray to nasal membranes for better drug absorption. (ex. Aplovir Nasal Sprays)
- **Wound Care Products:** Carrageenan's gelling properties make it useful in certain wound care products, where it can help create protective and soothing gels. (ex. Kelo cote gel)
- **Anti-Viral Formulations:** Carrageenan has shown antiviral properties, particularly against certain viruses. Research has explored its potential application in antiviral pharmaceutical formulations, especially in products targeting viral infections. (ex. Galactan drug)
- **Oral Care Products:** Carrageenan is used in some oral care products like toothpaste and mouthwash, contributing to the product's texture and stability. Its gelling properties can help maintain the consistency of oral gels. (ex. Gaviscon Oral Product)
- **Diagnostic Imaging:** In some medical imaging applications, carrageenan is used as a contrast agent. It can enhance visibility in imaging procedures, aiding in the diagnosis of certain conditions.
- **Drug Delivery Systems:** Carrageenan is investigated for its role in drug delivery systems, particularly in controlled-release formulations. Its ability to form gels can be leveraged to regulate the release of drugs over time.
- **Inhalation Products:** Carrageenan is investigated for its potential in pulmonary drug delivery. It may be used in inhalable formulations, contributing to the viscosity and stability of respiratory medications.
- **Anti-Inflammatory Applications:** Some studies suggest carrageenan's anti-inflammatory properties, leading to exploration in formulations targeting inflammatory conditions. It could play a role in developing medications for conditions like arthritis.
- **Vaccine Stabilization:** Carrageenan's stabilizing properties make it valuable in the formulation of certain vaccines. It helps maintain the stability and efficacy of vaccine formulations during storage and transportation.
- **Ophthalmic Products:** Carrageenan's viscosity and gelling characteristics are employed in certain ophthalmic formulations, such as eye gels. These formulations aim to provide prolonged contact time and enhanced drug absorption. (ex. Lumigan Eye Drop)

1. Human And Animal Food: -

It is used as foods from about thousand d years in Asia and specific regions. Used in the form of powdered, salts, salad and ingredients ingredients in soups. In animal it is used as supplement for reduce emissions of methane from grazing ruminants . Specially in aquaculture life beneficial for health of animal due to its high number of vitamins, minerals, and nutrients. In European countries like Scotland Iceland seaweed used against the corn and soya, Brine contains salts of carrageen , calcium and phosphates in muscles of meats overcome problem of cuisine. When swab or fat reduced its lead towards the loss of juiciness, loss of tender- heartened Ness, flavour so it can be overcome with addition of Kappa carrageen's e.g., Kappa carrageenan has been used with some success in replacing half the normal fat in frankfurters.

2. Dairy Product: -

Carrageenan, a natural extract from red seaweed, finds extensive use in the dairy and food industry. It serves as a thickening and stabilizing agent in various products like ice cream, yogurt, and dairy desserts, enhancing texture and preventing separation. Additionally, carrageenan is employed in processed meats, sauces, and plant-based products for its gelling and emulsifying properties. Its versatility makes it a valuable ingredient in achieving desired product characteristics. In dairy applications, carrageenan contributes to a creamy texture in ice creams and prevents crystallization. It's also utilized in low-fat or fat-free dairy products to mimic the mouthfeel of full-fat alternatives. In the food industry, carrageenan acts as a binder in processed meats, improving water retention and creating a smoother texture. Furthermore, its ability to stabilize suspensions makes it valuable in salad dressings and sauces, preventing ingredient separation during storage.

Carrageenan plays a crucial role in enhancing the overall quality and shelf life of various food products. Moreover, carrageenan acts as a crucial component in the production of deli meats and processed poultry, where it improves slicing and enhances the overall quality of the final product. In the realm of confectionery, it's employed in gummy candies to create a desirable chewy texture. The versatility of carrageenan extends to its role in stabilizing and thickening certain beverages, including fruit juices and nutritional drinks. Its widespread application underscores its importance in maintaining product integrity, improving sensory qualities, and extending shelf life in both dairy and food manufacturing.

