Syn allowed

NOSB NATIONAL LIST
FILE CHECKLIST

~~#6~~

PROCESSING

MATERIAL NAME: Pectin, Low-Methoxy (LM)

CATEGORY: Synthetic Allowed **Complete?:** 3/17

✓ **NOSB Database Form**

✓ **References**

MSDS (or equivalent)

✓ **FASP (FDA)**

✓ **Date file mailed out:** 2/6/95

✓ **TAP Reviews from:** Steve Harper
Richard Theuer
Mark Schwartz

✓ **Supplemental Information:**
Copenhagen Pectin: excerpts
Product Data - Genu pectin
Dictionary of Additives

High-Methoxy ("natural") non allowed

MISSING INFORMATION: no MSDS available

NOSB/NATIONAL LIST
COMMENT FORM/BALLOT

Use this page to write down comments and questions regarding the data presented in the file of this National List material. Also record your planned opinion/vote to save time at the meeting on the National List.

Name of Material Pectin, Low-methoxy

Type of Use: ____ **Crops;** ____ **Livestock;** ✓ **Processing**

TAP Review by:

1. Richard Theuer
2. Mark Schwartz
3. Steven Harper

Comments/Questions:

My Opinion/Vote is:

Signature ____________________ **Date** ____________

USDA/TAP REVIEWER COMMENT FORM

Use this page or an equivalent to write down comments and summarize your evaluation regarding the data presented in the file of this potential National List material. Attach additional sheets if you wish.

This file is due back to us within 30 days of: 6 Feb

Name of Material: Pectins

Reviewer Name: Steven Harper

Is this substance Natural or Synthetic? Explain (if appropriate)

Synthetic substance because they have been chemically modified. High-methoxy pectins are naturally derived.

Please comment on the accuracy of the information in the file:

Accurate.

This material should be added to the National List as:

X **Synthetic Allowed** ____ **Prohibited Natural**

or, ____ **This material does not belong on the National List because:**

High methoxy pectin is a naturally derived pectin and should not be on the national list.

Are there any restrictions or limitations that should be placed on this material by use or application on the National List?

The Lm pectin and amidated pectins are only needed for low solid, low calorie applications.

Any additional comments or references?

I have indicated that these pectins discussed above should be placed on the synthetic allowed listing because of their specific uses in the applications noted above. They are non-toxic and have not shown any deleterious effects.

Signature Steven Harper **Date** 3/10/95

USDA/TAP REVIEWER COMMENT FORM

Use this page or an equivalent to write down comments and summarize your evaluation regarding the data presented in the file of this potential National List material. Attach additional sheets if you wish.

This file is due back to us within 30 days of: 6 Feb

Low
Z

Name of Material: Pectins

Reviewer Name: Mark Schwartz

Is this substance Natural or Synthetic? Explain (if appropriate)

Natural

Please comment on the accuracy of the information in the file:

Accurate

This material should be added to the National List as:

_____ **Synthetic Allowed** _____ **Prohibited Natural**

or, _____ This material does not belong on the National List because:

Are there any restrictions or limitations that should be placed on this material by use or application on the National List?

No.

Any additional comments or references?

Signature Mark G Schwartz **Date** 2/24/95

USDA/TAP REVIEWER
COMMENT FORM

Original mailing date: 6 Feb 1995.

Material: Pectins, Low-methoxy (non-amidated)
Reviewer: Richard C. Theuer

SYNTHETIC Pectin, low-methoxy, is the purified material prepared from citrus peel and, to a lesser extent, from apple pomace by acidified water extraction, followed by precipitation with aluminum salts or with alcohol. The aluminum or alcohol are subsequently removed, yielding natural high-methoxy pectin. High-methoxy pectin is then partially demethylated by treatment with mild acid or alkali (other than ammonia) to form low-methoxy pectin. This last step is a synthetic process, rendering the substance synthetic.

COMMENTS RE SECTION 2119(m) CRITERIA:

1. Low-methoxy pectin is active as a gelling agent at lower soluble solid levels than high-methoxy pectin is, thus permitting creation of lower calorie preserves. It will be nearly impossible to achieve such products without low-methoxy pectin.
2. The residue from pectin extraction - peel waste - is used as cattle feed, so the manufacture of pectin, including low-methoxy pectin, is consistent with sustainable agriculture.
3. Pectins are Generally Recognized As Safe. Pectins, natural components of fruits, have been part of the human diet for millennia.

The following substances should be added to the National List of Substances as allowed synthetic ingredients in Organic Food:

low-methoxy pectins, non-amidated

23 Feb 1995

4.

USDA/TAP REVIEWER
COMMENT FORM

Original mailing date: 6 Feb 1995.

