Carrageenan

1 Nonproprietary Names

BP: Carrageenan

PhEur: Carrageenan

USP–NF: Carrageenan

2 Synonyms

Carrageenanum; chondrus extract; E407; *Gelcarin*; *Genu*; *Grindsted*; *Hygum TP-1*; Irish moss extract; *Marine Colloids*; *Satiagel U*; *SeaSpen PF*; *Viscarin*.

3 Chemical Name and CAS Registry Number

Carrageenan [9000-07-1]

ι-Carrageenan [9062-07-1]

κ-Carrageenan [11114-20-8]

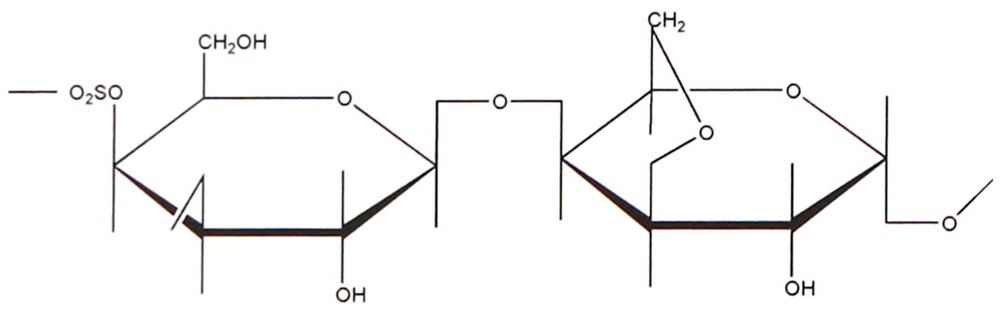
λ-Carrageenan [9064-57-7]

4 Empirical Formula and Molecular Weight

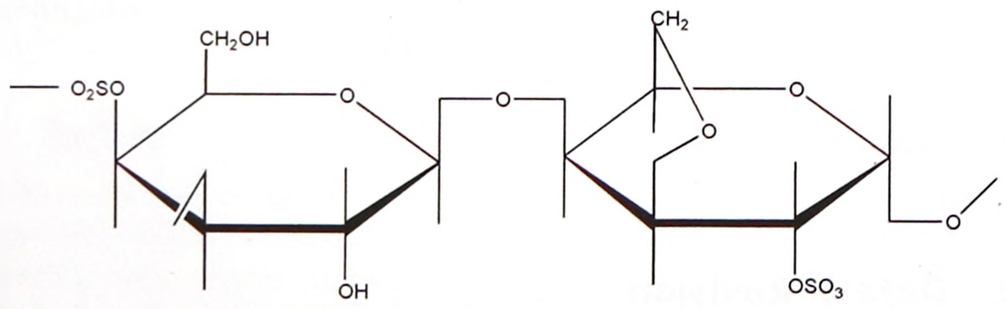
The USP 40–NF 35 S1 describes carrageenan as the hydrocolloid obtained by extraction with water or aqueous alkali from some members of the class Rhodophyceae (red seaweeds). It consists chiefly of potassium, sodium, calcium, magnesium, and ammonium sulfate esters of galactose and 3,6-anhydrogalactose copolymers. These hexoses are alternately linked at the α-1,3 and β-1,4 sites in the polymer.

5 Structural Formula

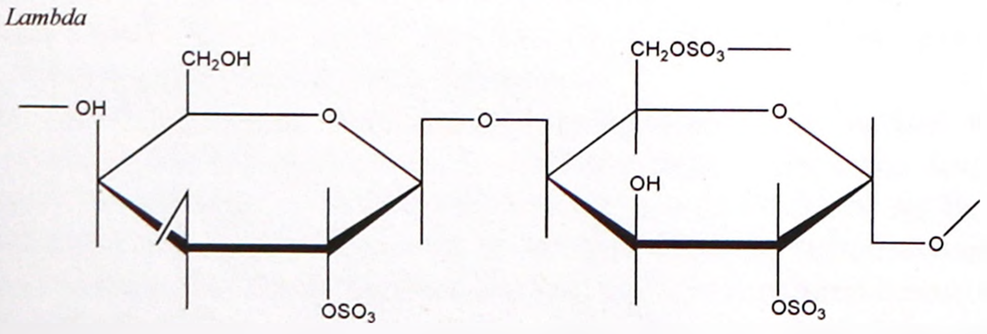
Kappa



Iota



Lambda



Three commercially important carrageenans exist currently and are divided according to the number and position of ester sulfate groups and the percentage of 3,6-anhydrogalactose.

κ-Carrageenan (kappa-carrageenan) is mainly the alternating polymer of D-galactose-4-sulfate and 3,6-anhydro-D-galactose. It contains approximately 25% ester sulfate and 34% 3,6-anhydrogalactose.

ι-Carrageenan (iota-carrageenan) is similar except that 3,6-anhydrogalactose is sulfated at carbon 2. It contains approximately 32% ester sulfate and 30% 3,6-anhydrogalactose.

λ-Carrageenan (lambda-carrageenan) has alternating monomeric units, which are mostly D-galactose-2-sulfate (1,3-linked) and D-galactose-2,6-disulfate (1,4-linked). It contains approximately 35% ester sulfate by weight and little or no 3,6-anhydrogalactose.

6 Functional Category

Capsule shell material; emulsion stabilizing agent; gelling agent; microencapsulating agent; modified-release agent; suspending agent; viscosity-increasing agent.

7 Applications in Pharmaceutical Formulation or Technology

Carrageenan is used in a wide variety of nonparenteral dosage forms, including suspensions (wet and reconstitutable), emulsions, gels, creams, lotions, eye drops, suppositories, tablets, and capsules; *see* Table I.

In suspension formulations, usually only the ι-carrageenan and λ-carrageenan fractions are used. λ-Carrageenan is generally used at levels of 0.7% w/v or less, and provides viscosity to the liquid. With pure ι-carrageenan, about 0.4% w/v is required for most suspensions, plus the addition of calcium ions to establish a gel network. However, if *SeaSpen PF* is used, it should be used at about 0.75% w/v level, although no additional calcium is required as it is already present in the product to control the rate of gelation. Carrageenan has been shown to mask the chalkiness of antacid suspensions when used as a suspending agent in these preparations.[1] When used in concentrations of 0.1–0.5%, carrageenan gives stable emulsions.

Transdermal patches of cubic gels using carrageenan as the matrix have been formulated.[2,3] Carrageenan has also been used in the preparation of hard capsule shells.[4]

ι-Carrageenan and κ-Carrageenan are claimed to provide a creamy mouthfeel in chewable tablet formulations. κ-Carrageenan, along with other excipients, is also used for oral instant-release formulations.[5] Carrageenan-based chewing gums are reported to be useful in the treatment of xerostomia.[6]

κ-Carrageenan is known as a novel pelletization aid in the manufacture of pellets by extrusion/spheronization.[7–10]

Due to its mucoadhesive properties, carrageenan has been evaluated for oral,[11] nasal,[12] and vaginal drug delivery.[13,14] It was found to prolong the local residence time of a poloxamer 407-based *in situ* vaginal gel, and also showed a synergistic bioadhesive effect with acrylic acid polymers.[15] Carrageenan in combination with poloxamers have been also investigated as a mucoadhesive polymer for buccal drug delivery.[16–19]

Different carrageenans along with various drugs and other excipients in tablet matrices have been shown to retard drug release in oral controlled-release[20–24] and ophthalmic formulations.[25,26] Furthermore, the inclusion of calcium or potassium salts in the tablet creates a microenvironment for gelation to occur, which further controls drug release.