Gellan Gum

Gellan gum (E418) is a bacterial exopolysaccharide, prepared commercially by aerobic submerged fermentation from *Sphingomonas elodea* (previously called *Pseudomonas elodea*), in a manner similar to xanthan. discovered in 1978,1988 Approved in Japan,1992 USA full approved.

Compared with other colloids, Gellan Gum has many peculiar advantages:

1. Low dosage;
2. Excellent thermal and acid stability;
3. Good taste-releasing ability;
4. High transparency;
5. Adjustable gel elasticity and rigidity;
6. Good combinability.

Gellan gum is widely used in foods and various other fields.

(1)Typical foods prepared using gellan gum: Gelled desserts, jam, jelly, pudding, confectionery, sugarcoating of confectionery, frost of cake, filling of cake or bread, and other foods, cakes, and pet foods.

(2) Other applications:

Microbiological media, capsules, perfumes, etc.

Soft Candy

Jelly

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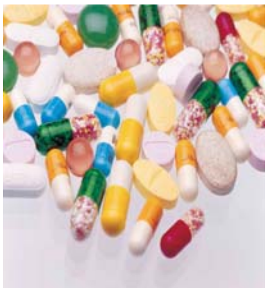
Characteristic and efficacy of Gellan Gum

Characteristic	Efficacy
1. Very Low dosage, form gel at 0.05-0.25% concentration	Gellan gum is a very effective gelling agent
2. Excellent thermal stability and acid stability	1.Little effect to gel strength after heat sterilization 2.Its powder form allows longer term of use and long-term stability even under acid condition.
3.Sodium or potassium irons can form thermal reversible gel, while Magnesium or calcium irons form thermal un-reversible gels	Can be made into thermal reversible and thermal un-reversible gels
4. Retains excellent flavor releasing ability	Improve product quality
5. Good combination with other hydrocolloids	Adjustable gel elasticity and rigidity
6. Good compatibility with other ingredients	Can be widely used in many formulations
7. Can form gel between pH 3.5~7.0	Can form high quality gels and have good gel strength in acid to neutral food formulations.
8.Anti-aging function	Prevent aging and viscosity raising of starch
9.Not easy lead to enzymolysis	Enabling flexibility in the manufacturing process, very suitable for Microbiological media and plant media.


Capsules


Culture Media

Antworks

Air fresher


Shampoo


Eye Drops


Comestic


Pet food

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Representative Applications of Gellan Gum

Function	Application
Adhesiveness	Sugar frost, sugar coat
Paint filming ability	Succade, candy
Emulsibility	Salad cream
Film forming ability	Synthetic casing
Foam stabilizer	Beer
Gelling agent	Jelly, stuffing, dessert, fruit jam
Anti-graining agent	Frozen food, syrup
Stabilizer	Ice cream, salad cream


Jams

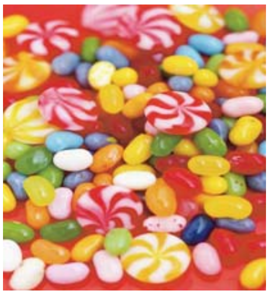

Jelly


Icecream


Beverage


Sausage


Dessert


Candy


Noodle

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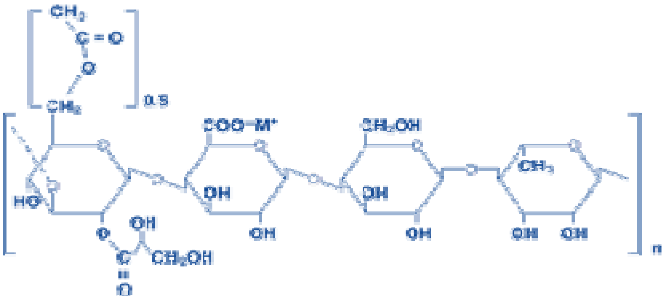
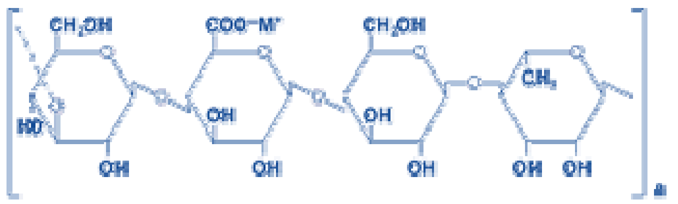
Structure of two types of gellan gum