Hi

Material: Pectins, Natural (high-methoxy pectin)
Reviewer: Richard C. Theuer

NATURAL Pectin, natural high-methoxy, is the purified natural gum prepared from citrus peel and, to a lesser extent, from apple pomace. Citrus peel oils are removed by hexane extraction. The pectin is then removed by acidified water extraction, followed by precipitation with aluminum salts or with alcohol. The aluminum or alcohol are subsequently removed, yielding purified high-methoxy pectin.

COMMENTS RE SECTION 2119(m) CRITERIA:

1. Natural high-methoxy pectin forms gels only if the soluble solids level exceeds 55%. This situation would normally exist only for high-sugar jams and jellies.
2. The residue from pectin extraction - peel waste - is used as cattle feed, so the manufacture of pectin is consistent with sustainable agriculture.

The following natural substances should be allowed as ingredients in organic foods. They should not be added to the National List of natural substances prohibited for use as ingredients or processing aids in Organic Food:

natural (native) high-methoxy pectins from citrus and apple.

23 Feb 1995; modified March 12, 1995

Identification

Common Name **Pectin, Low-Methoxy (LM)** **Chemical Name**

Other Names Low-Ester Pectin; Amidated LM Pectin; Acid Demethylated LM Pectin

Code #: CAS 9000-69-5 **Code #: Other**

N. L. Category Synthetic Allowed **MSDS** ○ yes ● no

Chemistry

Family

Composition Properties Purified natural gum derived from citrus peel. Consists of partially methoxylated polygalacturonic acid. A purified carbohydrate polymer. Practically odorless, yellowish white, coarse to fine powder having a mucilagenous taste. Dissolves in water, forming an opalescent colloidal solution. Practically insoluble in alcohol. High ester pectin requires sugar to gel, while low ester (methoxy) requires calcium.

How Made Extraction from rinds of lemon, lime, grapefruit and orange is with hot water and nitric or hydrochloric acid (acid does not stay in the product). The resulting High Methoyx pectin would be considered natural. It is then demethylated by ammonia introduction under refrigeration and then dried and ground. This step involves a chemical change which would be considered synthetic. It is standardized by the addition of sucrose. Can also be made from apple pomace (by-product of juice manufacturing) and sugar beet pulp.

Use/Action

Type of Use Processing

Specific Use(s) Stabilizer and thickener; gelling agent. Used in jams & jellies with soluble solids below 55%. Also in fruit preparations for yogurt and bakery fillings. Can be used in salad dressings, malted milk beverages, and frozen fruit products.

Action Gelling agent requiring calcium ions for gel formation rather than sugar. Calcium content of fruit is normally sufficient to set an amidated LM pectin, whereas acid demethylated LM pectin requires addition of a calcium salt, such as dicalcium phophate.

Combinations Used with calcium salts.

Status

OFPA

N. L. Restriction

EPA, FDA, etc FDA-GRAS

Directions

Safety Guidelines

State Differences

Historical status Restricted by most organic certification groups: case-by-case approval.

Internationl status Allowed by EU and Codex.

NOSB Materials Database

OFPA Criteria

2119(m)1: chemical interactions **Not Applicable**

2119(m)2: toxicity & persistence **Not Applicable**

2119(m)3: manufacture & disposal consequences

No apparent consequences beyond those typical of a processing plant. Residual biomass from pectin production is useful as an animal feed.

2119(m)4: effect on human health

Generally recognized as safe in foods. Evaluated and cleared toxicologically by Joint FAO/WHO Expert Committee on Food Additives; which considers pectins and their salts to be normal constituents of the human diet. Pectins are found universally in plants.

2119(m)5: agroecosystem biology **Not Applicable**

2119(m)6: alternatives to substance

Non-LM Pectin requires over 50% sugar to gel. In products with very low solids, carrageenan or agar may be alternative.

2119(m)7: Is it compatible?

May be compatible because of its applicability to production of food products which contain reduced amounts of sugar. This is a priority in the natural food industry, although not a direct concern of organic production. (SH).

