GENU® Pectin

GENU® Pectin Book

www.cpkelco.com
GENU® PECTIN
GENERAL DESCRIPTION

CP Kelco ApS
Ved Banen 16 • 4623 Lille Skensved
Denmark
Telephone: +45 56 16 56 16
TeleFax: +45 56 16 94 46
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DEFINITION
Pectin is a purified carbohydrate product obtained by aqueous extraction of appropriate
edible plant material - usually citrus fruits or apples.

All green land plants contain pectin substances which in combination with cellulose are
responsible for the structural properties of fruits and vegetables. Pectin consists mainly of
galacturonic acid and galacturonic acid methyl ester units forming linear polysaccharide
chains and is normally classified according to its degree of esterification.

In high (methyl) ester or HM-pectin a relatively high portion of the carboxyl groups occur as
methyl esters, and the remaining carboxylic acid groups in the form of the free acid or as its
ammonium, potassium, calcium or sodium salts; its useful properties may vary with the
degree of esterification and with the degree of polymerization. Pectin in which less than
50% of the carboxyl acid units occur as the methyl ester is normally referred to as low
(methyl) ester or LM-pectin. In general, low ester pectin is obtained from high ester pectin
by a treatment at mild acidic or alkaline conditions.

Amidated pectin is obtained from high ester pectin when ammonia is used in the alkaline
deesterification process. In this type of pectin some of the remaining carboxylic acid groups
have been transformed into the acid amide. The useful properties of amidated pectin may
vary with the proportion of ester and amide units and with the degree of polymerization.
Commercial pectin is normally blended with sugars for standardization purposes, and some
types may contain suitable food grade buffer salts required for control of pH and desirable
setting characteristics.

FOOD REGULATORY STATUS
As a constituent of all land plants, pectin has been part of the human diet from the origin of
man. Pectin has been evaluated and cleared toxicologically by JECFA (the Joint FAO/WHO
Expert Committee on Food Additives). A group ADI „not specified“ was established
for pectins and amidated pectins, meaning that from the toxicological point of view there
are no limitations on the use of pectins and amidated pectins.

In most countries, food legislative authorities recognize pectin as a valuable and harmless
food additive. If regulated, permitted use levels are generally in accordance with „Good
Manufacturing Practice.“

RAW MATERIAL
The amount and composition of pectin contained in plant material vary from one variety of
plant to another. Mainly citrus fruits and apples are used as raw materials for the manufacture
of commercial pectins.

Citrus pectins are derived from the peel of lemon and lime and, to a minor extent, orange
and grape fruit. Citrus peel is a by-product from juice and oil pressing and contains a high
proportion of pectin with desirable properties.
Apple pomace, the residue from apple juice pressing, is the raw material for commercial apple pectins. These are normally darker in colour (brownish shade) than citrus pectins, but in functional properties there are no essential differences.

MANUFACTURING PROCESS
Pectin manufacture comprises three to four essential steps:

1. Extraction from the plant material.
2. Purification of the liquid extract.
3. Isolation of pectin from the solution, and - if low ester (LM) pectin is the end product desired:
4. De-esterification of the high ester (HM) pectin.

The extraction of pectin is made with hot acidified water. Quantity and quality of pectin from the specific raw material to a great extent depend on proper selection and control of extraction conditions. The extract is clarified by centrifugation and a number of filtrations, the last step being a polishing filtration to ensure complete transparency in application.

Precipitation of pectin from solution may either be done with alcohol from a concentrated (2-4%) pectin solution or with an aluminium salt from a diluted (0.3-0.5%) pectin solution. When pectin is isolated as aluminium pectinate, precipitation must be followed by washing with acidified alcohol to convert the aluminium pectinate to the acid form and subsequent neutralization with slightly alkaline alcohol.

The pectin obtained by these processes is high ester pectin. This type of pectin only forms gels above a soluble solids of approx. 55%.

Low ester pectin - which forms gels in the presence of calcium ions irrespective of soluble solids - is obtained by a controlled de-esterification of high ester pectin at either acidic or alkaline conditions. If ammonia is used to de-esterify the pectin, some amide groups are introduced into the molecule and a so-called amidated pectin is obtained. The manufacturing processes are in principle simple unit operations, but much know-how
is accumulated in the practical execution of the processes. The flow chart below gives a general description of the process used by CP Kelco ApS.

