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AN OVERVIEW ON CARRAGEEN FROM SEA WEEDS

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Abstract: Seaweed *Chondracanthus canaliculatus* and *Furcellaria fastigiate*, they are types of red sea weeds and red sea algae ,they are majorly used for carrageen production and extraction . Carrageen is a natural polysaccharide which can be derived from mainly from sea weeds of Rhodophyceae class. It is used as a strong viscous agent and jellying agents and for complete drug release, food industries , pharmaceuticals, cosmetics , agriculture and other industries. After having such useful applications still there are many demerits of carrageen and adverse effects on the human physiology ,so its modification is prepared for more accuracy and efficiency regarding results by combing their natural forms and semi synthetic forms. This information provides about different sources and properties of carrageenan on natural polymer-based carrageenan mixtures and ingredients and their applications in CDDS, injuries, healing of wounds(dressing) and tissue culturing this is possible because of their degrading and compatibility properties, in food industry as gelling and other types of agents. In cosmetics industries used as emulsifying and moisturising agents . κ-Carrageenan is normally withdrawn from algae "Kappaphycus alvarezii, while ι-carrageenan is produced from "Eucheuma denticulatum",. λ-Carrageenan is obtained from various types of sea weed like Gigartina radula and Chondrus crispus, etc. In Asian continents and nearby most of countries withdraw carrageen from algae and weeds like K. alvarezii and others, in other business as species of sacol and spinosum. In sea weeds, carrageen plays an important role as they contain 50% of their dry mass carrageen .The outcomes of carrageen basically depends upon various factors as methods, time of harvesting, extraction, distribution and handling. extraction methods applied like traditional-boiling, cellulase-assisted extraction and fungal treatment. In extraction process the enzymes used are economic, safe, and friendly to surrounding(environment). As in extraction most yield is cultivated from cellulase-assisted method(45%),next to this traditional-boiling method(37.5%) and least yield comes from fungal treatment method(25%). Commonly cellulase-assisted method and traditional-boiling method are most yield generating method they might be alternative to each other in some regions of countries. (Rhodophyceae, Carrageen, Gigartina radula ,suspending agents polysscharide).

I. INTRODUCTION

CARRAGEEN TYPES	PROPERTIES
IOTA CARRAGEEN	Gel is stable and elastic, formed by calcium salt. Gel is clear in form, having no bleeding of liquid(no syneresis). Examples:-Algae Gymnogongrus furcellatus.
KAPPA CARRAGEEN	Gel is brittle in from with calcium salt. Gel is strong and rigid with potassium salt. Gel is slightly opaque when sugar is added, it shows some syneresis. Examples :- Algae Chondrus crispus
LAMDA CARRAGEEN	Gel is not formed . But forms high viscous solutions Examples:-Algae Gigartina acicularis and G. pistil Lata