References

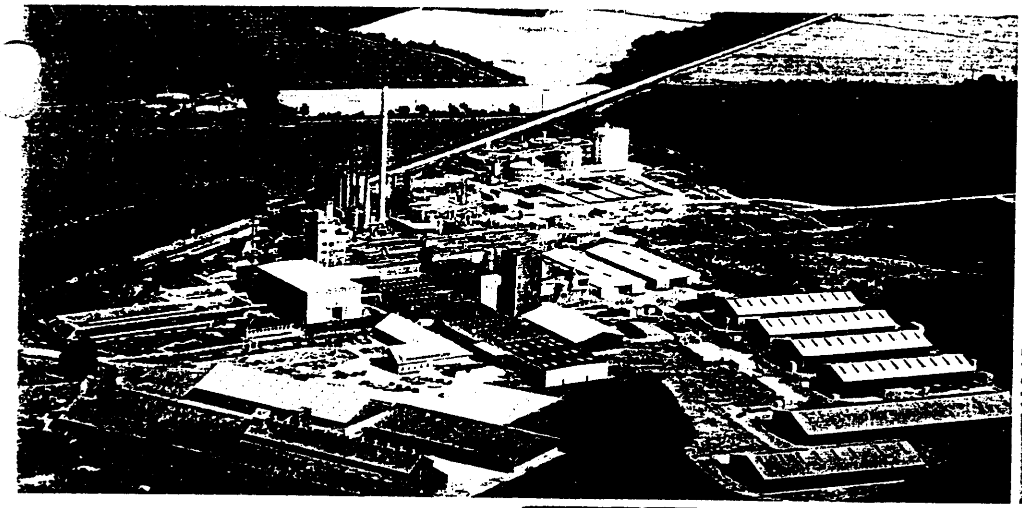
AU: Pandolf,-T.; Clydesdale,-F.M.
TI: Dietary fiber binding of bile acid through mineral supplementation.
SO: J-Food-Sci-Off-Publ-Inst-Food-Technol. Chicago, Ill. : The Institute. Sept/Oct 1992. v. 57 (5) p. 1242-1245.
CN: DNAL 389.8-F7322
AB: Iron and/or calcium were added to psyllium, guar gum, locust bean gum, citrus rag, high methoxy pectin, and low methoxy pectin. This mixture was then incubated with either cholic acid, deoxycholic acid, glycocholic acid, or taurocholic acid to evaluate the effect of minerals on fiber-bile acid binding. The addition of iron with or without calcium increased the binding of deoxycholic acid to all fibers (p less than or equal to 0.01 and p less than or equal to 0.025) except low methoxy pectin. Iron and calcium caused increased binding of high methoxy pectin to all bile acids (p less than or equal to 0.01 and p less than or equal to 0.025). Dietary fiber's ability to bind certain bile acids may be maximized through mineral supplementation.

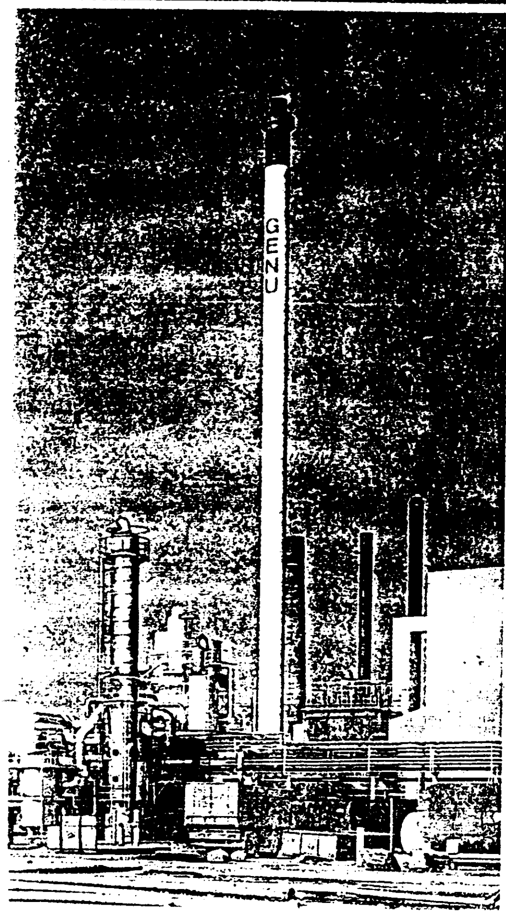
Product Data on Genu® Pectin LM 15AB (attached)

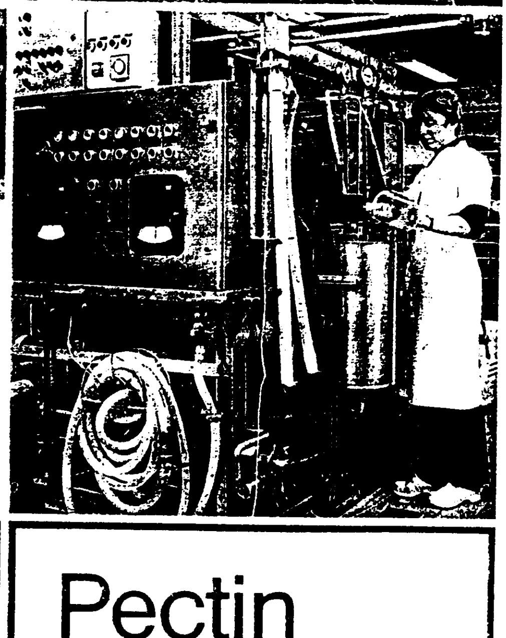
Dictionary of Additives: "Pectin" (attached)

Copenhagen Pectin: "Pectin, General Description", B 4 (attached excerpts)

Ag Partners of Davis, *Materials Report on Pectin*. 1995. Organic Trade Association, Greenfield, MA.