Marketed Preparation Of Carrageens:

Carrageenan is used as a thickener, emulsifier, and preservative in many foods and drinks, including fruit drinks, sorbet, and salad dressings. It can also be used in food packaging films, and in skincare products to protect against ultraviolet B radiation.

Marketed Formulation of Carrageen's In The Form of Capsule: 1 Anti- Bacterial Capsule:

The inherent source of gelatin used for commercial hard capsules causes a surging demand for vegetarian capsules. In this work, carrageenan is utilized in preparing hard capsules to meet consumer preferences.

Hydroxypropyl methylcellulose (HPMC) was incorporated as a reinforcing agent to improve the low mechanical properties of hard capsules made of carrageenan.

The HPMC concentration was manipulated from 0.2 to 1.0 w/v% in the carrageenan matrix. The increasing concentration of HPMC exerts significant effects on the tensile strength and elongation at break, with an improvement of



59.1% and 46.9%, respectively, at the optimized HPMC concentration of 0.8 w/v%.

The loop strength of the capsule is also increased by 56.4% with decreasing moisture content. The downfield movement from around 3.20 ppm of the carrageenan proton to 3.33 ppm in the proton nuclear magnetic resonance (¹H-NMR) spectrum suggests the formation of intermolecular hydrogen bonding between carrageenan and HPMC, which correlates to the results of Fourier-transform infrared spectroscopy (FTIR) and zeta potential.

The glass transition temperature of the film was increased from 37.8 to 65.3°C, showing an upgrade in thermal stability. The film possesses a major mass loss with an activation energy of 64.7 kJ/mol with an increment of 43.4% compared to the control carrageenan.

These findings support the conclusion that HPMC enhanced the mechanical properties and thermal stability of the carrageenan film, and the comprehensive analysis of the molecular interaction and decomposition kinetics subsequently may expand the application fields of the carrageenan-HPMC hard capsule as an alternative to gelatin in the future.

Bioprinting: - In this field of tissue engineering carrageenan has been explored for its potential due to its ability to form a gel, it is important to note that applications of biotechnology depend on experiment.

Frozen dessert: - In frozen dessert and ice-cream carrageenan contributes to improve colour, texture and taste. It is used to prevent excess crystal formation and this helps overall quality management.

Toothpaste: - carrageenan used in toothpaste and dental products contributes to cleaning of teeth and

provide stability for use and also contribute to maintaining alkaline nature and texture of products. It is also used as an alternate to synthetic thickening agent. [20-24]

Future Prospect of Carrageenan's:

These new technologies, in which carrageenan has shown potential applications, include encapsulation, plant-based meat products, and 3D/4D printing, serving as a wall material, edible sheet composite, texturing agent, and food ink, respectively. With the advent of new technologies in food production, the requirements for food ingredients are also changing. Carrageenan is no exception, and research is underway to understand its potential role in these emerging technologies. However, since the underlying principles are shared in these applications, it is important to understand the classical applications and mechanisms of carrageenan's functions in order to better evaluate its potential in new areas. Hence, this paper aims to describe the mechanisms of carrageenan's functions, its traditional applications in food products, and its potential applications in encapsulation, edible films/coatings, plant-based analogs, and 3D/4D food printing, especially reported within the past five years, to better understand the wide variety of potential applications alongside the classical and emerging food technologies.

CONCLUSION OF CARRAGEENAN'S:

The results of the few parallel studies suggest that there are no large differences in the effects of the different forms of carrageenan or in the effects of carrageenans prepared from different species of seaweed. Carrageenans have very low toxicity, and have been shown not to be teratogenic.

Carrageenan is used in many dairy products such as cream cheese, cottage cheese, skimmed milk,



and yogurt as well as desserts and sweets such as custards, ice cream, milk shakes, pie fillings and chocolate products.

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