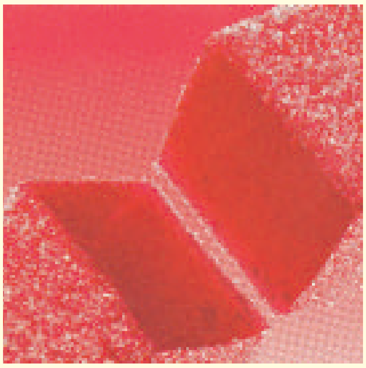


Herbstreith&Fox

Confectionery
Gum and Jelly Products

Content

Pectins for the production of confectionery

Due to their various possibilities of application and their technological advantages pectins are becoming more and more important as texturizing gelling agents and thickeners in the confectionery industry.

The confectionery sector comprises a wide range of articles which vary substantially in texture.

By far the most widespread use of pectins is in the so-called gum and jelly products, namely jelly fruits, fruit gums, pâtes de fruits and pastilles. For these applications H&F offers an assortment of standardized pectins which determine not only the intended gelling behaviour but also specific textures.

H&F Classic Pectins are also ideal for the manufacturing of products like biscuit layers, „dominos", muesli bars, Turkish delight, fillings for biscuits, chocolates and hard candies, aerated sweets like marshmallows and zefir.

Pectin based jellies for sweets can be produced very efficiently and specifically tailored to formulations and production parameters.

In contrast to other hydrocolloids, Classic Pectins are standardized to constant gelling strength, they dissolve rapidly and they are heat-resistant even with low pH-values. Classic Pectins allow sufficient time for depositing but at the same time set relatively quickly.

After a relatively short standing time the products can be processed quickly. This guarantees an optimal use of the existing production capacities.

Jellies made with Classic Pectins are furthermore distinguished by a unique texture which can be determined individually. This texture ranges from firm and elastic to smooth and viscous. Due to this texture and the neutral taste of Classic Pectins the natural fruit taste or the added flavour can come into its own.

Theoretical principles

Structure of pectin

Pectin is an important structural element of all plant cell walls. From a chemical point of view, pectin is a macromolecule comprising polygalacturonic acid as the main component. The carboxyl groups are partially esterified with methanol and the secondary alcohol groups can be partially acetylated. If the degree of esterification exceeds 50% we refer to it as high methylester pectin, whereas compounds of less than 50% are known as low methylester pectins. The pectin chains are interrupted by rhamnose and linked to neutral sugar side chains composed of arabinose, galactose and xylose. The composition however depends on the raw material.

The production of pectin

Many plant materials with a high pectin content are suitable for the production of high quality and high molecular pectins. These include apple pomace or citrus peels but also sugar beet chips.
The water insoluble protopectin present in the raw material is brought into a soluble form by mild acidic extraction. The pectin extract obtained is clarified mechanically and concentrated in a gentle process.

The concentrated liquid pectin with a high degree of esterification is processed with close observance to the pH-value and temperature.

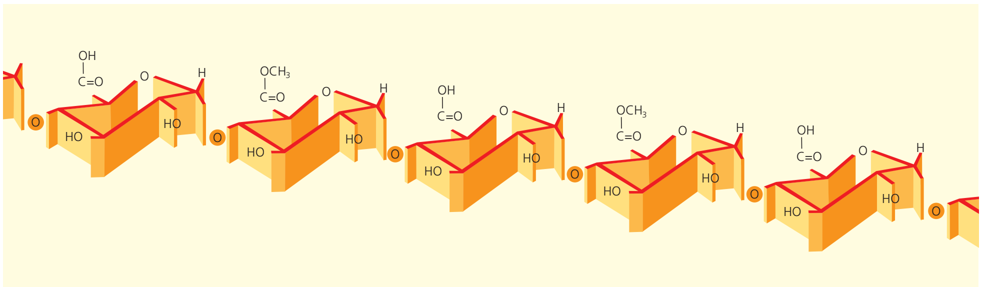
During this processing, methylester groups are continuously separating from the pectin molecule in the acidic medium. This so-called de-esterification can be controlled very precisely. If ammonia instead of acid is used for de-esterification amidated pectins will arise at which a part of the methylester groups will be replaced by amid groups.

Pectins with exactly defined degrees of esterification can be obtained by de-esterification. As soon as the desired degree of esterification is reached, the pectin is precipitated in alcohol, then pressed, gently dried, ground into a powder and blended homogeneously.