Pectin

General
Description

Contents

General Descriptions of Pectin

DEFINITION

Pectin is a purified carbohydrate product obtained by aqueous extraction of appropriate edible plant material - usually citrus fruit or apples.

All green land plants contain pectic 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 liniar 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 barboxyl 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

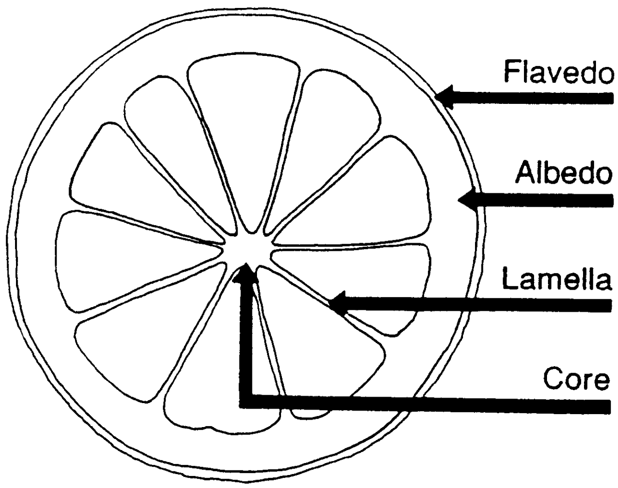
As a constituent in all land plants, pectin hasbeen part of the human diet from the origin of man. Pectin has been evaluated and cleared toxicologically by JECFA (The Joint FAO/WHO Expert Committee on Food Additives). A group ADI "not specified" was established for pectins and amidated pectins, meaning that from a 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.



Parts of the citrus fruits used in the pectin manufacture.

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.

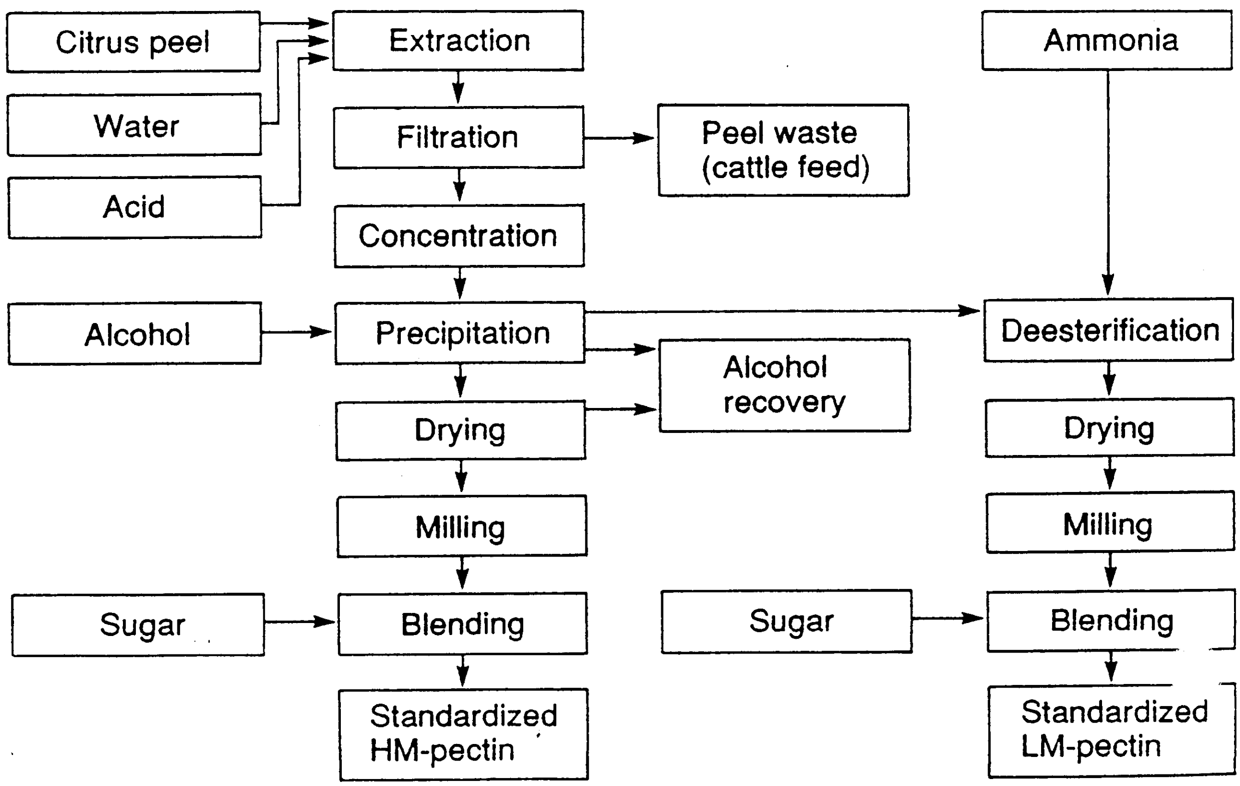
The extraction of pectin is made with hot acidified water. Quantity and quality of pectin from a specific raw material to a great extent depend on proper selection and control of extraction conditions.The extract is clarified by centrifugation and a number of filtrations, the last step being a polishing 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 dilute (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 a accumulated in the practical execution of the processes. The flow sheet below gives a general description of the process used by COPENHAGEN PECTIN A/S.