Table no. 1

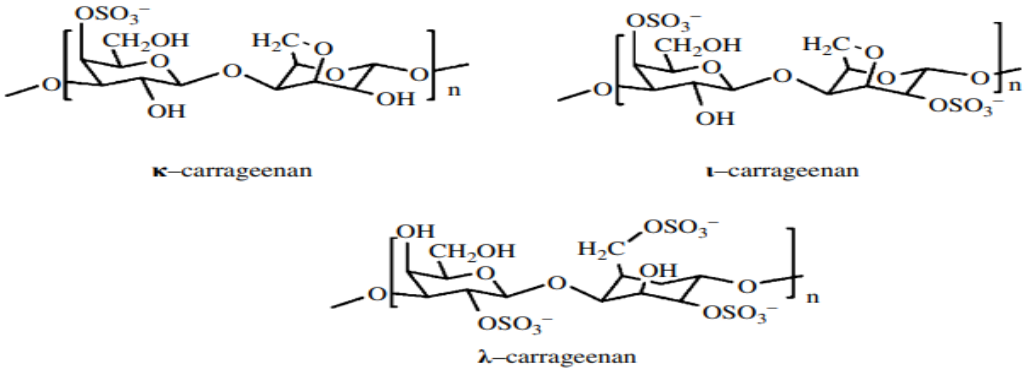


Fig no 1. structure of carrageen

Fig no 2

Carrageenan are very important marketed hydrocolloids(water-solvable gums) it's an abundant chemical which plays an important role in food and pharmaceutic industries and its mainly extracted from Rhodophyceae class and **"it's similar to cellulose in land plants"**. they are large structure of sulphated galectins by chemical formulation. Due to such structure, it contains half-ester moieties, have dynamic anionic polymeric characters. By this, they are classified with agars and algins, the other two classes of seaweed. In Agars, galectin is present, have half-ester - sulphate ionic characters in some practical . Alginates, possess anionic characters , are combination polymers of mannuronic and guluronic acids and similarly possess ionic characters to carboxyl group instead of sulphate group. According to this, alginates are more alike to pectin, present in land plants, than any other sea weeds (hydrocolloids) . [1-4]

II. CLASSIFICATION

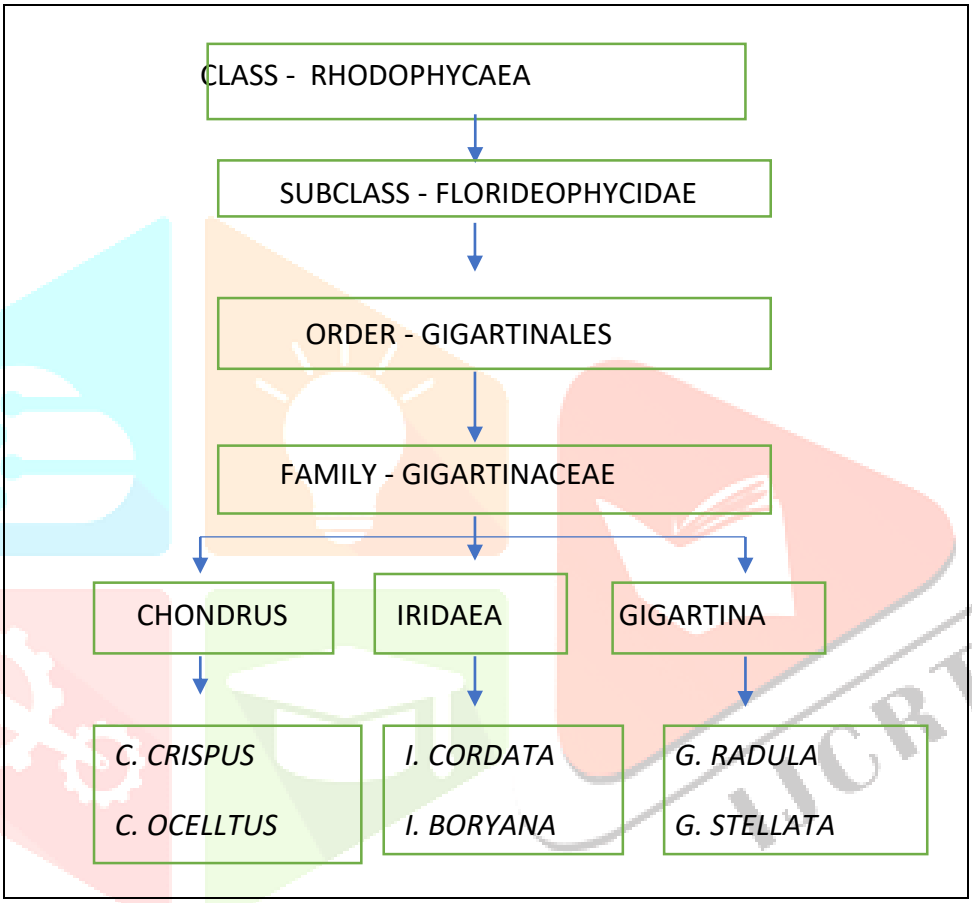


Fig no 3

2.1 SOURCE: -

1. **Algae Chondrus crispus**: - Mixture of lambda and kappa carageen.
2. Marine algae of the **genus Eucheuma** in the Solieriaceae family.
3. **Algae Gigartina acicularis and G. pistil Lata**: - lambda or iota type carrageenan.
4. **Algae Gigartina radula**
5. **Seaweed Eucheuma cottonii and E. spinosum:-** kappa-carrageenan
6. **Algae Gymnogongrus furcellatus**:-source of iota-type carrageenan
7. **Red algae Furcellaria fastigiate**: - furcellaran ("Danish agar"), it bears some similar structure that makes it eligible for carrageen extraction and makes member of carrageen family .
8. **Red algae Hypnea musciformis**: - It yields a kappa carrageenan {mot in used nowadays because difficult to extract}