A precisely defined degree of esterification and homogeneous blending guarantee optimal processing properties

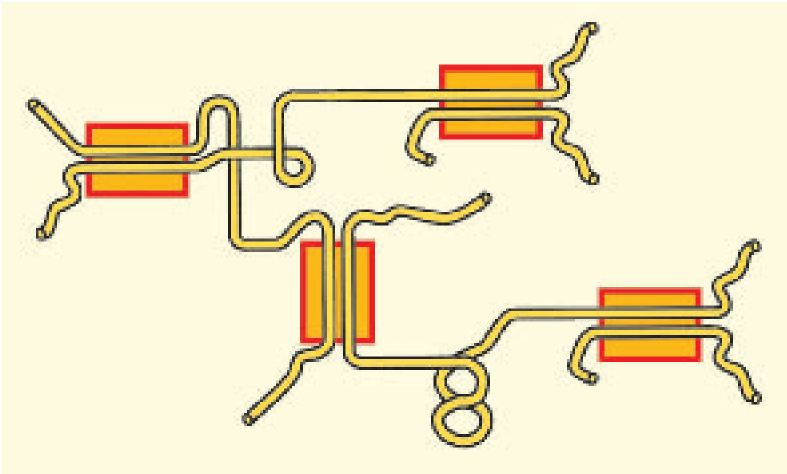
As pectins are extracted from natural plant materials in a practically unchanged form, they demonstrate different properties depending on the quality of the raw material. Therefore quality control and standardization of the pectins are very important criteria.

Pectins for use in confectionery products are standardized to constant processing properties with sugars and buffer salts, if appropriate.



Poly-D-Galacturonic acid partially esterified (pectin)

Gelling mechanisms



Bonding zones in the gel network

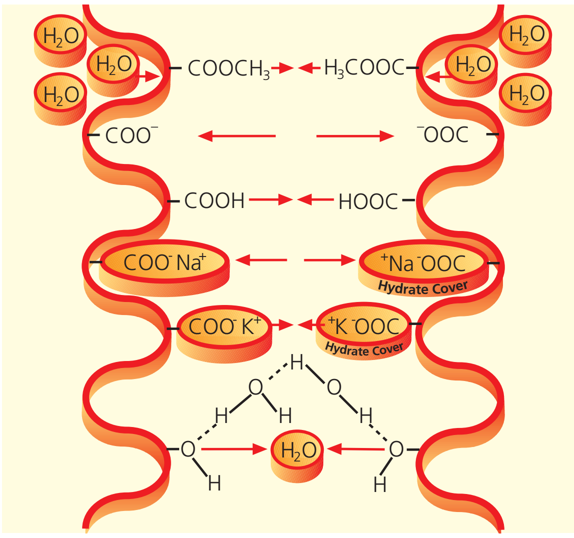
1. Gel formation of high methylester pectins

Associations of pectin chains lead to the formation of three-dimensional networks, i.e. to gel formation. Two or more chain segments bond together and start to interact, thus becoming longer segments of regular sequence, which are interrupted by rhamnose or by branching of the pectin chain. The spatial association of the chain segments to bonding zones with high methylester pectins is favoured by two decisive factors:

A. The addition of neutral sugars, e.g. sucrose, dehydrates the pectin molecules, which facilitates the approach of the polymer chains and enables the cross linkage by hydrogen bridges.

B. The lowering of the pH-value suppresses the dissociation of the free carboxyl groups thus reducing the electrostatic repulsion between the otherwise negatively charged pectin chains so that a spatial approximation becomes possible.

According to modern gelling theories, the association of high methylester pectin chains is the result of two different mechanisms.



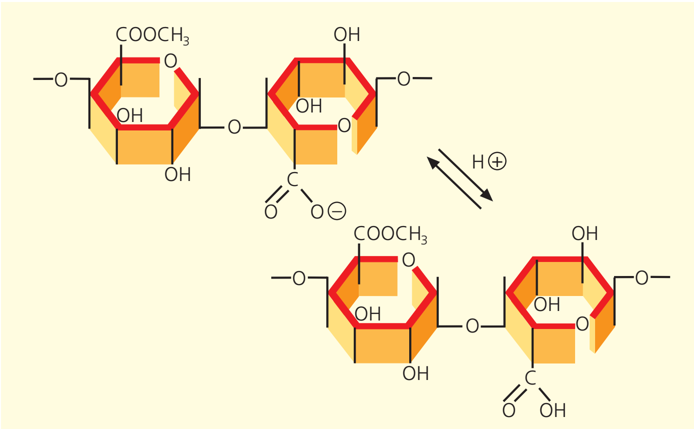
Gelling mechanisms of high methylester pectins

● In the first step, the methylester groups, the hydrophobic part of the pectin, attempt to cluster in a way that the surface of contact with water remains as small as possible. They are responsible for the first aggregation of the pectin chains and determine the setting temperature of the high methylester pectins.

Gelling mechanisms

- In the second step, hydrogen bridges are formed between the free undissociated carboxyl groups. They stabilize the aggregates formed in the clustering process of the methylester groups and hold them together. The smaller the part of dissociated carboxyl groups, that means the lower the pH-value in the system, the better the formation of hydrogen bridges.