The molecular structure of gellan gum is a straight chain based on repeating glucose, rhamnose and glucuronic acid units. In its native, or high acyl form, two acyl substituents --- acetate and glycerate are present. Both substituents are located on the same glucose residue and, on average, there is one glycerate per repeat and one acetate per every two repeats. The high acyl form produces soft, elastic, non-brittle gels, whereas the low acyl form produces firm, non-elastic, brittle gels.

Structure of Native or High Acyl Gellan Gum



Structure of Low Acyl Gellan Gum



→3)-β-D-Glcp-(1→4)-β-D-GlcpA-(1→4)-β-D-Glcp-(1→4)-α-L-Rhap-(1→

Comparison of Physical Properties of High Acyl and Low Acyl Gellan Gum

	High Acyl Gellan Gum	Low Acyl Gellan Gum
Molecular Weight	$1\sim2\times10^6$ Daltons	$2\sim3\times10^5$ Daltons
Solubility	Hot water above 70℃	Hot water above 80℃ or cold water with sequestrants
Sensitivity to cations	Relatively insensitive to ions	Very sensitive to ions, especially to divalent cations such as calcium ions
Gelling conditions	Just Cooling (do not need cations)	Cations, acids or soluble solids

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Set temperature	70~80℃ （158~176℉）	30~50℃ （86~122℉）
Thermoreversibility	Thermo-reversible	Heat stable if using divalent
Gel texture	Soft and elastic gels	Hard and brittle gels

Solution Preparation

The hydration temperature of low acyl gellan gum is very sensitive to the ionic environment and particularly sensitive to divalent ions. Low acyl gellan gum is a mixed salt and will only partially hydrate in cold deionized water. Gum hydration is further inhibited by the divalent ions in most water supplies. This inhibition makes low acyl gellan gum easy to disperse in cold water without forming lumps. Subsequently, the gum can be hydrated using sequestrants, heat or a combination of both.

Calcium sequestrants, such as citrates and phosphates, can be used to control the divalent ions. Therefore, the hydration temperature of low acyl gellan gum can be effectively controlled. Without sequestrants, low acyl gellan gum requires a temperature of 75°C (167°F) to fully hydrate the gum. However, low acyl gellan gum can be hydrated in cold soft water using 0.3% sodium citrate, as seen in the chart below.

The setting temperature, melting temperature and final gel strength of low acyl gellan gum are also affected by cations and, therefore, sequestrants. Control of low acyl gellan gum properties can be achieved by balancing sequestrants, pH and added ions.

High acyl gellan gum will swell in deionizer water creating a starch-like consistency. This swelling behavior can inhibited by low levels of sodium. The use of sodium to inhibit swelling is a useful strategy for improving gum dispersion and for minimizing viscosity during processing. Heat is required to fully hydrate high acyl gellan gum. While ions affect dispersion and particle swelling behavior, the hydration temperature of high acyl gellan gum is relatively insensitive to ions. High acyl gellan gum hydrates between 70°C and 80°C (158°F and 176°F) even in relatively high ion concentrations.

Both forms of gellan gum can be dispersed directly in milk will hydrate during normal heat processing without sequestrants.

Gum hydration is inhibited by soluble solids and low pH for both forms of gellan gum. In high solids systems, extra care must be taken to ensure that the gellan gum hydrates. In acidic environments, the pH must be above 4 for good hydration.

Hydration Temperatures of 0.25% Gellan Gum Solutions

Water Hardness ppm $CaCO_3$	Added sodium Citrate %	Hydration Temperature ℃	
		Low Acyl	High Acyl
0	0	75	71

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100	0	88	73
200	0	> 100	75
200	0.3	24	70
400	0.3	35	70

In many systems, hydration of gellan gum is not practical by simply dispersing the gum in water and heating. In these situations, hydration is brought about by inclusion of a sequestrant such as sodium citrate. The sequestrant removes the inhibitory divalent ions both from the gum and the aqueous environment, but (if used at the appropriate amounts) does not introduce sufficient sodium ions into the system to impair hydration. Depending on the ions initially present and their concentrations, gellan gum can be hydrated at room temperature with the aid of a sequestrant. The influence of sodium citrate on hydration temperature in water containing different levels of dissolved calcium is shown in following Table.