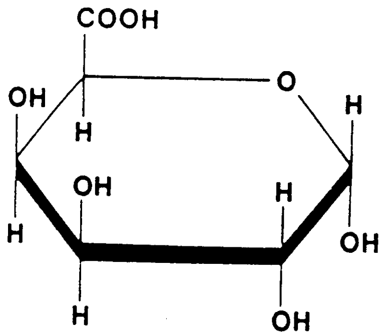


Pectin manufacture
(alcohol precipitated product)

STRUCTURE

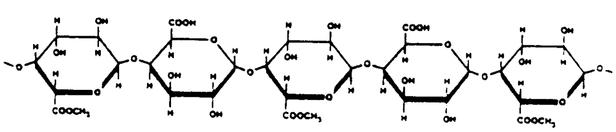
Pectin is an essentially linear polysaccharide containing from a few hundred to about 1000 saccharide units in a chain-like configuration; this corresponds to average molecular weights from about 50,000 to 150,000.

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 - 1.4 glycosidic linkages.



D-galacturonic acid

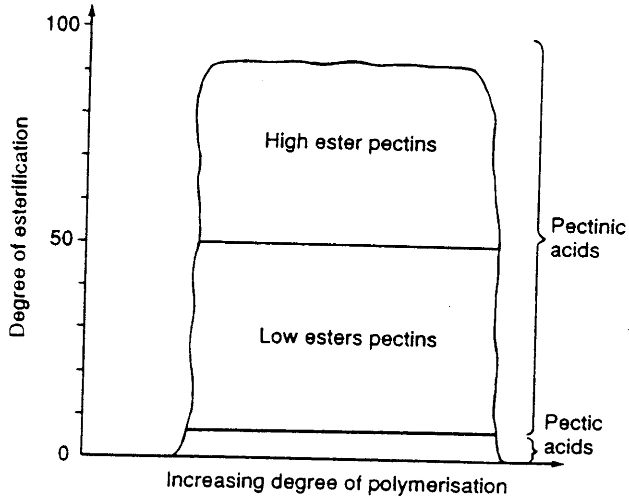
The polygalacturonic acid is partly esterified with methyl groups and the free acid groups may be partly or fully neutralized with sodium, potassium, or ammonium ions. The ratio of esterified galacturonic acid groups to total galacturonic acid groups - termed the degree of esterification (DE) - has vital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



High ester pectin
Degree of esterification (DE) = 60%

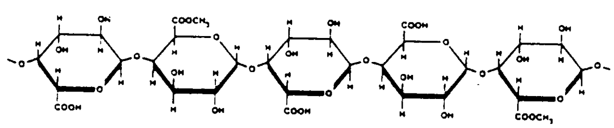
The DE of 50% divides commercial pectins into high ester (HM) and low ester (LM) pectin. These two groups of pectin gel by different mechanisms.

HM pectins 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.

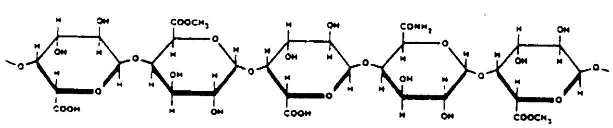


Nomenclature of pectin substances

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.



Acid Demethylated



Amidated
low ester pectin

General Properties of Pectin

SOLUBILITY

Pectin must be completely dissolved to ensure full utilization and to avoid heterogeneous gel formation. Complete dissolution presupposes 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 before 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 can 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.

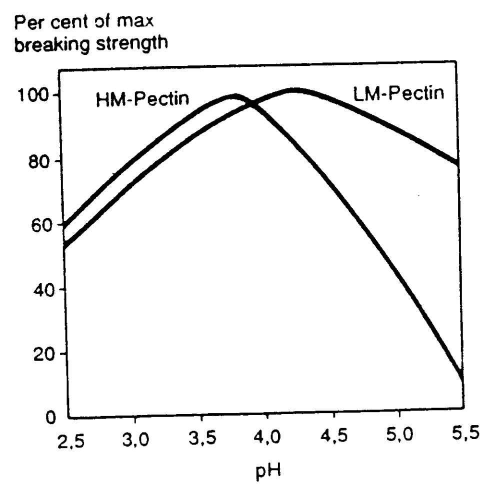
Viscosity

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. pH also influences the viscosity of pectin solutions. 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

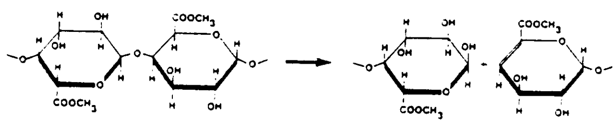
Most reactions which pectin undergoes in use tend to degrade the pectin. As a rule, maximum stability is found at pH - 4. The presence of sugar in the solution has a certain protective effect while elevated temperatures increase the rate of degradation.