Due to the higher amount of possible bonding sites, pectins with a high degree of esterification and a lot of hydrophobic methylester groups need less acid for the stabilization and formation of the gel network than pectins with a low degree of esterification.



Dissociation of carboxyl groups

2. Gel formation of low methylester pectins

Low methylester pectins, which are less important in the manufacture of gum and jelly products, also gel according to the mechanism described above. However, they are capable of forming a gel even relatively independently of the soluble solids content and pH-value if multivalent cations are present.

In this case, the association of pectin chains occurs by the reaction with multivalent cations, e.g. calcium ions. Due to their bent shape, they create cavities between them, which become occupied by carboxyl and hydroxyl groups. Both carboxyl and hydroxyl groups favour the association of pectin chains by calcium gelation.

3. Gel formation of high methylester, amidated pectins

In principle the gelation of high methylester, amidated pectins is also effected according to the sugar-acid-mechanism comparable to the high methylester, non-amidated pectins.

In their hydrated condition the amidated groups in the molecule lead at first to a sterical interference which means that the pectin chains cluster together under heat influence more slowly than high methylester, non-amidated pectins do. Subsequently the amidated groups contribute additionally to the stabilization of the gel net by the linkage of hydrogen bridges resulting in very firm gels with elastic-viscous gel texture.

Setting range of high methylester pectins

The gelation of high methylester pectins depends on the soluble solids content and on the pH-value of the product. Three ranges have to be differentiated:

● A range, in which gelation does not occur due to a lack of sufficient bonding sites. The gel preparation remains liquid or highly viscous.

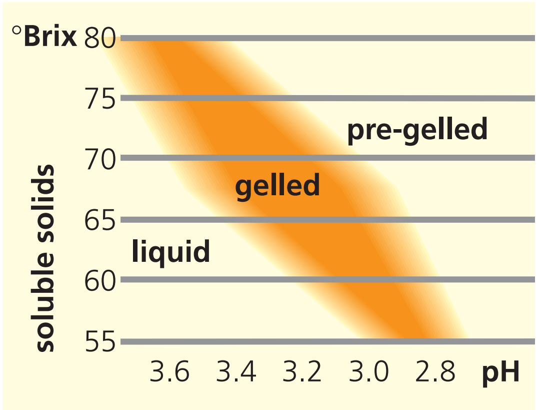
● A range, in which the pH-value and soluble solids match perfectly, resulting in well gelled products.

● A range, in which there are so many bonding sites that gelation starts at temperatures above the filling temperature. During depositing, the forming gel will be partially destroyed, which results in products with a mushy, viscous texture. This effect is called pregelation.

The figure explains that sugar and acid may substitute each other within certain limits in their contribution to gel formation. A lower sugar content requires a lower pH-value for gelation. Higher pH-values are possible when the sugar content is high.

High soluble solids contents of approx. 78%, usual in the production of gum and jelly products, require relatively high pH-values to prevent pregelation and to achieve long depositing times.

For taste reasons, a high product-pH is not desired in confectionery articles, but at the same time long depositing times are required for technological reasons. Therefore for products with a high soluble solids content a pectin with very low setting temperature with simultaneously low viscosity during the boiling process such as pectin Amid CS 005 or substances delaying gelation, so-called retarders, are used.



Setting range of high methylester pectins (modified according to Pilnik, 1980)

Retarders are buffer salts (mainly salts of the edible acids citric acid or tartaric acid) which make it possible to work at lower pH-values without any risk of pregelation.

The combination of Classic Pectins with a buffer salt (retarding agent), which lowers the setting temperature, guarantees a well defined setting temperature and setting time. They both can be tuned exactly to the production technology.

Depending on the formulation requirements, Classic Pectins are offered as standard products with or without retarding agents.

The lower limit for gelation of high methylester pectins is a soluble solids content of approx. 55%. At lower soluble solids high methylester pectins do not gel sufficiently, in this range low methylester pectins with the addition of calcium salts are used.

The special production process and the specific raw materials of the Classic Pectins allow the observance of precisely defined gelling properties.

Specific influence on texture, setting time and setting temperature

The consumer requirements of gum and jelly products vary substantially as far as texture goes. So jelly fruits are expected to have an elastic texture whereas in the case of fruit gums (e.g. gum bears) a more typically gum-like texture is required. Products like pâtes de fruits are of elastic, viscous texture.

The texture of a gel therefore contributes decisively to the sensory feeling we have when biting, chewing and swallowing.

With its Classic Apple and Citrus Pectins H&F offers solutions for every texture needed

As gum and jelly products are usually produced with very high soluble solids contents the technological advantages of pectins and their influence on setting time and setting temperature are used. This enables on the one hand a sufficiently long depositing time and on the other hand quick processing of the products.

Surface structure of gels, produced with Classic Apple Pectin (left) and Classic Citrus Pectin (right)

Changes in recipe parameters such as soluble solids content, types of sugar, pH-value, type and dosage of buffer salts etc. influence the setting time and setting temperature and with that the rheological and sensory properties of the products.