2.2 CHEMICAL COMPOSITION

Carrageenan is direct linkage of 1,3- linked b- D-galactophyranosyl arid 1,4- linked a- 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

Chondrus 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 fastigiate: 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

2.3 CHARACTERS OF CARRAGEEN

Chemical composition	Carrageenan is direct linkage of 1,3- linked b- D-galactophyranosyl arid 1,4- linked a- 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.
Gel formation	λ carrageenan (no gel formation) λ and ι carrageenan(forms gel -right handed) k carrageen(forms gel with potassium chloride ι carrageenan (forms gel with calcium ions)
Solubility	λ carrageenan (soluble in hot or cold aqueous solution) κ carrageenan (soluble in hot aqueous solution) κ carrageenan(soluble when treated with hot aqueous solution)
Viscosity	**Viscosity is directly proportional to concentration** as concentration increases viscosity will directly increases it creates an linear graph .
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 × 106 to 2 × 107

	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 4. furcellaran has average molecular weight 20 000–80 000

Table no 2

Fig no 4 : Dry sea weed

III. PRODUCTION

There are methods for production of carrageen as products and those methods are given below:

1. **Refined carrageen: -**

Refined carrageen ,in beginning of 1970s and in mid of 1980s it is known as "simple carrageen" was extracted in original form by simple technique. it is also treated with alkali containing water like sodium hydroxide, this process continues for hours, along the time, is based type of sea weed and harvesting method, which are done on small scale. Salts are used because they provide strength by changing its chemical structure.

It expelled out some sulphated groups from the structure and increases the arrangements of 3,6-anhydrogalactose due to this strength and quality both increases..,now on this stage, filtered substance consist of 1- 2% carrageenan and by using ultrafiltration and vacuum filtration, concentration of substance is scaled up to required percents. [24-25]