STRUCTURE
Pectin is an essentially linear polysaccharide containing from a few hundred to about 1000 saccharide units in a chain-like configuration; this corresponds to average molecular weights from about 50,000 to 150,000.

D-galacturonic acid is the principal constituent of the pectin molecule, but some neutral sugars are also commonly present in pectin. The D-galacturonic acid units are linked together by β-1.4 glycosidic linkages. The polygalacturonic acid is partly esterified with methyl groups and the free acid groups

\[ \text{D-galacturonic acid} \]
may be partly or fully neutralized with sodium, potassium or ammonium ions. The ratio of esterified galacturonic acid groups to total galacturonic acid groups - termed the degree of esterification (DE) - has vital influence on the properties of pectin, especially the solubility and the gel forming characteristics. The highest DE that can be achieved by extraction of natural raw material is approx. 75%. Pectins with DE from 20-70% are produced by controlled de-esterification in the manufacturing process.

The DE of 50% divides commercial pectins into high ester (HM) and low ester (LM) pectin. These two groups of pectin gel by different mechanisms.

HM-pectin require a minimum amount of soluble solids and a pH within a pretty narrow range, around 3.0, in order to form gels. LM-pectins require the presence of a controlled amount of calcium or other divalent cations for gelation and do not require sugar and/or acid.

Degree of esterification of HM-pectins controls their relative speed of gelation as reflected
by the designations ‘slow set’ and ‘rapid set’ high ester pectin. Degree of esterification of LM-pectins controls their calcium reactivity. Some types of LM-pectins also contain amide groups, which strongly affects the calcium reactivity.

**General Properties of Pectin**

**SOLUBILITY**

Pectin must be completely dissolved to ensure full utilization and to avoid heterogeneous gel formation. Complete dissolution presumes dispersion without lumping; if pectin lumps are allowed to form they are extremely difficult to dissolve. Pectin, like any other gelling agent, will not dissolve in media where gelling conditions exist. HM-pectin thus becomes increasingly difficult to dissolve as the soluble solids in the medium increases. It is recommended that HM-pectin is dissolved at solids below 20% and preferably in water.

**Dissolution with high-speed mixer**

The simplest way of dissolving powdered pectin is by means of a high-speed mixer with superior shearing action. In this way 4-8% solutions of pectins are easily made. With the best mixers and using hot (min. 80°C) water it is possible to make 10% solutions of most pectins.

**Preblending with sugar**

When dry blended with 5 parts of sugar or more, pectin may easily be dispersed into water. Fine mesh pectin may even at low concentrations dissolve readily into cold water by this method. Using regular mesh pectin and conventional stirrers it is possible to make up to approx. 4% pectin dispersions. At higher concentrations the viscosity of the batch becomes a limiting factor for homogeneous dispersion.

To ensure complete dissolution of the pectin, it is recommended that the dispersion is boiled for 1 minute. As dissolution of pectin becomes increasingly difficult at higher soluble solids, the bulk of the sugar in the recipe should not be added until the pectin is dissolved.
Dispersing in concentrated sugar solution
As pectin does not dissolve at high sugar concentrations, it is possible to make a dispersion of pectin in a concentrated sugar solution without tendency to lump formation. Depending on stirrer efficiency and process, 2-12% pectin dispersions may be obtained by this procedure. Complete dissolution of the pectin requires dilution with water, optimally down to 20% solids or below, followed by boiling for 1 minute.

Viscosity
Pectin solutions usually show relatively low viscosities compared to other plant gums and thickeners. Calcium or other polyvalent ions increase the viscosity of pectin solutions and low ester pectin solutions may even gel if the calcium content exceeds a certain limit. The viscosity of pectin solutions is also influenced by pH. In a calcium-free solution, the viscosity drops when pH is increased from below the pK-value to above this value. Viscosity of a pectin solution may be determined for the purpose of obtaining a measure of the molecular weight of the pectin or for evaluating the thickening effect of the pectin. In the former case, the viscosity must be determined in a calcium-free solution at a fixed pH, e.g. 4.0.

REACTIONS
Stability in solution
Most reactions which pectin undergoes in use tend to degrade the pectin. As a rule, maximum stability is found at pH 4. The presence of sugar in the solution has a certain protective effect while elevated temperatures increase the rate of degradation.