Influence of sequestrant, sodium citrate, on hydration temperature of gellan gum (0.25%)

Dissolved Ca^{2+} %	Corresponding Water Hardness ppm $CaCO_3$	Added sodium Citrate %	Hydration Temperature
0.008	200	---	>100
0.008	200	0.3	24
0.016	400	----	>100
0.016	400	0.3	35
0.040	1000	0.3	78

Gel Formation

Gellan gum solutions form gels on cooling. The setting temperature will depend on the grade of gellan gum, which cations are present and their concentration, and the presence of other dissolved solids.

In the absence of added cations, low acyl gellan gum gels set at around 25ºC (77ºF), where high acyl sets at around 65ºC (149ºF). With added calcium or sodium ions, the setting temperature increases.

Low acyl gellan gum typically forms gels in the range of 30 - 50ºC (86 - 122ºF), while high

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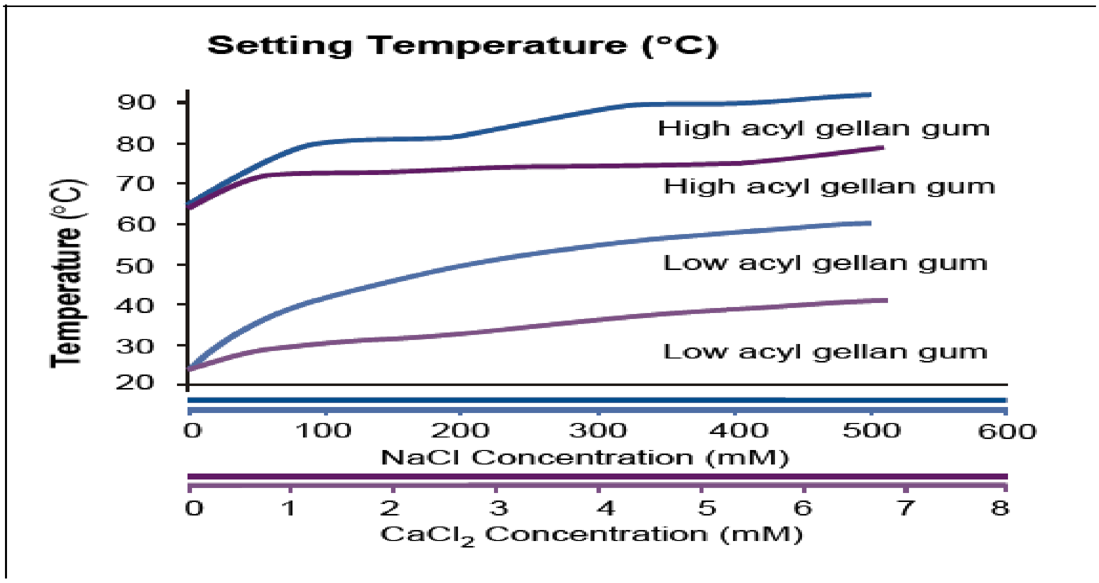
acyl gellan gum normally forms gels at around 70ºC (158ºF). Gellan gum sets very quickly, as soon as the setting temperature has been reached. This is known as “snap” setting.
High acyl gellan gum forms a gel simply on cooling. Low acyl gellan gum, however, requires cations, acid, soluble solids or some combination of these additives. Divalent cations such as calcium and magnesium are the most effective for gel formation, but sodium and potassium will also work to form a gel. To optimize gel properties, it is sometimes necessary to add extra cations. Optimization is often accomplished by adding a soluble calcium salt. To avoid localized gelation, the cations are best added when the solution is hot. The solution then gels on cooling.