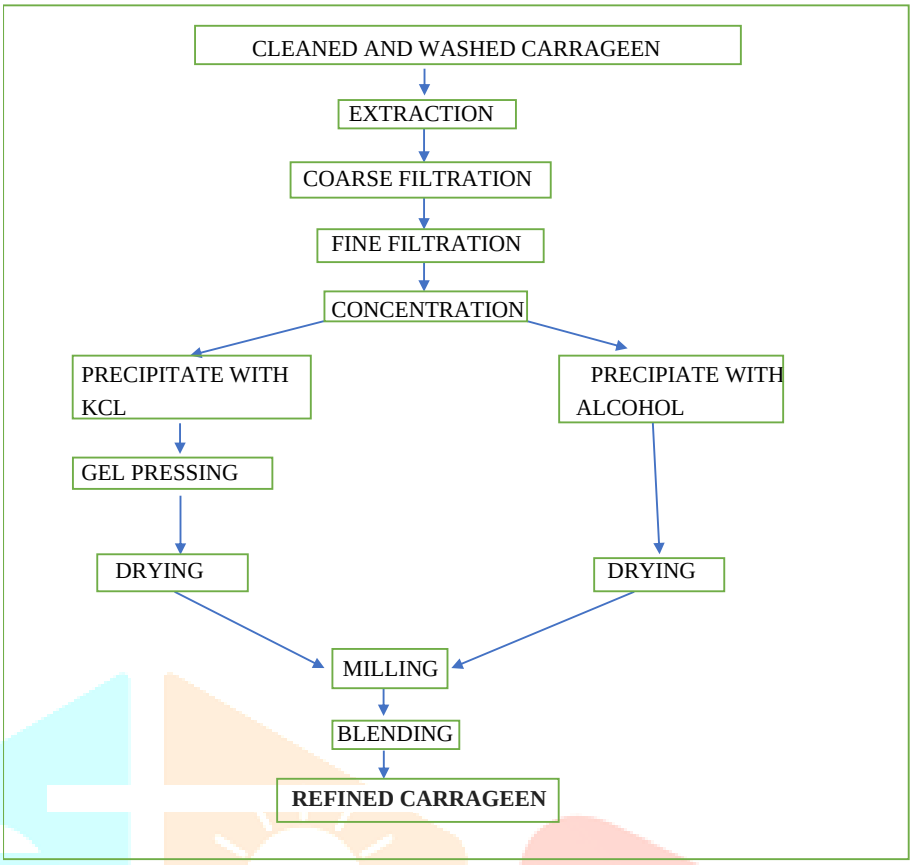

CLEANED AND WASHED CARRAGEEN
EXTRACTION
COARSE FILTRATION
FINE FILTRATION
CONCENTRATION
PRECIPITATE WITH KCL
PRECIPIATE WITH ALCOHOL
GEL PRESSING
DRYING
DRYING
MILLING
BLENDING
REFINED CARRAGEEN

Fig No 5

Fig no 6

Fig no 7: Solar Drying of sea weeds

The Processor has developed 2 new methods for solidifying the carrageen, by using alcohol rush system any type of carrageen can be solidify. Kappa carrageen can be transformed into gel form, and this gel can be obtained by hydrating or using a method named snap-thaw process. In that alcohol rush system, later they add isopropanol into carrageen up to the forms masses of lumps, as lumps are not required so they are separated out by centrifugation method. They apply pressure on lumps for getting rid of detergents, cleaning it with adding more alcohol that is it can dry quickly, after drying blend it and pass through sieve number 80. For making economic, alcohol used in both processes should be recovered and reused in other similar experiments, in alcohol rush system kappa carrageen forms gel with potassium salt as explained above and it bears various methods for extraction of gel form, similarly in snap-thaw process, carrageen forms shape of "long noodles" by passing through holes in Potassium chloride solution.

Now these noodles are collected and washed more Potassium chloride solution to remove excess water, fatty liquids and pressured foe solidifying. When it melts down, water is removed, these noodles are again washed

with Potassium chloride solution, cut into pieces and dried using hot air oven. After such extraction still some trace amount of Potassium chloride is present. The main aim of snap-thaw method is to remove water form gel by applying excess pressure, similarly used in agar extraction. After removing water for hours, remaining is cut off into small pieces and grinded into fine powder and many peoples using same method for extraction of Kappa carrageen and similar equipment.

2. Philippine natural grade (PNG) and processed *Eucheuma* seaweed (PES)

Carrageen farmers improved quality of production, and consumable for humans this is all done by changing the process of SRC. After this, the product is treated with alkali and cleaned with water, it is cut into pieces and bleach is added for removing the colour(cutting aids, and bleach also eliminate bacterial company), After eliminating colour bleach is washed out and dried in closed dryer, in such type of dryer, hot air is applied on sides and rises through pores of ungrounded chips or pieces on the chain belt. Such type of dryer is used for reducing bacterial count that it would suitable for human use, the dried pieces are washed with ethanol(alcohol), ethanol can be recovered if bacterial count is essential for process. A simple alternative is to provide superhot steam to grounded pieces.