In the sensory assessment of gum and jelly products one distinguishes between consistency of the gels and the construction of the gel formation, i.e. the gel structure. In practice, both criteria have to be considered together to give an overall evaluation of the gels.

Consistency describes the density, firmness and viscosity of a sample. These properties are observed sensorily by pressing and spreading and usually defined as firmness in general. The behaviour during deformation (pressing etc.) can be determined rheologically e.g. by penetration measuring. Here a plunger is pressed into the gel at a given speed until it reaches a certain depth. The necessary strength to achieve this is measured.

Structure means formation, it describes the bonding, gel structure and homogeneity of a sample. The gel structure can be observed on the surface of a destroyed gel. Thus a rough and brittle surface points towards an inhomogeneous gel structure, whereas a smooth surface points towards a homogeneous structure.

The typical texture of citrus pectin gels is more brittle and elastic, whereas gels with apple pectin and also pectin gels produced with high methylester, amidated citrus pectins form smooth, elastic-viscous textures.

Texture and flavour

The determination of the **visco-elasticity** allows us to make a rheological statement on the gel structure. Gels are mainly elastic because of their relatively rigid gel formation. Easily shifting bonds within the gel structure will always result in a certain amount of viscous shares. The proportion of the rigid bonds to shifting bonds within the gel formation determines the gel structure. The higher the elastic shares in the gel, the more fragile and brittle the gel structure.

With increasing viscous shares in the gel, the gel structure becomes smoother. If fruit pulp is used in jelly products, less elastic gel structures develop due to the presence of fruit fibres.

Consistency and structure together make up the so-called **texture**. Texture is the overall impression of the sensory feeling and describes especially the mouthfeel of a product e.g. the softness when biting, the way it disintegrates, its delicateness and the way it sticks to the tongue while chewing.

An important aspect of the sensory properties of gels is the way in which flavour is released while eating. The texture of the sample has a great influence on the release of these substances. Smooth gels, like the ones made with Classic Apple Pectins and high methylester, amidated citrus pectins seem to be more aromatic because of their higher viscous shares than gels with lower viscous shares, since the flavour remains in the mouth for a longer period due to the better flow behaviour.

Classic Apple Pectins guarantee optimum release of flavour

Setting temperature and setting time

Knowing the setting temperature or the setting time is of great importance for the user. It tells the manufacturer how much time is available for depositing without pregelation and how fast the product will set afterwards, thus providing the guarantee for efficient processing.

This is the reason why special methods with more or less accuracy have been developed a long time ago to determine the setting temperature and time (e.g. method for determining the setting time according to Joseph & Baier, test tube method). The principle behind all of these methods is to measure the formation of elasticity during gelation, which means the transition from viscous solcondition to elastic gelcondition.

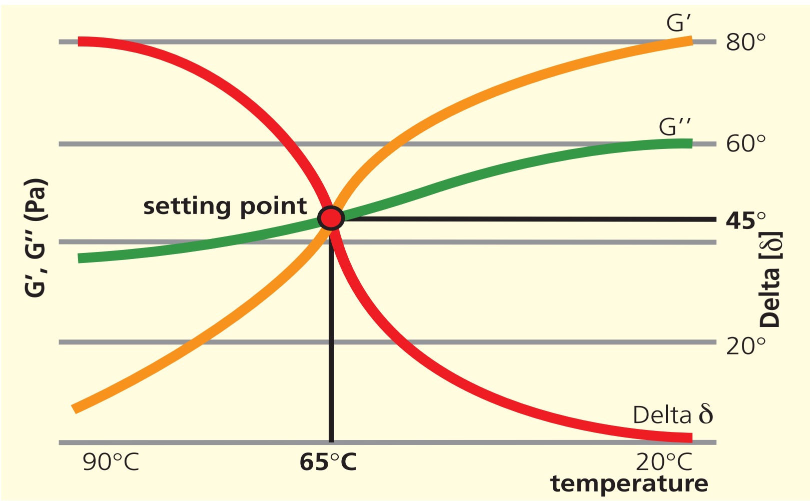
A precisely defined setting temperature promotes optimum depositing behaviour

H&F has developed a method for determining the setting temperature and setting time, in which a shear stress controlled oscillating rheometer measures the solgeltransition. The sample is deformed in the process between two parallel plates in a sinusoidal oscillation motion.

The measure yielded is likewise a sinusoidal response curve, which is time delayed depending on the viscosity of the sample. The degree for this delayed response is the so-called phase displacement angle Delta which is 90° for a completely viscous sample and 0° for a completely elastic sample.

The setting temperature or the setting time is measured exactly at the point at which the viscous (G'') and elastic (G') phases in the sample are equivalent to one another, which means measuring the sol-gel-transition (Delta = 45°). The advantage of this method is that it is an absolute measurement, which is not subject to any subjective impressions.