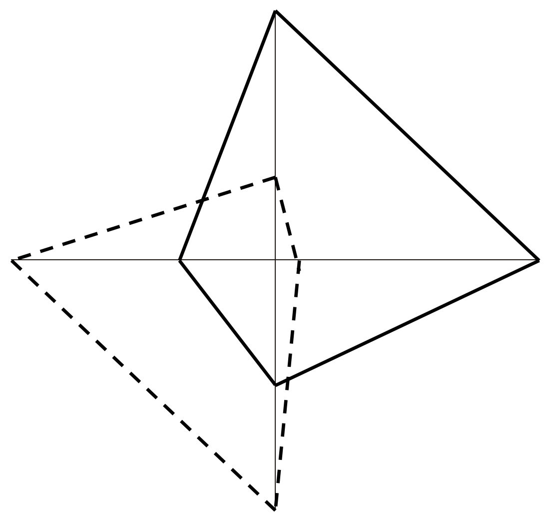


Gel Texture

One of the most important features of a gelling agent is the texture it provides. Low acyl gellan gum forms hard and brittle gels. High acyl gellan gum forms soft and elastic gels.

- - - - - - - High acyl gellan gum

——— Low acyl gellan gum



Gel Texture Parameters for Low Acyl and High Acyl Gellan Gum

Texture Profile Analysis uses a gel tester to compress a gel specimen twice in succession. The following parameters are measured:

Hardness The maximum force that occurs during the first compression cycle. It usually corresponds to the rupture strength of the gel.

Modulus The perceived firmness when the gel is squeezed by a small amount. It is analogous to the gentle squeezing of a fruit to test ripeness.

Fracture Strain A measure of how the gel can be compressed before it ruptures. A low number is indicative of high brittleness.

Springiness A measure of how much the gel springs back after the first compression cycle. A high number is indicative of a high degree of elasticity.

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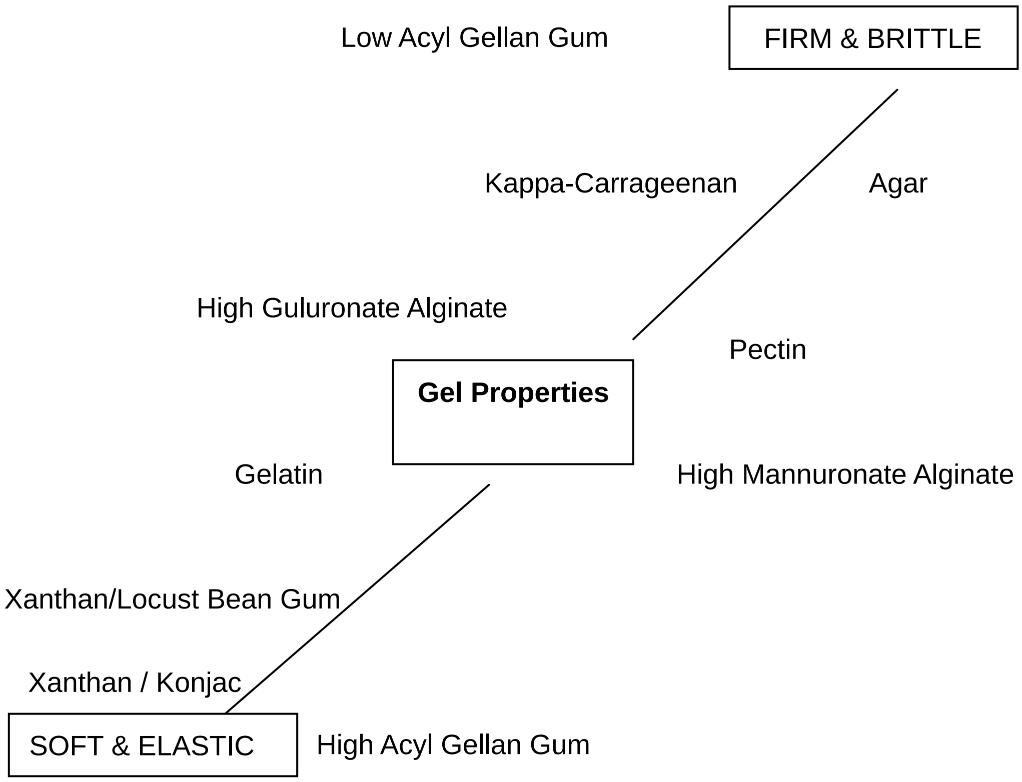