At low pH-values and elevated temperatures degradation due to hydrolysis of glycosidic links is observed. De-esterification is also favoured by low pH. By de-esterification, a high ester pectin becomes slower setting or gradually adapts low ester pectin characteristics. At near-to-neutral pH (5-6), HM-pectin is stable at room temperature only. As the tempera-
ture (or pH) increases, a so-called β-elimination starts. The β-elimination results in chain cleavage and very rapid loss of viscosity and gelling properties.

LM-pectin shows a somewhat better stability at these conditions as illustrated in the graph on page 12. At alkaline pH-values pectin is rapidly de-esterified and degraded even at room temperature.

Reactions with other electrically charged hydrocolloids
Pectin is a polygalacturonic acid and the chain molecule is negatively charged at neutral pH. The pK-value of pectin is approx. 3.5. Pectin reacts with positively charged macro-molecules, e.g. proteins at pH-values below their isoelectric pH. Pectin precipitates gelatine at low pH-values, but this reaction can be prevented by addition of salt. When pectin is added to milk at the pH of milk (6.6) a two-phase system is formed. At lower pH, pectin may combine with casein particles present to produce a stable acidified milk, which may even be heat treated to extend the shelf life of the product. Without pectin the milk protein would agglomerate to cause „sandy“ mouthfeel and separation.

GELLING MECHANISM
A pectin gel may be regarded as a system in which the polymer is in a state between fully dissolved and precipitated. It is theorized that segments of the molecule chains are joined together by limited crystallization to form a three-dimensional network in which water, sugar and other solutes are held.
Formation of a gel, from a state where the polymer is fully dissolved, is caused by physical or chemical changes that tend to decrease the solubility of the pectin and this favours the formation of local crystallization. The most important factors which influence the solubility of pectin (tendency to gel) are:

1. Temperature
2. Molecular composition of the pectin (pectin type)
3. pH
4. Sugar and other solutes
5. Calcium ions
Temperature
When cooling a hot solution containing pectin, the thermal motions of the molecules are decreased and their tendency to combine into a gel network is increased. Any system containing pectin at potential gelling conditions has an upper temperature limit above which gelation will never occur. Below this critical temperature low ester pectins gel almost instantly while the gelation of high ester pectins is time dependent, the time taken being related to the temperature at which gelation occurs. In contrast to low ester pectin, high ester pectin gels are not temperature reversible.

<table>
<thead>
<tr>
<th>HM-pectin type</th>
<th>Degree of esterification</th>
<th>Gelling time, when cooled to and subsequently held at</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid set</td>
<td>73.5</td>
<td>60 min. 10 min. Pre-gel Pre-gel</td>
</tr>
<tr>
<td>Medium set</td>
<td>69.5</td>
<td>No gel 40 min. 5 min. Pre-gel</td>
</tr>
<tr>
<td>Slow set</td>
<td>64.5</td>
<td>No gel No gel No gel 30 min.</td>
</tr>
</tbody>
</table>

Gelation of HM-pectins with various DE (pH = 3.0, SS = 65%, pectin concentration = 0.43%)
Types of pectin

The overall distribution of hydrophilic and hydrophobic groups on the pectin molecule determines the solubility (tendency to gel) of a particular pectin.

The degree of esterification of a high ester pectin influences the gelling properties. The ester group is less hydrophilic than the acid group and consequently a high ester pectin with a high degree of esterification gels at higher temperatures than a high ester pectin with a lower degree of esterification. This difference is reflected in the terms rapid set, medium set and slow set, which is illustrated in the above table.

The solubility of the calcium salt of completely de-esterified pectin (polygalacturonic acid) is extremely low and a similar tendency to precipitate (form gels) in the presence of calcium ions is found with low ester pectin. The lower the degree of esterification - the more pronounced the similarity to polygalacturonic acid - and the greater the reactivity with calcium as reflected in the higher gelling temperatures observed.

Introduction of amide groups into the LM-pectin molecule tends to make the pectin less hydrophilic - increasing the tendency to form gels. In practice, amidated LM-pectins show a wider „working range“ with regard to calcium content of the system and yield increasing gelling temperatures with increasing degree of amidation.

<table>
<thead>
<tr>
<th>Degree of esterification</th>
<th>Gelling temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>26%</td>
<td>100</td>
</tr>
<tr>
<td>30%</td>
<td>80</td>
</tr>
<tr>
<td>35%</td>
<td>50</td>
</tr>
<tr>
<td>40%</td>
<td>20</td>
</tr>
<tr>
<td>45%</td>
<td>0</td>
</tr>
</tbody>
</table>

\[ pH = 3.3 \text{ - SS} = 45 \% \]

*Calcium: 15 mg/g pectin, pectin: 1%*
**pH**

Pectin is an acid with a pK-value of approx. 3.5.

