Helping to Build a Better Tomorrow Through Plant Science™

***Phyto*Technology Laboratories®**

CARRAGEENAN

BACKGROUND

Carrageenan is produced from a family of red seaweeds, *Rhodophyceae*, of many different genera. It was first originated from Irish moss, also known as *Chrondus crispus* in the 1800s. However, as carrageenan became popular for use in the food industry, manufacturers started producing carrageenan from different seaweed species other than *Chrondus crispus*. There are four most common genera in carrageen production which are *Chondrus, Eucheuma, Gigartina,* and *Iridaea*. These different genera produce different types of carrageenans. Of the four most common genera, only *Eucheuma* mainly produces iota type carrageenan while the rest mainly produce kappa and lambda type carrageenans.

While there are many types of carrageenan, different types create different levels of gel strength, which in turn have different uses. Kappa-carrageenan forms a strong, rigid gel in the presence of potassium or calcium ions. Iota-carrageenan forms a soft and elastic gel in the presence of calcium ions. Lambda does not form a gel when dissolved in water. Most kappa-carrageenan is produced with the presence of potassium ions under the process called potassium precipitation (McHugh, 1987).

HOW CARRAGEENAN IS MADE

While specific production steps are proprietary to each manufacturer, general steps in extracting refined grade carrageenan from seaweed are as follows:

1. Seaweed is washed free of sand, dirt and debris.
2. It is then treated with hot water under alkaline conditions to dissolve the carrageenan from the tissue while enhancing the gel strength.
3. Filtration then separates the carrageenan solution from the seaweed.
4. Recovering of carrageen from solution has two different methods:

a. Alcohol precipitation: the carrageenan solution is treated with 2-propanol or other alcohol to precipitate out carrageenan. The precipitate is removed, dried and ground into a powder form.
b. Potassium Chloride precipitation: the carrageenan solution is treated with concentrated potassium chloride to cause kappa carrageenan to gel. The gel material is removed, dried, and ground into a powder form.

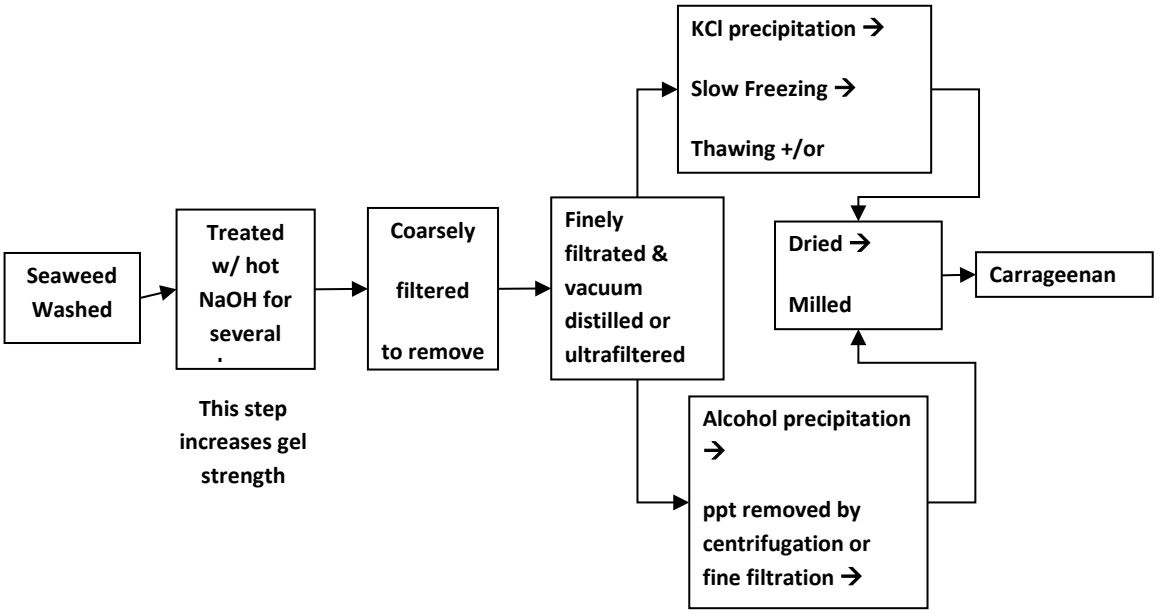

Figure 1: The general, non-proprietary production methods of Carrageenan (McHugh, 2003)

COMPARISON BETWEEN C2000 AND C257

*Phyto*Technology Laboratories® offers two kappa-carrageenans, C257 and C2000. Product C257 is Gelcarin GP 812® produced by FMC BioPolymer. Both products are high purity carrageenans; however, C2000 exhibits higher gel strength than C257. Additionally, C2000 produces a clear, colorless gel while C257 produces a slightly hazy, light tan tinted gel. A visual clarity comparison can be seen in Figure 2. A summary of physiochemical testing of at least two different lots for the two carrageenan products can be found in Table 1. Even though physiochemical testing results show some differences between the two carrageenans, product C2000 performs as well as product C257 when biologically tested.