Factors Effecting Gel Texture

Effect of Cations

For both low and high acyl gellan gum, the gel structure increases sharply with increasing cation levels at moderate levels of calcium and sodium. For low acyl gellan gum, the modulus (gel firmness) increases, passes through a maxima, then decreases as the calcium concentration increases. The hardness falls with added calcium because the gel texture becomes more brittle. A similar response in gel texture is seen for monovalent salts, but the cation concentrations are an order of magnitude higher when compared to divalent cations. Note also, that a second peak is found for higher levels of monovalent ions.

Hardness and Modulus vs Ca^{2} Concentrations; Low Acyl Gellan Gum (0.25%)

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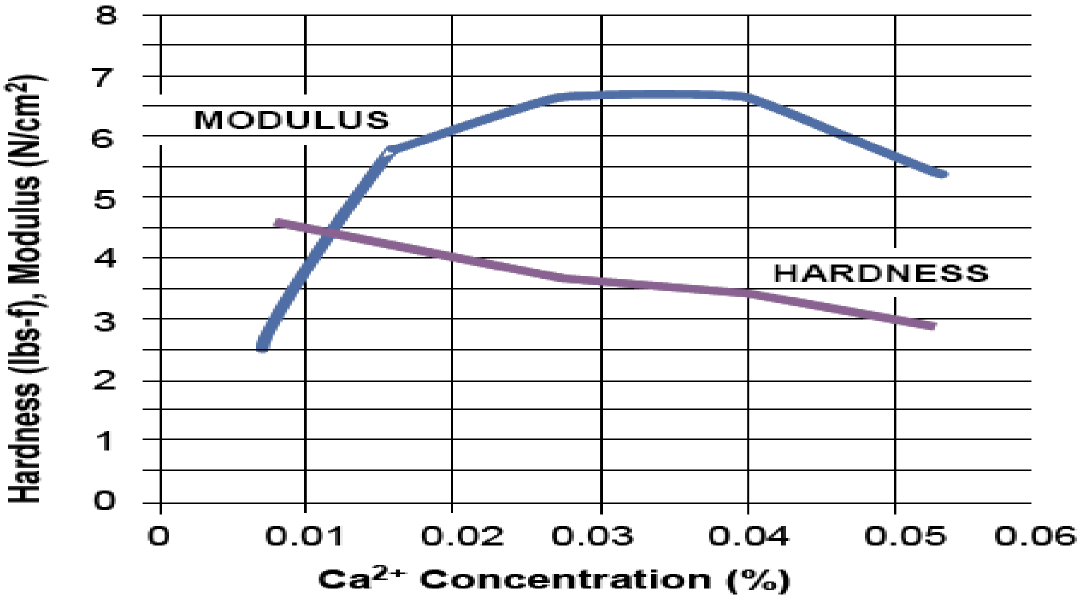
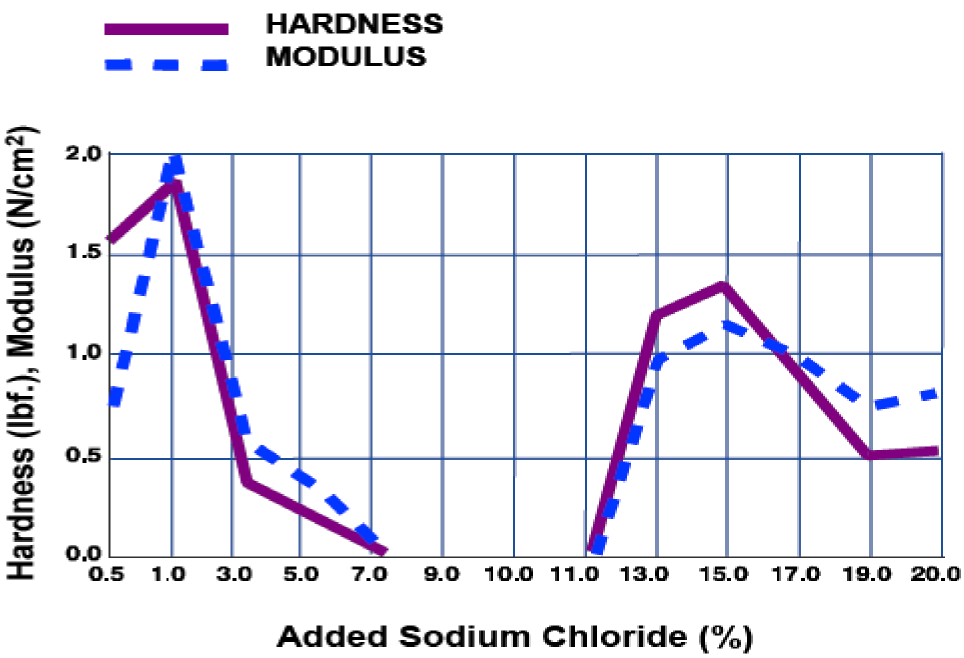