Fig no 8

Fig No 9

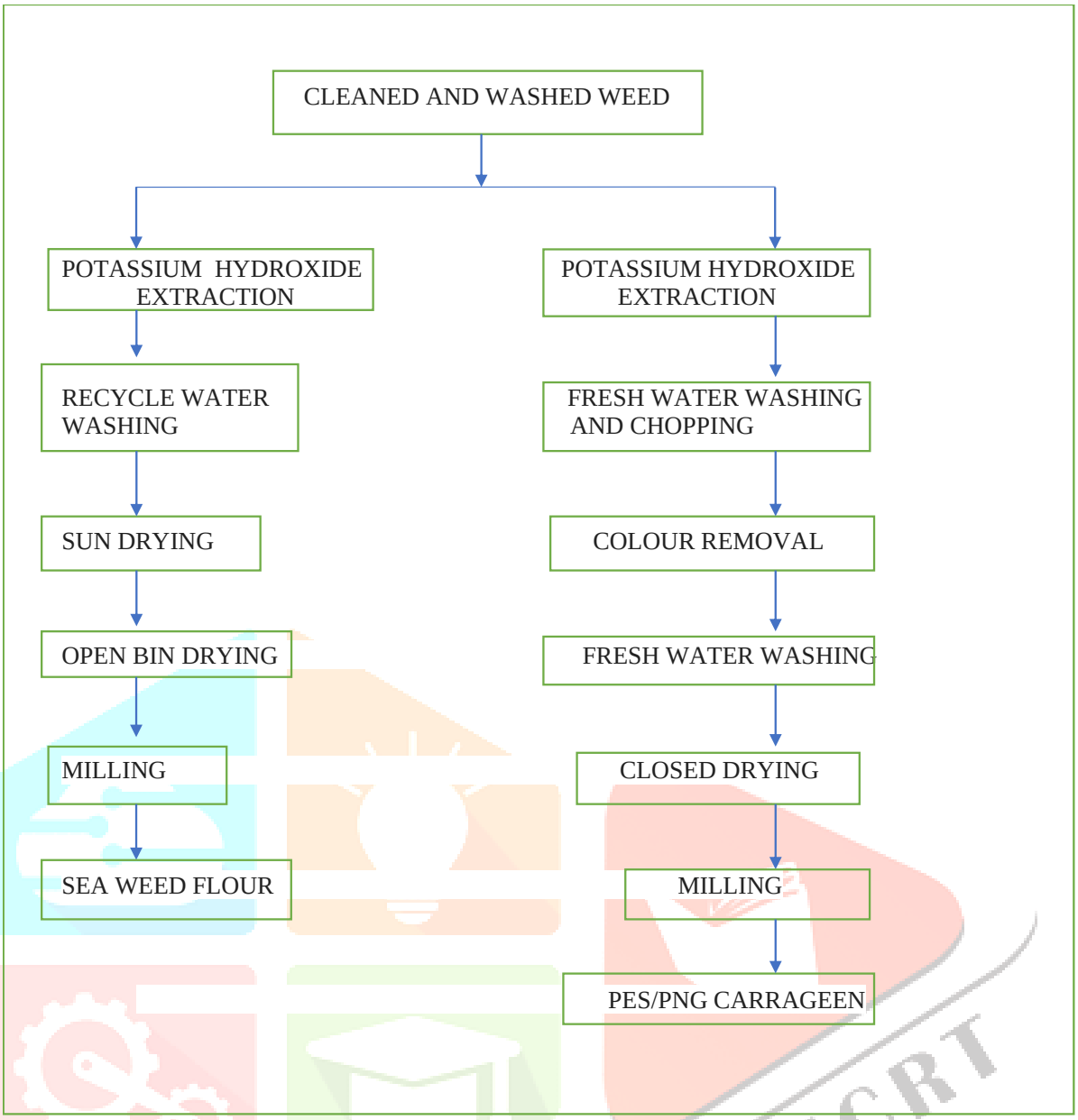


Table no 3

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. [21-24]

IV. EXTRACTION

There are two different methods for extraction of carrageen from seaweed and they are as follows: -

Extraction of l-carrageen by Ca $(OH)_2$: -

There are some steps in extraction of I-carrageen by $Ca(OH)_2$, these are as follows:-

1)Raw Material:-

Take dried E.Denticulatum = 25 gms

Solid-liquid ratios of solution = 120,125,130,135,140.

2)Boiling :-

Boil seaweed at 100^{o} C for 1 hour in water bath

3)Adding of $Ca(OH)_2$:-

Add amount of calcium hydroxide in different proportion(0.1,0.5,1.0,1.5).

4)Mixing and temperature:-

Continuously mix the solution thoroughly,

Now add water bath at different values of temperature from 60° C to 100° C for 2-4 hours.
5)Filtration :-
Remove the impurities by double layer cotton plug,
Release CO_2 into filtrate having pH 7-8, again filter it.
6)CO_2 treatment and alcohol precipitation :-
Pass carbon dioxide for making solution clear and transparent,
Mix solution with spirit of 11.5(v/v) for alcohol precipitation.
7)Final filtration and drying , dehydration :-
At last filter solution by double layer cotton plug,
Dehydrate and dry the solution at 55° C for 12 hours.
8)Crushing and Final product :-
Crushed the remaining product ,
Finally obtained product is I-carrageen.[11-14]

