CARRAGEENAN

GENUGEL® & GENUVISCO®

CP Kelco is one of the world's leading producers of carrageenan, a family of rheology modifiers for aqueous systems.

By using the appropriate **GENUGEL®** and **GENUVISCO®** carrageenan product, the formulator can create textures ranging from free-flowing liquids to solid gels.

Composition

Carrageenans are sulfated polysaccharides occurring in certain species of red seaweed. There are three basic types:

- Kappa carrageenan forms firm gels in the presence of potassium ions
- Iota carrageenan forms elastic gels and thixotropic fluids in the presence of calcium ions. These do not exhibit syneresis (exudation of free water during storage).
- Lambda carrageenan forms viscous, non-gelling solutions

Product Range and Applications

GENUGEL® products are based on kappa carrageenan. Applications include air freshener gels.

GENUVISCO® products are based on iota and lambda carrageenan. Although certain **GENUVISCO®** products form solid, self-supporting gels, they are more commonly used to create thixotropic fluids (*liquid gels*). Applications include toothpaste, face masks, skin creams and lotions.

As well as offering standard carrageenan types, CP Kelco works in conjunction with customers to develop new products and formulations for specific applications.

CPKelco
Global Leader in Hydrocolloids

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Carrageenans from CP Kelco

Carrageenans are anionic, sulfated polysaccharides which are derived from red algae. Different types of red algae contain different types of carrageenans. The difference is the three-dimensional structur which has direct influence on viscosity and consistency.

There exist three typical types that are different in the three-dimensional structure:

- **Kappa Carrageenan**
  They form strong and brittle gels which are clear and transparent.

- **Iota Carrageenan**
  They form transparent, visco-elastic and middle-to low viscous gels. Iota-Carrageenans mainly are used in toothpaste production but also rasor foam, hair gel or emulsions are interesting fields of application. It is used as structure agent, to improve a slippery effect on the skin or to leave a velvet and soft skin feel.

- **Lambda Carrageenan**
  They build viscous solutions, but are not used in personal care applications normally.

Carrageenans are used at pH value above 5, below pH 5 they can be degradated continuously.

Selection for cosmetic application:

Type	Class	Solubility	Function
GENUGEL CI-102	Kappa	hot	Forms strong, transparent gels
GENUVISCO TPC-1	Iota	cold	Toothpaste binder
GENUVISCO CI-123	Iota	cold	Interesting universal-type for cosmetics

General recommended use concentration: 0.1-2%

Recommendation for Genuvisco CI-123

- 0.1-0.3% to improve the slippery effect and the skin feel
- 1-2% as gelifying agent and for viscosity incraease (e.g. Hair gel)

CPKelco

Technical Bulletin

TB-02

Features of GENU® carrageenan in Personal Care Applications

Occurrence

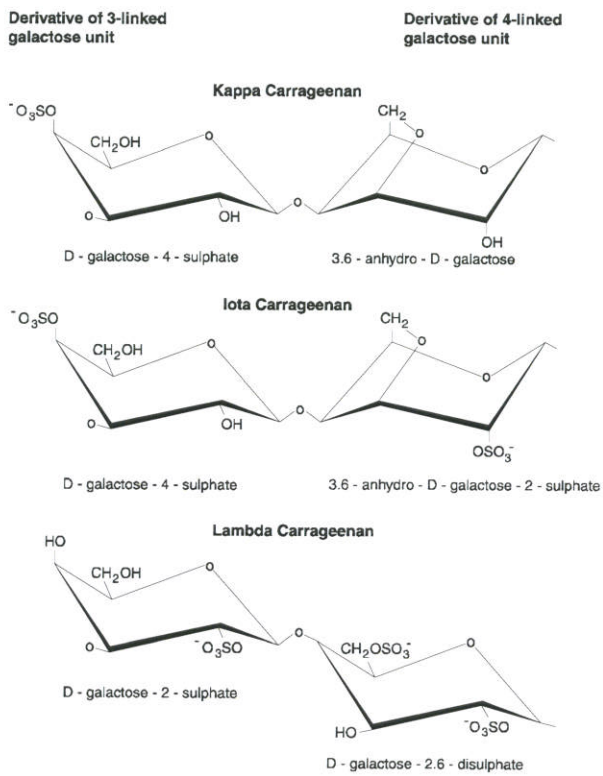
The most common and most abundant cell wall constituents yet encountered in the *Rhodophyta* are families of galactans such as carrageenan.