Increasing ratio of dissociated acid groups to non-dissociated acid groups generally makes the pectin molecule more hydrophilic. The tendency to form gels is therefore strongly increased by decreasing pH of the system. This is especially evident for high ester pectins which normally require a pH below 3.5 in order to gel.

**Sugar and other solutes**

Sugar and similar solutes generally tend to dehydrate the pectin molecules in solution. At higher solids there is less water available to act as a solvent for the pectin and the tendency to crystallize or gel is consequently favoured.

Above 85% soluble solids, the dehydration effect is so strong that, in practice, gelation of any commercial pectin can hardly be controlled. High ester pectins form gels at soluble solids down to approx. 55%. For each soluble solids value above 55% there is a pH-value at which gelation is optimum for a particular high ester pectin, and a pH-range within which gelation can be obtained in practice.

Low ester pectins may gel at any soluble solids. For a particular pectin, the gelling temperature decreases with decreasing soluble solids.

**Calcium ions**

In contract to high ester pectin, low ester pectin forms gels in the presence of divalent
cations such as calcium. As illustrated below, acid-demethylated low ester pectins require a fairly high amount of calcium within quite narrow limits to give optimum gel strength. Amidated low ester pectins show greater flexibility in this respect. For both pectin types increasing calcium concentration results in increasing gel strength - and increasing gelling temperature - to a point where pregelation occurs. i.e. the gelling temperature close to the boiling point.

![Graph](image_url)

**Commercial Pectins**

**POWDER CHARACTERISTICS AND STORAGE STABILITY**

The powder density of a typical standardized HM-pectin produced by alcohol precipitation is 0.70.

A typical mesh specification says: 90% through a 60 mesh (0.25 mm) sieve. The colour of a commercial pectin may vary from light cream to light tan for an alcohol precipitated pectin or sometimes greenish yellow for an A1-precipitated pectin. Apple pectins are generally darker than citrus pectins.

Commercial pectins will absorb water under most climatic conditions. Their equilibrium water content are:

9% in an atmosphere of 50% relative humidity.
12% in an atmosphere of 70% relative humidity (valid for a 150 grade HM-pectin blended from 70% pectin and 30% sucrose).

Pectins standardized with dextrose (9% water) have a higher moisture content than those standardized with sucrose (0% water) and have correspondingly higher equilibrium water contents in any atmosphere. Pectins are normally packed in vapour tight packaging labelled

STORE COOL AND DRY.

Stability
Powdered HM-pectins lose about 5% in jelly grade per year when stored at room temperature. Furthermore, HM-pectin is slowly de-esterified during storage, whereby e.g. rapid set pectin over a period of a year become a medium rapid set pectin. Degradation and de-esterification rates are more than doubles when the storage temperature is increased from 20°C to 30°C. LM-pectins are more stable at storage than HM-pectins and degradation is normally not detectable over a period of a year at room temperature.

STANDARDIZATION
Pectins are standardized by the manufacturers to ensure that the users always get the same gel strength in their product and at the same point in the production process, provided the pectin is used under the same constant conditions.

High ester pectin
Commercial HM-pectins are characterized by, and standardized to, uniform „jelly grade“ and gelling velocity. „Jelly grade“ expresses the amount of sugar than can be gelled in a standard gel (standard composition and standard gel strength).

Various methods are used in measuring gel strength, the most common method being the SAG-method, where deformation by gravity of the demoulded gel is measured. In other methods, breaking strength of the gel is determined. For specific applications the ratio between strength based on SAG-grade and strength based on breaking strength grade is of importance. In jellies, specifically confectionery jellies, a high breaking strength is required, whereas in jams the need for spreadability favours a pectin with a low breaking strength. International trade gives preference to the SAG-method developed by the US IFT in 1959 and published in Food Technology 13, 496 (1959).

The majority of HM-pectins are standardized to 150 grade USA-SAG, which means that 1 kg of standardized pectin will turn 150 kg of sugar into a standard gel (SS = 65.0%, pH = 2.2-2.4, gel strength = 23.5% SAG).

In other words:

1 kg 150 „jelly grade“ pectin can set 230 kg standard jelly.