Setting temperature and setting time are influenced by different factors. These are, beside the time-temperature-profile during the production process, essentially the degree of esterification, the raw materials used, the soluble solids content, the types of sugar used, the product-pH-value and the concentration and type of buffer ions.



Definition setting point: G' = G''; Delta = 45°

Influence of raw material and degree of esterification (DE)

The selection and treatment of the raw material for pectin production influence, among other things, the setting time and setting temperature. Apple pomace or citrus fruit peels are primarily used as raw materials. Pectins made from apple pomace show a very regular distribution of carboxyl groups within the pectin molecule. This means for gel formation that the pectin chains are able to approach each other very homogeneously at regular distances.

Distribution of the degree of esterification is dependent on the raw material used and influences the texture of the confectionery

Pectins made from citrus peels do not show such regular distribution of carboxyl groups. The reason for this is that the enzyme pectinesterase de-esterifies a certain part of the methylester groups while still in the citrus peels.

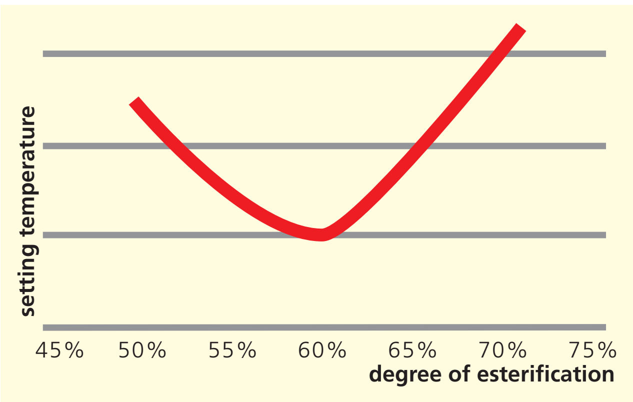
This de-esterification occurs in blocks whereby the pectin chains are able to bond together more quickly than apple pectins with the same degree of esterification. This is due to the fact that additional bonding possibilities are created by ion reactions with bivalent cations, e.g. from the water or fruit, at the sites where blockwise free carboxyl groups are present.

This means that citrus pectins have a higher setting temperature or a shorter setting time compared to apple pectins with the same DE.

The degree of esterification has a decisive influence on the clustering of the pectin chains by the formation of aggregates of the methylester groups. The higher the degree of esterification, the more methylester groups are present for aggregation. This results in a higher setting temperature, i.e. a shorter setting time.

With reduced degree of esterification the setting temperature decreases and the setting time increases. However, once the degree of esterification is lowered to a level where reactions with added cations, coming either from the fruit or from the water, have gained sufficient influence on the setting process, the setting temperature increases again and the setting time becomes shorter. The lowest setting temperature, or the longest setting time, is reached at a degree of esterification of approx. 60%.

In confectionery products, therefore, slow setting pectins with a DE around 60% are used. However, depending on the formulation it is also possible that setting will be too fast even with such pectins. Then the use of gel retarding agents, so-called retarders, becomes necessary.
The setting temperatures and viscosities in the product during the boiling process are definitely lower for high methylester, amidated pectins than for high methylester, non-amidated citrus pectins.



Dependence of the setting temperature on degree of esterification of the pectins

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Influence of buffer salts (retarders)

Depending on the requirements, sodium or potassium salts from citric acid, tartaric acid, lactic acid and phosphoric acid are used as retarders. The differences between these salts are their molecular weight, their acidity and taste.

The salts from citric acid and tartaric acid are used for their molecular size, the salts from phosphoric acid, especially longer chained phosphates, for their complexing characteristics.

	Citric acid	Tartaric acid	Lactic acid
E-number	E 330	E 334	E 270
Chemical structure	$C_6H_8O_7$	$C_4H_6O_6$	$C_3H_6O_3$
Mol-weight	192	150	90
Dissociation constant			
pka 1	3.09	2.98	3.86
pka 2	4.74	4.34	
pka 3	5.41		
pH-value (0.1n solution)	2.2	2.2	2.8

Chemical data of edible acids (Belitz, Grosch)

With the addition of these retarders the approaching of the pectin molecules during the hot phase is interfered sterically. The cations bond to the dissociated carboxyl groups, thus preventing the clustering of the pectin chains to the extent that bonding sites become impossible. The formation of the gel network is delayed in time until a new dissociation equilibrium is reached.

Furthermore, buffer salts raise the pH-value before the acid addition, thus preventing pregelation. This rise in pH-value is regulated by adding acid to the batch. The higher the buffer salt, i.e. retarder, concentration, the lower the setting temperature and the longer the setting time. If buffer salts are used to prolong the setting time or for taste reasons resulting in a clearly increasing pH-value of the product (e.g. sodium citrate, potassium citrate, phosphates), the degradation of the pectin chains by β-elimination may occur at defined buffer salt concentrations due to the rising of the pH-value under heat influence at the same time.