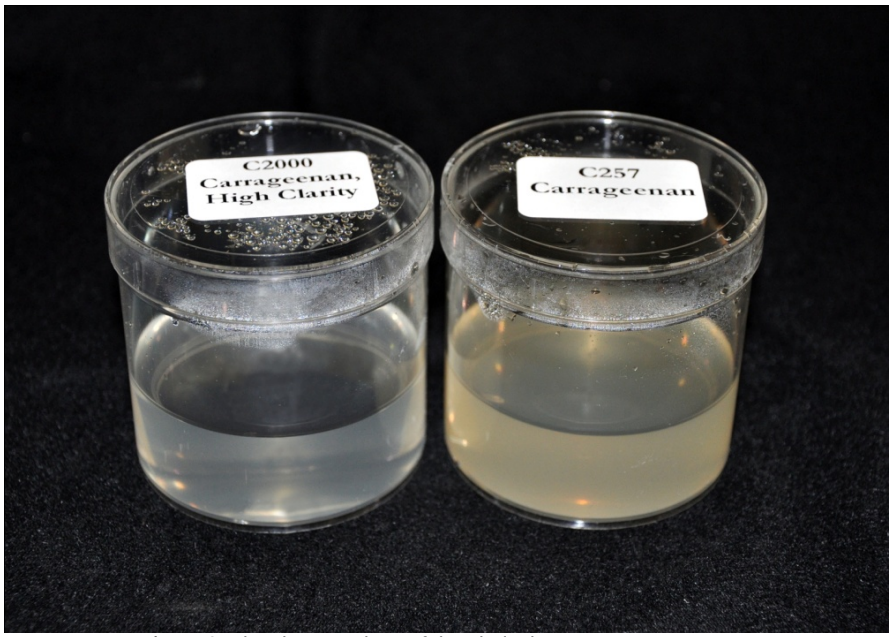

Figure 2: Visual comparison of the clarity between carrageenans.

Table 1: Summary Comparison of C2000 and C257

Comparison of C2000 and C257		
	C2000	**C257**
Brand	*Phyto*Tech	Gelcarin GP 812® (FMC)
Physical Appearance	Cream Powder	Tan Powder
pH (10 g/L)	9.97	9.50
Gel Strength (g/cm^2)	1620	864
Gel color	Colorless	Light Tan
Visual Clarity	Clear	Slightly hazy

Fourteen different plant species were biologically tested on C2000 and C257. Plant species tested for growth performance are listed in Table 2. Product number C257 was used as a control for comparison with product number C2000. Murashige and Skoog basal medium with Gamborg vitamins (Prod. No. M404) supplemented with 1 mg/L BA, 0.1 mg/L NAA, and 30 g/L sucrose was used as base medium for biological testing. Both C257 and C2000 were used at concentration of 10 g/L. Six plantlets of each species were inoculated on C2000 and C257. The size of each plantlet was relatively equal in weight when inoculated. Data were collected after 30 days in culture.

Table 2: % Increase in Fresh Weight of C2000 and C257 over a 30 day growth period in culture.

Plant Species Tested	% Increase of C2000	% Increase of C257	% Increase of C2000 relative to C257
African Violet	251%	416%	-165%
Boston fern	439%	482%	-43%
Achemines	1202%	1229%	-28%
Hosta	151%	164%	-13%
Birch	814%	780%	34%
Potato	894%	817%	77%
Coreopsis	894%	744%	150%
Lily	573%	416%	157%
Asparagus	638%	406%	232%
Dianthus Arctic Fire	554%	312%	243%
Dianthus Micro	1231%	730%	501%
Echinacea	1231%	694%	537%
Tobacco callus	2967%	1982%	985%
Ajuga	10640%	1893%	8747%

The biological testing results in Table 2 show that ten of the fourteen species that were grown on C2000 performed as good as or better than those that were grown on C257. The results for most plant species are over 100% increase in growth when grown on C2000. Interestingly, Ajuga had a growth increase of 10640% when grown on C2000, which is 8747% higher than when it was grown on C257. While more than half of the plant species grew better on product C2000, only four of the fourteen species grew better on C257. Nevertheless, many plant species have growth increase of more than 200% in each individual product. Results show that certain species grew best on either C257 or C2000.

HOW CARRAGEENAN IS USED

When carrageenan is dissolved properly, it will produce a rigid gel. Carrageenan is typically used at a wide range of concentrations from 6 g/L to 10 g/L. It is suspended in a medium that is at room temperature or colder like agar. Carrageenan should be added last since the medium will become viscous, as carrageenan is a water-soluble polymer; the viscosity of carrageenan increases with concentration and decreases with temperature. Moreover, carrageenan should also be added slowly to an agitated medium to help prevent clumping of the carrageenan and to create a uniform suspension. A lumpy suspension of carrageenan will not dissolve uniformly when autoclaved. Next, the pH of the medium should be adjusted. After autoclaving, stir the medium to distribute the melted carrageenan uniformly into the solution.

References:

Kevers C, Franck T, Strasser RJ, Dommes J, Gaspar T (2004). Hyperhydricity of micropropagated shoots: a typically stress induced change of physiological state. Plant Cell Tissue Organ. Cult. 77: 181-191.

McHugh, D.J. (2003). A guide to the seaweed industry. FAO Fisheries Technical Paper 441, Food and Agriculture Organiza□on of the United Nations, Rome.

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