Gelling velocity of an HM-pectin jelly may be expressed as setting time or as setting temperature. None of these two characteristics are physical constants as they vary with

a) the composition of the jelly, i.e. pH, SS, pectin concentration, etc.

b) the cooling rate of the jelly.
The setting temperature of and HM-pectin jelly is defined as the temperature at which the first sign of jellification is observed. The setting time is defined as the time from the end point of the jelly preparation to the first sign of jellification.

The most commonly used method for determination of gelling velocity is the Joseph Baier method that enables gelling time and specifies the important variables as follows:

$$SS = 65\%$$  
$$pH = 2.2-2.4$$

**Gel strength of test jelly = 23.5\% SAG**

**Cooling rate = As obtained in a standard USA-SAG jelly glass in a 30^\circ C water bath.**

The test jelly is in fact exactly the same as the one used for the USA-SAG grade determination.

**Low ester pectin**

LM-pectin may be graded by a method with some similarities to the USA-SAG method used for HM-pectin. The composition of the test jelly may for example be:

$$SS = 31.0\%$$  
$$pH = 3.0$$  

**Calcium concentration = 250 mg Ca/kg test jelly**

or

**25 mg Ca/g standardized 100 grade LM-pectin.**

Jelly grade expresses the number of kg jelly of standard firmness (20.5\% SAG) which can be produced from 1 kg LM-pectin. As application conditions for LM-pectin show rather wide variations, jelly grade methods are not always sufficiently relevant for the use of LM-pectin. Performance tests may be used as sole or additional test procedure.

**QUALITY CONTROL**

**Purity determination**

The "pure pectin" content is determined as percent anhydro-galacturonic acid by official method of Food Chemicals Codex (FCC), Third Edition, Washington, D.C., 1981 (incl. supplements), or as galacturonic acid by official method of FAO Food and Nutrition Paper (FNP), 52, 1992. The method involves washing of powdered pectin in a mixture of hydrochloric acid and 60% alcohol, which removes sugars and salts and converts the pectin to its acid form. If the galacturonic acid content as calculated on the acid/alcohol purified sample is low, it indicates the presence of non-uronic acid polysaccharide material in the pectin, or a pectin of low purity and often of low gelling power. Citrus pectins of high purity have a galacturonic acid content above 74\%, which is the lower limit in USP XXII specifications for pectin.
Content of heavy metals in pectin is determined by official methods as published in FCC, FAO, FNP, EU Directive of 25th July, 1978 and USP XXII. A summary of various official purity specifications is shown in the table down below. Microbiological quality is determined by official methods.

**Calcium reactivity**
LM-pectins require a minimum calcium concentration in order to yield gels with desirable properties. At too high calcium levels, pregelation and tendency to syneresis occur. The „calcium working range“ - or calcium reactivity - of a specific LM-pectin depends primarily on degree of esterification and degree of amidation, but is also influenced by degree of uniformity within and among molecules of the pectin lot.

Thus, calcium reactivity is not only controlled by proper processing ocnditions, but also through careful selection of suitable raw material. Calcium reactivity is evaluated in test jellies with different concentrations of calcium. The test jellies may be similar to those used for grade determination, except for calcium concentration.

<table>
<thead>
<tr>
<th>OFFICIAL PURITY SPECIFICATIONS FOR COMMERCIAL PECTINS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reference</strong></td>
</tr>
<tr>
<td>Drying loss (volatile matter)</td>
</tr>
<tr>
<td>Acid-insoluble ash</td>
</tr>
<tr>
<td>Sulphur dioxide</td>
</tr>
<tr>
<td>Sodium methyl sulphate</td>
</tr>
<tr>
<td>Methanol, ethanol and isopropanol</td>
</tr>
<tr>
<td>Nitrogen content, amidated pectin</td>
</tr>
<tr>
<td>Nitrogen content, pectins</td>
</tr>
<tr>
<td>Galacturonic acid</td>
</tr>
<tr>
<td>Total anhydrogalacturonides in pectin component</td>
</tr>
<tr>
<td>Degree of amidation</td>
</tr>
<tr>
<td>Arsenic, ppm</td>
</tr>
<tr>
<td>Lead, ppm</td>
</tr>
<tr>
<td>Copper, ppm</td>
</tr>
<tr>
<td>Zinc, ppm</td>
</tr>
<tr>
<td>Copper and zinc, ppm</td>
</tr>
<tr>
<td>Heavy metals (as Pb), ppm</td>
</tr>
</tbody>
</table>
Applications

FOOD APPLICATIONS
Pectin is first and foremost a gelling agent used to impart a gelled texture to foods, mainly fruit-based foods. The gelling ability is further utilized where stabilization of multiphase foods is required, either in the final product or at an intermediate stage in the process.