Retarders enable long depositing times and influence the texture of the products

Hence the final product shows a weaker gel strength. This chain degradation can be largely prevented if a certain amount of the acid necessary to adjust the desired product-pH-value is added to the product formulation at the beginning and not at the end of the cooking process.

Setting temperature and setting time as well as texture may be decisively changed by the type of buffer salt chosen. The result may be either a smooth or a brittle gel structure.

H&F offers Classic Pectins for confectionery applications which are already standardized with different buffer salts.

	Potassium citrate	Seignette salt	Sodium lactate	Sodium citrate
E-number	E 332	E 337	E 325	E 331
Gelling Temperature	+++	++	++	+
Texture	elastic-brittle	elastic-brittle	elastic with small viscous shares	elastic-viscous

Influence of pH-value

The pH-value of the product is regulated by the addition of acid and has a very strong influence on gel formation. A certain proton concentration is needed to enable gel formation.

The amount of acid depends on
- the type of pectin used
- the pectin concentration
- the soluble solids content
- the amount and type of buffer salts present

By lowering the pH-value in the medium the dissociation of the free carboxyl groups is suppressed, thus minimizing the electrostatic repulsion between the pectin chains and permitting the formation of hydrogen bridges between non-esterified carboxyl groups.

If the other formulation parameters remain unchanged but the amount of acid is increased, the setting temperature will increase and the setting time will be shorter, due to the greater aggregation tendency of the pectin chains. This will increase the risk of pregelation.

If the product-pH-value is too high, the opposite effect will occur. The setting temperature decreases, the setting time is prolonged, the risk that the product will not gel, increases.

For taste reasons a pH-value of 3.2-3.6 in the finished product is generally chosen in the manufacturing of gum and jelly products. This is the optimal pH-range for the setting of high methylester pectins with a high soluble solids content. This results in products with a firm, elastic texture.

If with this soluble solids content the pH-value is lowered below 3.0, pregelation may occur, which means gel formation starts immediately following the addition of acid. The time for depositing these products is too short and the partially formed gel is irreversibly destroyed. These gels are characterized by an inhomogeneous, weaker gelation.

A precisely regulated pH-value ensures optimum gelation and the required acidity

Glucose syrups often used

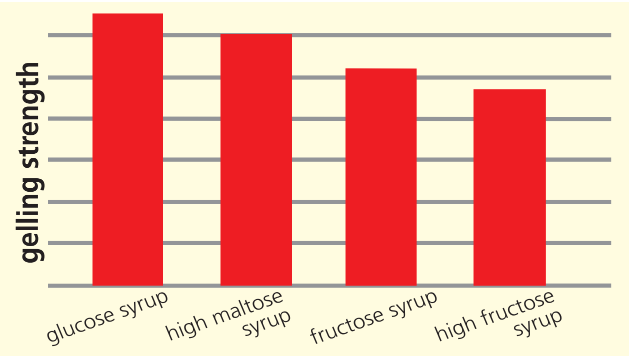
Typical composition of some glucose syrups				
Type	**Glucose syrup**	**High maltose syrup**	**Fructose syrup**	**High fructose syrup**
DE	39	44	66	82
Dextrose (%)	17	3	30	41
Fructose (%)	--	--	9	28
Maltose (%)	14	49	38	20
Maltotriose (%)	12	22	3	3
Polysaccharides (%)	57	26	20	8

Concentration and kind of soluble solids

The type of sugar and the concentration of soluble solids also influence the gelling behaviour of pectins.

With an increasing amount of soluble solids the setting temperature will also increase, i.e. the setting time of the product is reduced. The amount of elastic shares in the gel increases and the texture of the final product becomes firmer, more elastic and brittle. The reason for this is that the sugar partially dehydrates the pectin chains thus supporting their association in cluster zones.

Depending on the type of sugar and their different water activities the extent of dehydration is influenced and hence also setting temperature, setting time and firmness of the final products.



Gelling strength of a jelly fruit mass, produced with glucose syrups of different composition

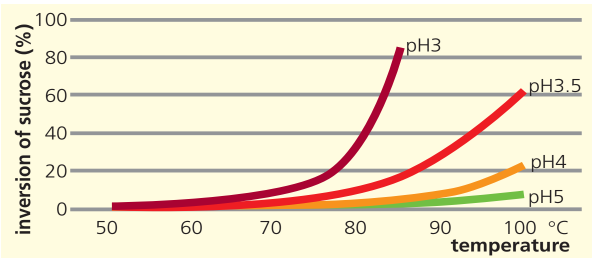
In the production of confectionery articles the soluble solids content is usually provided by sucrose and glucose syrup.