1. Extraction of l-carrageen by NaOH :

Similarly, as $Ca(OH)_2$ have some steps to extract carrageen. NaOH also plays similar role in extraction of I-carrageen they are as follows:-
1)NaOH-KCL solution formation :-
Prepare solution of NaOH and KCL having concentration of 7.5 and 12.
2)Alkali treatment:-
Add 10kg of E.Dentaculatum in NaOH – KCL solution at 43° C having solid – liquid ratio of 130 for 2.5 hours.
3) Refining and Cleaning :-
Wash and clean solution sample with 400kg of circulating water with agitation, repeating same cycle for 3 times,
Now stir and wash remaining sample.
4)Acidification and Neutralization :-
Add sample to HCL solution for acidification at ratios of 140 and have concentration of 0.35 for 0.75 hours,
Now add sample to 800kg of water for removing acidity.
5)Water Soaking and Floccules formation:-
Now pour the sample onto hot water for ratio of 130 for 5 hours of solid-liquid,
Now put sample into filtrate from hot water to industrial spirit at 11.5(v/v) to form floccules.
6)Crushing and dehydrating with drying :-
Air dry the sample for 36 hours and let it dehydrate it for removal of water ,crush the dry product for obtaining carrageen. [15-19]

V. PROPERTIES OF CARRAGEEN

The properties of carageen 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 subtills, 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 carageen 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 cinic 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).

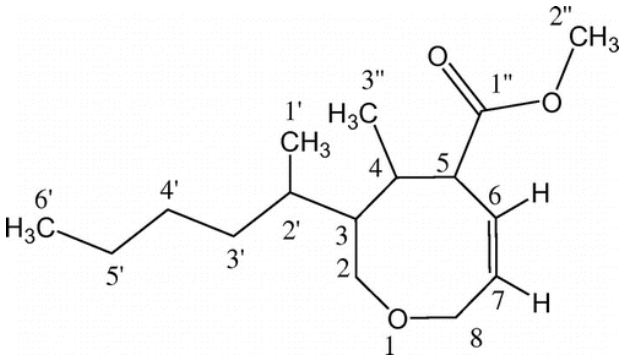


Fig No 11

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 acid-pyridine 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 µg/mL), suggesting potential safety concerns in vivo at such concentrations. However, λ-carrageenan, even at concentrations up to 300 µg/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.

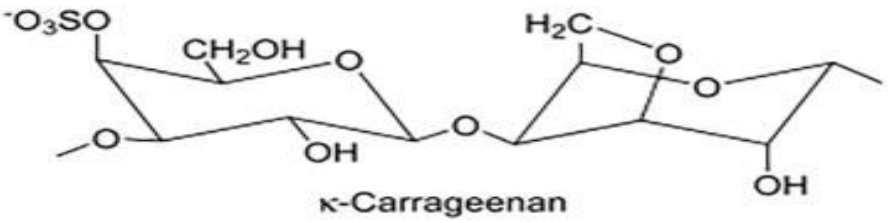


Fig no 12

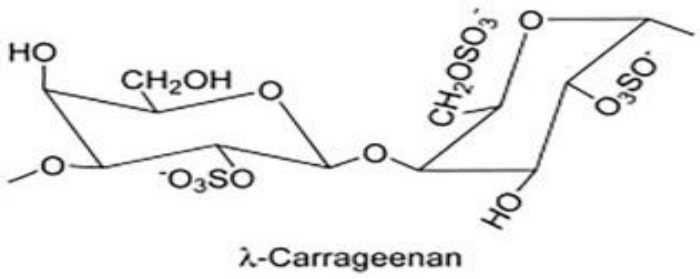


Fig no 13

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 defence 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 un mice with B16-F10 and 4T1 tumour which are injected into body of mouse.[5-10]