Jams and jellies
HM-pectin requires 55-85% sugar and pH 2.5-3.8 in order to gel. These requirements limit the possible uses of HM-pectin as a gelling agent to sweetened fruit products and about 80% of the world production of HM-pectin is used in the manufacture of jams and jellies, the pectin being added to make up for "deficiency of natural pectins."

The role of pectin is to impart a texture to the jam or jelly that allows transportation without changes, that gives a good flavour release and that minimizes syneresis. During manufacture of a jam the pectin must ensure a uniform distribution of fruit particles in the continuous jelly phase from the moment the mechanical stirring ceases, i.e. the pectin must set quickly after the filling operation. The use concentrations for pectin vary from 0.1-0.4% in jams and jellies.

Pectin gelation can be obtained in a cold process by mixing a pectin-sugar-syrup with soluble solids 60-65% and pH 3.8-4.2 with fruit acid solution to achieve pH 3.0. This process is used in Scandinavia by the bakers to make jelly-covered fruit tarts. A variation of the technique is mixing a pectin solution with pH 2.9 and soluble solids 25% with a liquid sugar to obtain soluble solids 53%.

These two processes can be used as a result of gelation of HM-pectin being time, as well as temperature, dependent.

The traditional application of LM-pectin is in jams with soluble solids below 55%, which is the limit for the use of HM-pectin. The calcium content of the fruit is normally sufficient to set an amidated LM-pectin, whereas acid demethylated LM-pectin requires addition of a calcium salt. The type of LM-pectin must be carefully selected according to the soluble solids/pH conditions in the application medium. In products with very low solids, as for instance sugar-free jams for diabetics, LM-pectin hardly has sufficient water binding and a
carrageenan is better suited. In some instances combinations of LM-pectin and carrageenan offer advantages.

The heat reversibility of LM-pectin gels may be utilized in bakery jams and jellies for glazing purposes. A jam or jelly base with soluble solids of approx. 65% has a relatively good microbiological stability, but the LM-pectin only imparts a paste-like texture to the product, due to pregelation. Prior to application, the base is diluted with water to approx. 40% solids and heated to remelt the LM-pectin gel. When poured on top of cakes and tarts, the LM-pectin gels optimally at the reduced solids to form a coherent and glossy glazing.

**Fruit preparations for yoghurt**
Low ester pectins are often used in fruit preparations for yoghurt to create a soft, partly thixotropic gel texture, sufficiently firm to ensure uniform fruit distribution but still allowing the fruit preparation to be easily stirred into the yoghurt. The pectin may further - especially when combined with other plant gums - reduce colour migration into the yoghurt phase of the final product.

**Fruit drink concentrates**
Gelation of pectin may be used as a means of stabilizing a multiphase system if gelling conditions can be achieved at some stage in the process. Gelation provides the yield value which is required to obtain permanent stabilization of emulsions, suspensions and foams. HM-pectin is used in fruit drink concentrates, stabilizing any oil emulsions and fruit particle suspensions. In this application the gelation is apparent in the end product only as a thickening effect, as the coherent gel texture has been broken mechanically to obtain a smooth flow. Extensive homogenization must not be used, as sufficient yield value must still be present to ensure stabilization.

**Fruit juice**
The viscosity or mouthfeel creating properties of HM-pectin find use in recombined juice products to restore the mouthfeel of the juice to that of the fresh juice. Pectin is further used to provide a natural mouthfeel in instant fruit drink powders.

**Fruit/milk desserts**
The calcium response of LM-pectin may be utilized to obtain an instant gelation when adding calcium ions (milk) to a syrup containing LM-pectin. A canned fruit preparation containing 2% LM-pectin in a fruit syrup with 25-30% soluble solids and pH 4.0 is mixed with an equal amount of cold milk to quickly make a fruit flavoured semi-gelled milk dess-ert.

LM-pectin has excellent stability at the conditions of fruit preparation manufacture, i.e. pH 4.0 and suitable pasteurization conditions. The LM-pectin solution remains fluid at room temperature as calcium content is insufficient to cause gelation. When the fruit preparation is mixed with milk, sufficient calcium is available to gel the LM-pectin.