Due to its content of reducing sugars, glucose syrup is mainly used to prevent the recrystallization of sucrose. Depending on the composition of the syrup chosen, also the texture of the final products is influenced.

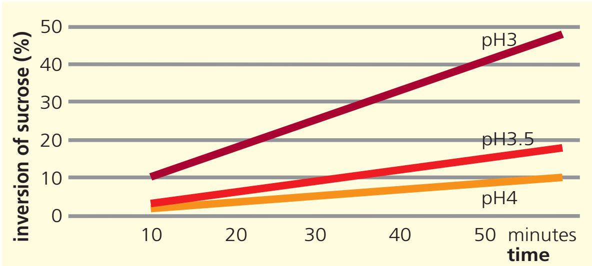
So gels produced with glucose syrup containing fructose have a lower setting temperature and longer setting time than comparable gels produced with traditional glucose syrup. The gel strength of these products is weaker and the texture of the gels is longer and more viscous compared to the elastic gels produced with glucose syrup. This can be compensated by a higher pectin dosage.

Confectionery articles produced with high-maltose glucose syrup are well depositable and show a short, elastic texture.

When sucrose is replaced by other sugars or sugar alcohols it is important to consider their different properties. A very decisive criterion is the solubility or the tendency to recrystallize. A certain amount of reducing sugars is also produced during the boiling process by inversion of sucrose. The inversion of sucrose is favoured by high temperatures and lower pH-values. A too high content of reducing sugars results in weaker gels with the tendency to wet.



Inversion of sucrose at different pH-values in dependence of temperature at constant 60min.



Inversion of sucrose at different pH-values in dependence of time at 90°C

Combination of pectin with other hydrocolloids

In practice three gelling agents in particular have proved to be useful in combination with pectin in gum and jelly products. These are gelatine, starch and agar-agar.

Combination of pectin with gelatine

Gelatine is used almost exclusively in confectionery products, in which long, tough, gum-like textures are desired. For these products a dosage of 7-10% gelatine is required to reach a sufficient firmness. In some gum products even up to 15% gelatine may be necessary to obtain the desired firmness.

When using gelatine alone, the low melting temperature of the products may prove to be a disadvantage. This may be compensated by combining it with pectin. Here a part of the gelatine is replaced by a substantially smaller amount of pectin. The products are more stable at higher temperatures, thus increasing the storage stability of the confectionery products.

Texture and chewing behaviour of the product can be regulated by the pectin/gelatine ratio. Depending on the ratio of the two gelling agents either the pectin or the gelatine has a greater influence on the texture of the gels. With increasing pectin share the texture of the gum articles becomes more elastic and brittle, with increasing gelatine share the products become more viscous.

A further positive effect of adding pectin is the reduction of the setting time compared to a pure gelatine system. With that the residence time in the mogul plant is shorter, resulting in higher production capacity.

Combination of pectin with starch

One example of a product produced using a combination of pectin and starch, are the so-called "jelly beans". The consumer expects a very special texture of this product and this is regulated with the pectin/starch ratio.

Compared with jelly products the texture is long and viscous. Alterations in consistency can be achieved by changing the pectin/starch ratio or by the choice of the pectin or starch used. When selecting the gelling agents, the manufacturers should be consulted.

Combination of pectin with agar-agar

Agar-agar is often used as the classic gelling agent in aerated confectionery products such as marshmallows. In these products a more viscous texture can be achieved by replacing the agar-agar partially or completely with pectin. This enhances the mouthfeel factor and hence provides a more distinctive flavour.

The water binding is positively influenced by pectin thus leading to better preservation and longer storage stability.

Standardization of pectins

The standardization according to the USA-Sag method is recognized as the international trading standard for pectin. A sugar-water-gel with 65% soluble solids and a pH-value of approx. 2.0 is produced and cooled under defined temperature and time conditions. The percentage of sagging of the gel under its own weight is then measured and converted into °USA-Sag. The standard gel strength is 150 °USA-Sag. However, due to the low pH-value, the method is almost useless for practical purposes.

Texture Analyzer for determination of gel strength

For pectins that are already standardized with buffer salts to a special gel texture, the determination of the gel strength according to the USA-Sag method is not at all meaningful and permits only few conclusions as to the practical applicability of the pectin.
Pectins can be evaluated more accurately using gel measurements on the basis of practical test recipes.

The gels produced in this way can be judged either by determining the breaking strength or by a penetration measurement.

When the breaking strength is measured with the Herbstreith Pektinometer, the internal gel strength of a standard gel with, e.g. 65% ss and a pH-value of 3.0 is determined by a standardized shear insert being pulled out of the gel at a defined velocity. The strength required for this action is measured by way of a strain gauge. The determination of the breaking strength is suitable e.g. for incoming goods control.

When the penetration measurement with a penetrometer or texture analyzer is used, the gel strength of e.g. a jelly fruit mass is determined by pressing a plunger into a gel at a constant velocity or over a defined distance.