Hardness and Modulus vs Na Concentrations; Gellan Gum (0.25%)



Effect of Acids

When the pH is below 3.6, gellan gum gels can be made with hydrogen ions. These gels, known as “acid gels”, have relatively low modulus and hardness values.

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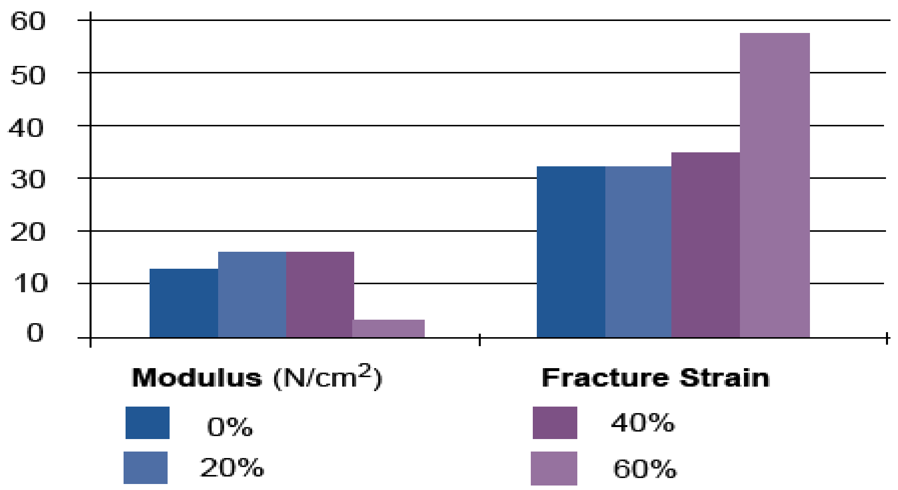
Effect of Sugars

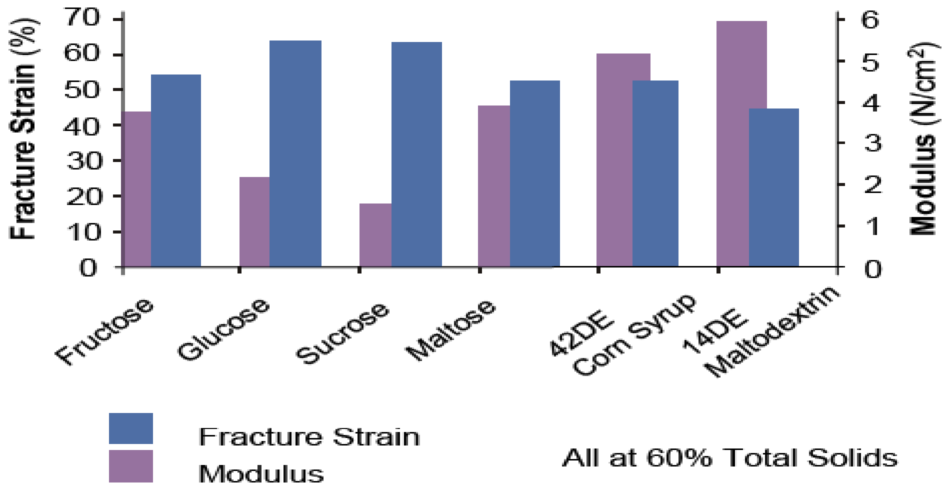
Soluble solids, such as sucrose and other sugars, effect the texture of gellan gum gels. With increasing sugar solids, low acyl gellan gum gels become less brittle and more elastic.