Another version of this basic idea is a concentrated, sweetened and flavoured LM-pectin solution, a paste to be mixed into three parts of cold milk. The ‘intermediate moisture food’ properties of this concept imply a wider pH-range allowing vanilla or chocolate flavouring to be used.

A third version is a powder to be dissolved in cold water prior to addition of milk.
**Fermented and directly acidified dairy products**
The ‘protective colloid’ effect of HM-pectin is utilized to stabilize sour milk products either cultured or produced by direct acidification (fruit juice-milk combinations).

The pectin reacts with the casein, prevents the aggregation of casein particles at pH below the isoelectric pH (4.6) and allows pasteurization of the sour milk products to extend their shelf life.

The texture of yoghurt may be improved by small amounts of LM-pectin which is added before the yoghurt milk is heated. The LM-pectin does not prevent syneresis.

**Gelled milk products**
LM-pectin is suited as a gelling agent in milk desserts, but less economical in use than carrageenan, which gels milk a much lower use concentrations.

LM-pectin may, however, be preferred as gelling agent for sour milk puddings or milk desserts combined with fruit. Unlike carrageenan, LM-pectin does not co-precipitate with casein at reduced pH-values and thus ensures a reasonable shelf life of the product.

**Confectionery products**
High ester pectin is mainly used within the confectionery industry for making fruit jellies and jelly centres, flavoured with natural fruit constituents and/or synthetic flavours. In combination with whipping agents it is further used as a texturizer for aerated fruit flavoured products.

Low ester pectin not requiring addition of acid for gel formation is used for jellies and centres in which the low pH-range necessary for HM-pectin gelation is not acceptable for flavour reasons (e.g. peppermint or cinnamon flavoured jellies).

At low concentrations, LM-pectin may further impart a thixotropic texture to confectionery fillings. At higher concentrations a cold gelation can be obtained if calcium ions are allowed to diffuse into the filling.

Compared to other gelling agents commonly used for confectionery products, pectin requires strict observance of the recipe and production parameters, but offers the advantage of a very fine texture and mouthfeel, excellent flavour release and compatibility with modern continuous processing due to a fast and controllable gelation.

**PHARMACEUTICAL APPLICATIONS**
The ability of pectin to add viscosity and stabilize emulsions and suspensions is utilized in a number of liquid pharmaceutical preparations.

Pectin is further reported to possess a number of valuable biological effects - the most well-known being an anti-diarrhoea effect. Anti-diarrhoea suspensions, powders or tablets often contain a mixture of koalin, pectin and a antibiotic.

Pectin is extensively used as a component in the adhesive part of ostomy rings. In this application the water binding effect and the ability to adhere to moist surfaces are utilized. Pectin is further non-irritating in contact with the skin, and certain bactericidal and wound healing effects have even been reported.
GENU Pectins

GENU is the trademark for pectins marketed by CP Kelco ApS, founded in 1934. CP Kelco ApS is the largest, most modern and automated pectin manufacturing plant in the world today. GENU pectins are marketed in more than sixty countries.

GENU pectins have established their position as uniform gelling agents of high quality for jams, jellies and marmalades. GENU pectins are finding increasing use in particular as gelling agents, but also as viscosity builders, protective colloids and stabilizers in a number of other foods, in beverages and in pharmaceutical and cosmetic products. In the research and application laboratories of CP Kelco ApS formulations and processing methods for new and traditional food products are continuously developed and perfected.

In close contact with the industry new pectin types and production processes are further developed to meet specific demands and new technology within the market.

Customer service is considered a very important part of the activities of CP Kelco ApS. Individual technical advice is available free of charge throughout the world either by contact to our local sales representatives or directly from

CP Kelco ApS
DK-4623 Lille Skensved
Denmark

Telephone: +45 56 16 56 16
Telefax: +45 56 16 94 16

www.cpkelco.com
email: solutions@cpkelco.com

ADDITIONAL TECHNICAL LITERATURE is available, such as:

Application Guides, Confectionery, Fruit Products, Dairy Products, Bakery Products, Meat Products, Handbook for the Fruit Processing Industry, Product Information sheets, Control Methods, Purity Specifications, Safety Data Sheets, Nutritional Information, Application Notes with individual recipes suggestions