Breaking strength of pectin gels as a function of previous heat treatment of the pectin (90°C, 15 minutes) at various pH-values

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 temperature (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.



β-elimination

LM-pectin shows a somewhat better stability at these conditions as illustrated in the graph page 6. At alkaline pH-values pectin is rapidly de-esterified and degraded even at room temperature.

Reactions with other electrically charged hydrocolloids

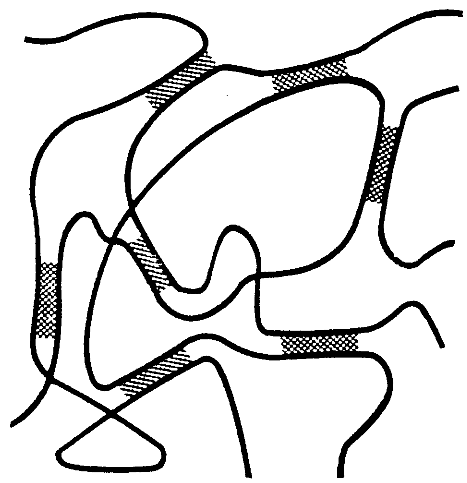
Pectin is a polygalacturonic acid and the chain molecule is negatively charged at neutral pH. The pK-value of pectin is approx. 3.5. Pectin reacts with positively charged macro-molecules, e.g. proteins at pH-values below their isoelectric pH. Pectin precipitates gelatine at low pH-values, but this reaction 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



Simplified model of the molecular network of a pectin gel. Shaded areas represent local crystallization.

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.

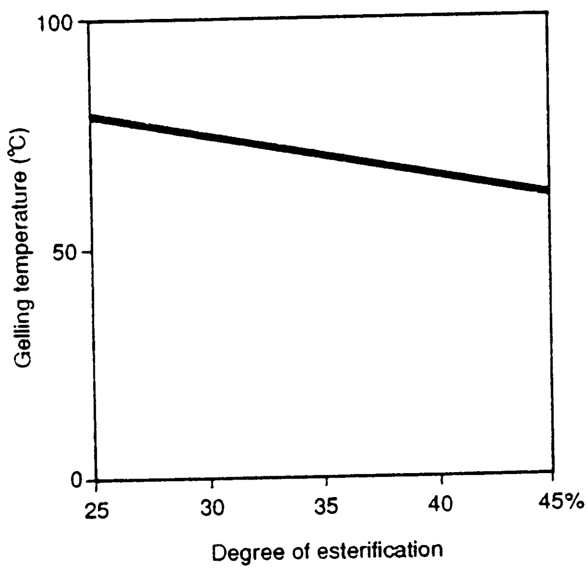
HM-Pectin type	Degree of esterifica-tion	Gelling time, when cooled to and subsequently held at			
		95° C	85° C	75° C	65° C
Rapid set	73.5	60 min.	10 min.	Pre-gel	Pre-gel
Medium set	69.5	No gel	40 min.	5 min.	Pre-gel
Slow set	64.5	No gel	No gel	No gel	30 min.

Gelation og 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.



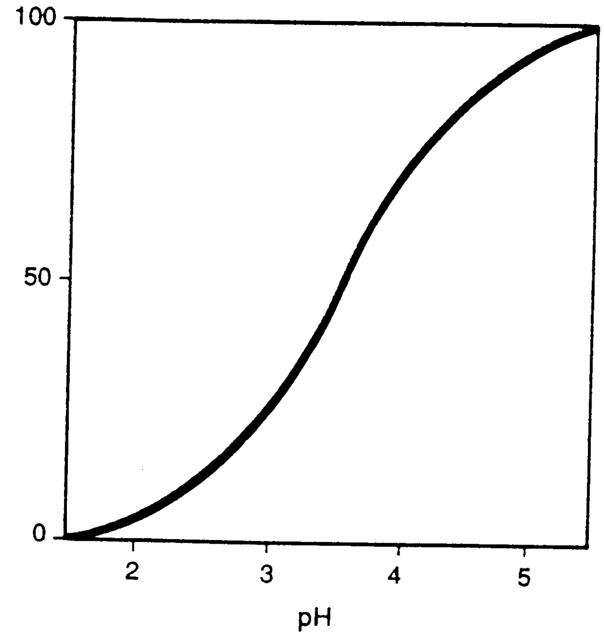
pH = 3.3 - SS = 45%
Calcium: 15 mg/g pectin, Pectin: 1%

The solubility of the calcium salt of completely deesterified 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.

pH

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



Dissociation (- charge density) of pectin at varying pH.