High acyl gellan gum gels also are more elastic above 60% total soluble solids content. The particular sugar also has a marked effect on the gellan gum gel texture. In high sugar systems, optimum gel properties can be obtained with a lower, or no extra, addition of ions. It is, however, necessary to increase the level of gellan gum. Low acyl gellan gum gels do not exhibit 'snap' setting in the presence of high sugar solids.

% Effect of Sucrose on Low Acyl Gellan Gum Gel Texture Parameters



Comparison of Modulus and Fracture Strain for 0.5% Low Acyl Gellan Gum Gels with Different Sugars



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Blends of Low Acyl and High Acyl Gellan Gum

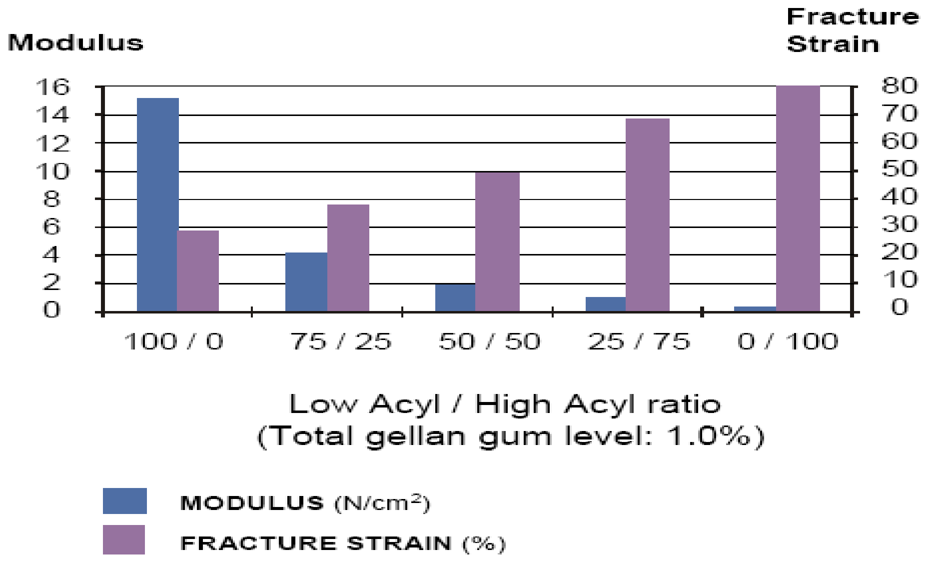
Low acyl gellan gum gels have a firm, brittle texture. Adding a high acyl gellan gum reduces the brittleness.

By varying the ratio of these two forms of gellan gum, a wide variety of textures can be obtained.

Blends of low acyl and high acyl gellan gum can match the texture of other hydrocolloids.

By varying the ratio of low acyl and high acyl gellan gums it is possible to obtain textures close to those of carrageenan and gelatin gels.

Textural Modification using Low Acyl Gellan Gum in Combination with High Acyl Gellan Gum