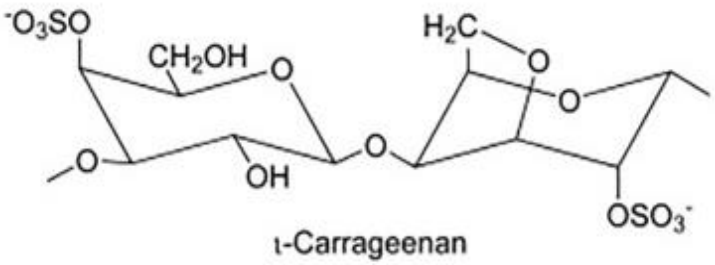


Fig No 14

VI. 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.

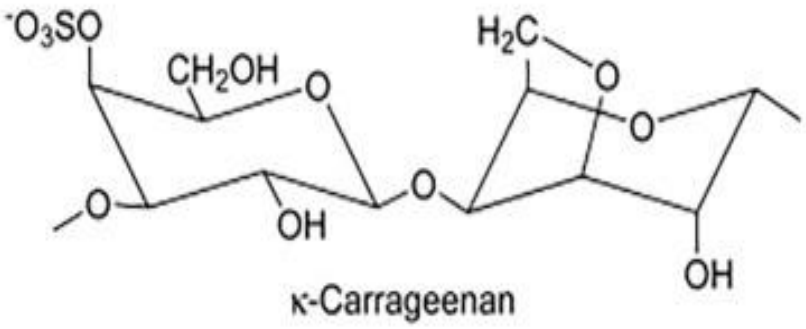
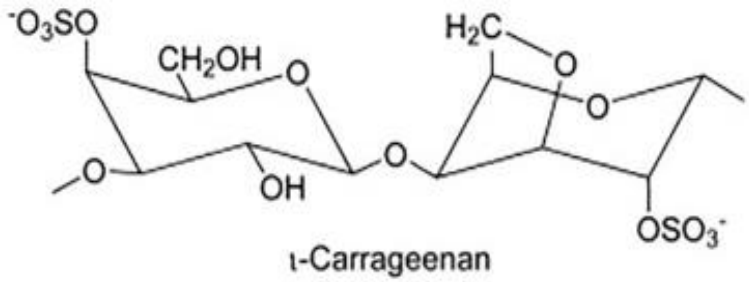


Fig no 15

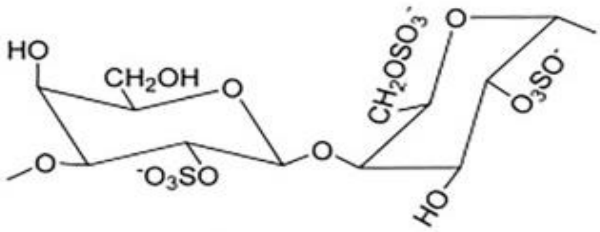
2. Iota carrageen- forms gels most explosively with calcium mariners, followed by potassium salts the reverse of kappa reactivities. Calcium gels are soft and flexible and are nearly free of bleeding. They can be firmed and fused without destroying the gel. They show an unusual property for a gel thixotropic 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.



ι-Carrageenan

Fig no 16

3. **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.



λ-Carrageenan

Fig No 17

INDUSTRIAL USES/ APPLICATION: -

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. Besides that, it used in emulsion, stabilization, for syneresis control, and for bodying, binding and dispersion of food, particularly dairy food applications.

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.

- **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.

- **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.

- **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.

- **Wound Care Products:** Carrageenan's gelling properties make it useful in certain wound care products, where it can help create protective and soothing gels.

- **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.

- **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.

- **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.

2. 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 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 carageen's e.g., Kappa carrageenan has been used with some success in replacing half the normal fat in frankfurters.

3. 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.

4. BIOTECHNOLOGY:

Biotechnology, including carrageen find application biotechnology particularly in cell culture processes. Its gelling properties make it useful as solidifying agent in microbiological culture media.
These helps to provide stable and consistent environment growth of microorganism in laboratory settings, gel forming ability of carrageen contributes to create in suitable matrix cell immobilization .

Microbial fermentation :- carrageen can be used as solidifying agent in fermentation process helps in production of various compound enzymes and metabolites

Encapsulation:- it is suitable for encapsulating cell or bio acting compound due to its gelling characters . in this field its widely used in protecting of sensitive materials and can be used in pharmaceutical sectors.

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

Frozen desert:- In frozen desert and ice-cream carageen contributes to improve colour, texture and test. It is use to prevent excess crystals formation and this helps overall quality management.

Toothpaste:- carageen used in toothpaste and dental products contributes in cleaning of teeth and provide stability for used and also contribute in maintaining alkaline nature and texture of products. It is also used as alternate to synthetic thickening agent. [20-24]

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