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 increasing 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

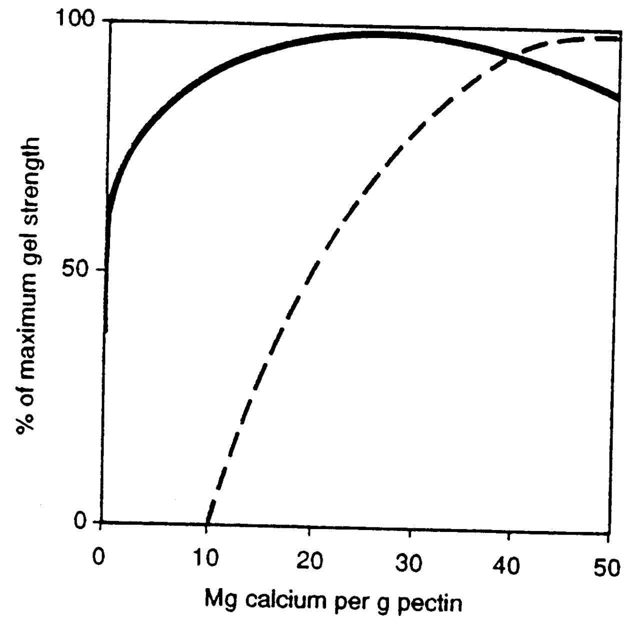
Sugar and similar solutes generally tend to dehydrate the pectin molecules in solution. At higher solids there is less water available to act as a solvent for the pectin and the tendency to crystallize or gel is consequently favoured.

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 contrast 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.



—— *Amidated LM-pectin (standardized)*
- - - *Acid demethylated LM-pectin (standardized)*

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 Al-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. Furtermore, HM-pectin is slowly de-esterified during storage, whereby e.g. rapid set pectin over a period of a year becomes a medium rapid set pectin. Degradation and de-esterification rates are more than doubled when the storage temperature is increased from 20 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 that 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 a 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 with turn 150 kg og 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

$$\frac{150 \times 100}{65} \approx 230 \text{ kg standard jelly.}$$

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 an 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 measures 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°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 (inc. supplements), or as galacturonic acid by official method of FAO Food and Nutrition Paper (FNP), 52, 1992. The metod 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.

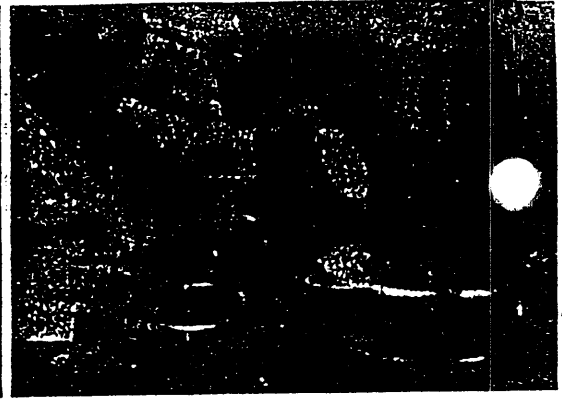
Content of heavy metals in pectin is determined by official methods as published in FCC, FAO, FNP, EEC Directive of 25th July, 1978 and USP XXII. A summary of various official purity specifications is shown in the table page 12. Microbiological quality is determined by official methods.

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 influence by degree of uniformity within and among molecules of the pectin lot.

Thus, calcium reactivity is not only controlled by proper processing conditions, 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.

PRODUCT DATA



NUMBER 901-1

Genu® Pectin
LM 15AB

LM 15AB Genu® Pectin is a purified natural gum derived from citrus peel. It consists of partially methoxylated polygalacturonic acid. A granular, free-flowing powder, it is noncaking and cream to light tan in color. Essentially flavorless, it is free from off-flavors and odors.

A low-methoxyl pectin, LM 15AB has been demethylated by ammonia and standardized by the addition of dextrose or sucrose. LM 15AB is used as a gelling agent in jams and jellies having 25 to 45% soluble solids without addition of calcium salts. LM 15AB can be used in dietetic jams and jellies having a soluble solids of 8 to 18%.

LM 15AB (REV) is used as the gelling agent in heat-reversible bakery jellies. The Grade[a] Specifications for LM 15AB (REV) are 110 ± 5; all other properties and specifications are the same as for LM 15AB.

Solubility: LM 15AB is cold-water-soluble, with optimum solubility in 25 parts of water at 70°C (158°F) with adequate agitation.

Regulatory Status: Pectin is generally recognized as safe for use in foods. Many food standards include pectin as an ingredient for its special properties. Both the *Food Chemicals Codex* and the Food and Agriculture Organization of the United Nations World Health Organization (FAO/WHO) have established specifications for identity and purity of pectin that are also met by Genu Pectin products.