Comparison of a Gelatin Table Jelly with a Low Acyl / High Acyl Gellan Gum Blend

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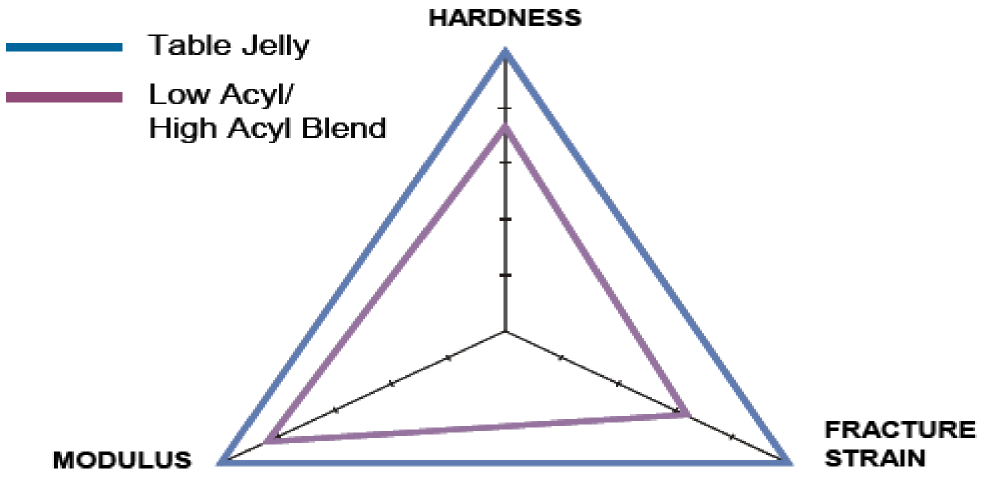
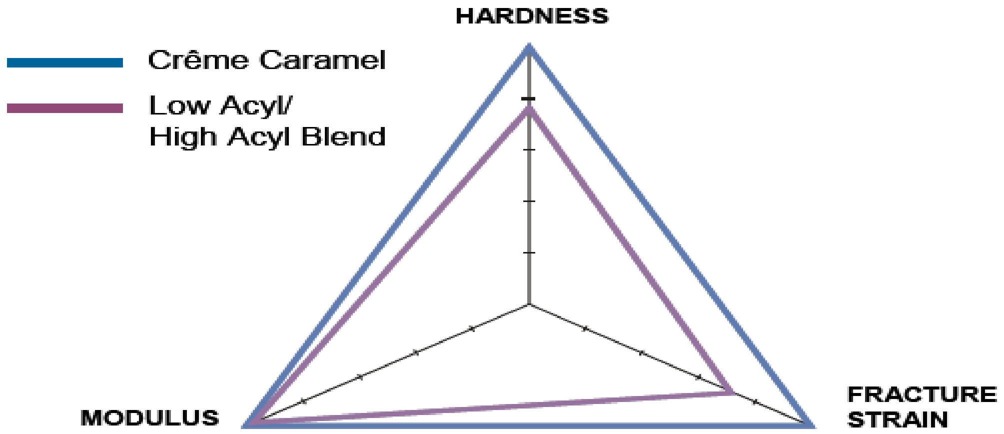


Comparison of a Ready-to-eat Crême Caramel with a Low Acyl / High Acyl Gellan Gum Blend



Blends with other Hydrocolloids

Other thickening or gelling agents, such as starch, guar gum, locust bean gum, cellulose derivatives or xanthan gum, may also be used with gellan gum in order to obtain the desired texture. Certain hydro-colloids, when combined with low acyl gellan gum, cause a progressive reduction in the hardness and modulus values of the gellan gum gels. Brittleness remains essentially constant and springiness increases slightly.

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Thermo-reversible Gels

In most practical situations, gels made with low acyl gellan gum are not thermally reversible. Most gels of low acyl gellan gum are retort or bake-stable. Gels made with high acyl gellan gum will soften with heating, and will melt with prolonged heating.

The greater the concentration of ions, the higher the melting temperature.
Milk Systems. Gels made with low concentrations of monovalent ions melt easily. For example, in milk systems both high and low acyl gellan gum form thermo-reversible gels as it is believed that in milk, gellan gum sets predominately with potassium rather than calcium ions.

Degradation during Gel Preparation

Low acyl gellan gum is very stable. Like other polysaccarides, gellan gum will undergo hydrolytic degradation at high temperature, especially in acidic conditions. However, at pH 3.5, a low acyl gellan gum solution can be maintained at 80°C for up to one hour with minimal deterioration in the quality of the subsequently formed gel. High acyl gellan gum is more susceptible to degradation so long hold times in acidic conditions should be avoided. For UHT milk process systems, the low acyl form of gellan gum should be used for long-term product stability.

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