Structure

The backbone structure of carrageenan is based on repeating D-galactose and 3,6-anhydro-D-galactose residues linked α-(1-4) and β-(1-3), respectively.

Replacing the 3,6-anhydro-D-galactose with D-galactopyranose residues may alter the repeating carrabiose structure of carrageenan. The glycosyl units may be substituted with sulfate hemiesters in various patterns or more rarely with methyl ethers, and occasionally with pyruvic acid as the 4,6-O-carboxyethylidene group. However, the overriding structural features are the degree and patterns of sulfation.

Currently, there are two models prevailing with respect to gel formation of carrageenan. For iota carrageenan, the individual molecules are arranged in a right-handed double helix with the strands parallel and threefold with a pitch of 2.66 nm. The helix is fully stabilized by inter-chain hydrogen bonds through the only unsubstituted positions, O-6 and O-2, of the complementary D-galactose units. The sulfate hemiesters project outward from the main axis of the helix.



The inter-chain packing of kappa carrageenan is more disordered than that of iota carrageenan, but otherwise it forms an analogous double helix with a shorter (2.46 nm.) pitch.

On heating, gels become increasingly disordered and the strands disperse into a random coil form, whereas on cooling, they re-aggregate to form gels. In the domain model of gelation, the primary association of molecules on cooling a carrageenan solution is through the formation of double helices. Gelation may be promoted by specific ions such as K^+, Rb^+, Cs^+, NH_4^+, or Ca^{2+}. This also facilitates side-by-side aggregation of kappa carrageenan double helices to form a three-dimensional gel network.

The molecular basis for gelation of kappa and iota carrageenan may not be identical as the disorder-order transition in kappa carrageenan is significantly influenced by anions, whereas helix growth and nucleation in iota carrageenan are unaffected.

Lambda carrageenan lacks the 3,6-anhydride residue, does not form helices, and will not gel. Its molecules are perceived as having a rather flat, highly extended, ribbon-like form.

It must be emphasized that the carrageenan extract from individual fronds is a complex mixture of related molecular species differing in average composition, and perhaps in molecular weight as well.

The carrageenans thus far encountered belong to the kappa (κ) family with the exception of that in *Eucheuma gelatinae*, which has a beta-kappa-gamma hybrid. The carrageenan of *Kappaphycus (as Eucheuma) cottonii, Hypnea musciformis* and *Furcellaria lumbricalis* approach the idealized structure of kappa carrageenan more closely than kappa carrageenan from other source. Still, it contains minor segments of iota carrageenan (ι) and small amounts of 6-O-methyl-galactose.

Cosmetic Applications

In cosmetic applications, the main features of carrageenan are:

- Gelation
- Thermo-reversibility
- Yield value
- Gel thixotropy
- Gel rehydration
- Viscosity
- Bio-adhesion
- Compatibility with amphoteric surfactant
- Protein reactivity
- Film formation

These features are utilized in a variety of cosmetic preparations, such as liquid eye make-up products, skin care products, sunscreens, hair setting products, shaving products, deodorants, foundations, coloring compositions, soaps, mascara, and breath freshener products.

Carrageenan's ability to form gels is used in numerous cosmetic products to impart texture and consistency. Gelling grades of carrageenan can be formulated in very low concentrations to form liquid gels that stabilize solid particles and give suspension properties to keep particles from settling, such as pigments in liquid preparations.

In mascara, carrageenan is used to prepare gel-in-water-in-oil emulsions. These emulsions provide improved lash lengthening and curling.

Gelation and bio-adhesion are combined in skin care and breath care products to obtain better contact between the preparation and the skin or the mucosa.

The thermo-reversibility of carrageenan gels is used to make microcapsules, which are formed during cooling. In addition, since the gel fracture strength of carrageenan gels is easily controlled, microcapsules, which are shear resistant, are formed along with microcapsules that physically rupture under certain applied stress.

The openness of dried carrageenan gels is ideal for use in solid cosmetic preparations, which rehydrate to their original volume when wetted by water. This feature is used to make dry sticks for hair setting and dry deodorants, and to make single-use solid cosmetic products, such as shampoos, soaps and shaving lotions.