Product Specifications

Grade[a]	100 ± 5[b]
pH of 1% solution in distilled water at 25°C (77°F)	3.8-4.8
Degree of esterification, %	27-33
Degree of amidation, %	20-25
Particle size on 0.25-mm test sieve, %	not more than 1
Moisture, %	not more than 12
Ash, %	not more than 7
Calcium	not more than 2 mg Ca^{++}/g pectin
Heavy metals — Arsenic (as As)	not more than 2 ppm
Lead (as Pb)	not more than 5 ppm
Total heavy metals (as Pb)	not more than 40 ppm

(a) Method: Gel power of low-ester pectin *Food Chemicals Codex*, pp. 680-1, 1972).

19.

Amidated Low-Ester Pectin; Low-Ester Pectin; High-Ester Pectin

Pectin is present in most plants, where it provides a cementlike strength to cell walls. Fruits and vegetables are highest in pectin content. The main sources for production of this substance for the food industry are citrus peels and apple pomace (the residue from apple pressings). Pectin is a complex polysaccharide, a carbohydrate that consists of a number of simple sugars and sugar-acids.

Pectin is added to foods for its gelling, thickening, and blending properties and to prevent separation of ingredients. It is useful in ice creams and ices; in processed fruits and juices; in fruit jellies, jams, and preserves; and in soft candies. The presence of sugar is usually required to make pectin gel, but its molecular structure can be altered to enable it to gel in products with low-sugar content. These are termed *low-ester pectins* (or *amidated low-ester pectins*, when ammonia is employed). *High-ester pectins* require sugar.

SAFETY: It has been estimated, based on a survey of usage by food processors in 1976 conducted by the National Academy of Sciences-National Research Council, that 23 milligrams of pectin as additives are consumed daily in the diet of an average individual in the U.S., or 0.4 milligram per kilogram of body weight (kg/bw) for a person weighing 60 kg (132 lbs.). Less than a fifth of this is low-ester pectin. The UN Joint FAO/WHO Expert Committee on Food Additives considers pectins and their salts to be normal constituents of the human diet and places a limitation on acceptable daily intake only on amidated low-ester pectin, their suggested limitation being 25 milligrams per kg/bw, or over 350 times the average consumption of all low-ester pectins.

Extensive studies of pectins have demonstrated that they are decomposed by organisms in the intestinal tract and, for the most part, are excreted in the feces. They do not appear to enter into the metabolic processes, and they are not absorbed into tissues to any extent. Thus, unlike some carbohydrates, pectins do not serve as a source for the body's energy.

Animal studies have failed to disclose adverse effects when these compounds, including amidated pectins, are fed in amounts far greater than their estimated human intake as additives. Amidated pectin administered in diets of pregnant rats did not cause birth defects in their newborn, or adversely affect maternal health, fertility, or fetuses. However, pectins have yet to be investigated as possible causes of cancer and gene mutation.

A study conducted on 24 men provided evidence that pectin can lower blood cholesterol level somewhat. Medically, it is used in combination with other ingredients for treatment of diarrhea.

ASSESSMENT: Pectin is a natural constituent in many edible plants, and, as such, is consumed in the normal diet in quantities far in excess of the amount that is added to foods. Animal feeding studies confirm that pectins do not present a hazard even in quantities far exceeding their consumption as additives by humans, and, since little if any is absorbed in the body's tissues, it appears unlikely for pectins to be of health concern.

RATING: S.

MAJOR REFERENCE: Evaluation of the health aspects of pectin and pectinates as food ingredients. FASEB/SCOGS Report 81 (NTIS PB 274-477) 1977.

CNUM=2521

U.S. FOOD AND DRUG ADMINISTRATION
FOOD ADDITIVE SAFETY PROFILE

CTIN, MODIFIED

S#:	977091874	HUMAN CONSUMPTION:	1.002824	MG/KG BW/DAY/PERSON
SP#:	2521	MARKET DISAPPEARANCE:	1183333.333	LBS/YR
PE:	EAF	MARKET SURVEY:	87	
S#:	0432	JECFA:		
MA#:		JECFA ADI:		MG/KG BW/DAY/PERSON
AS#:		JECFA ESTABLISHED:		
		LAST UPDATE:		
:		DENSITY:	LOGP:	

RUCTURE CATEGORIES: B3

MPONENTS:

NONYMS:

EMICAL FUNCTION: G

CHNICAL EFFECT: STABILIZER OR THICKENER
FIRMING AGENT
TEXTURIZER
SOLVENT OR VEHICLE
FLAVOR ENHANCER
FLAVORING AGENT OR ADJUVANT
EMULSIFIER OR EMULSIFIER SALT

R REG NUMBERS: 173.385 184.1588

NIMUM TESTING LEVEL: 3

MMENTS:

20.