The strength required to do this is measured and this is the scale for the firmness of the gel preparation.

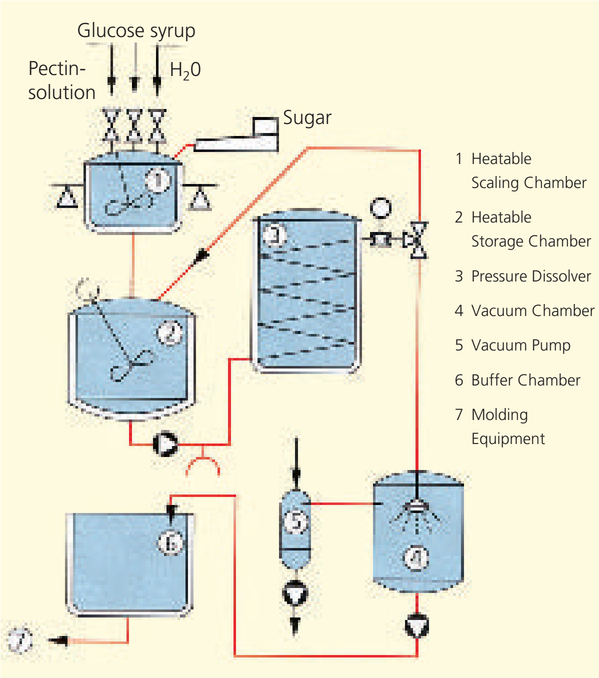
The standardization of the setting temperature is done by means of an absolute measurement using a shear stress controlled oscillating rheometer. The setting time is also often determined using the method of Joseph & Baier. In this method the gelation of a standard gel (65% ss, pH 2.2-2.4) during cooling is observed by giving special particles (e.g. bruised peppercorns) into the gel. Their movements are observed while the glass is turned and twisted. As soon as the gel preparation starts to gel and becomes elastic, the particles stop their twisting movement, and instead swing to and fro within the preparation. The time taken to reach this behaviour is measured and defined as the setting time.

The setting temperature and setting time requested by a manufacturer are the standardization criteria for H&F for Classic Pectins. The rheological measurements are complemented by texture analysis.

Production of gum and jelly products

Basically there are two different methods for the production of gum and jelly products. On the one hand gels can be produced in batches, on the other hand production can be continuous, e.g. using a pressure dissolver.

The hot gel preparation is then usually deposited in moulding starch. However it is also possible to deposit the product in metal or rubber moulds.



Cooking process

Batch production

For the batch production of jelly products the pectin is mixed with ten times the amount of powdered recipe components. Usually a part of the sugar required in the formulation is used for this purpose. If buffered pectins are used, it will not be necessary to add retarding agents. With non-buffered pectins the buffer component should be added to the pectin-sugar-mix. It is important that the pectin is distributed homogeneously in the sugar in order to prevent lumping when it is added to the product mix.

When sugar syrups or fruit juice concentrates are used, the pectin may also be suspended in ten times the amount of sugar syrup or fruit juice while being slowly stirred. In this case, however, it must be ensured that the soluble solids content in these solutions is not less than 60%, as otherwise the pectin might form lumps in the syrup and thus be prevented from dissolving completely.

The further processing of both premixtures is based on the same principle.

The recipe ingredients water, fruit juice or fruit pulp are poured into the vat and the premixture is then added while the mixture is being stirred. A separation should be prevented when using a pectin-sugar-mixture. The mixture is heated to boiling point and kept boiling until the pectin is completely dissolved. Then the remaining sugar is added. The preparation is boiled until the desired soluble solids content, which is usually 77-80%, is reached. The mixture is cooled to approx. 95°C, and the colourants, flavours and acid are added. Then the preparation is deposited quickly. Following the addition of acid, after a certain time a dissociation equilibrium is established between the added buffer salts and the edible acid. This causes a slow decrease of the pH-value. Depending on the retarding agents used, the pH-value required for the pectin gelation will be reached after different times.

Once the edible acid is added, the gelling process starts irreversibly. The mixture should now be quickly deposited into the desired mould to give sufficient time for proper setting.

If the depositing temperature drops too low or if the delay between the addition of acid and depositing the product is too long, pregelation may occur, considerably affecting the quality of the final product.

Continuous production

For the continuous production of gum and jelly products it is advisable to work with a pectin solution, not with a powder mixture, since this prevents separation and ensures a constant concentration of pectin in the final product.

As in batch production it is advisable to add the buffer substances for extending the setting time to the pectin solution. Depending on the Classic Pectin type used and the available dissolving equipment, solutions with up to 10% pectin may be produced.

In continuous production with a pressure dissolver the pectin solution is mixed with sugar, glucose syrup, water and fruit juice or fruit pulp and is then, without evaporation, heated and dissolved under a counterpressure of up to 2bar – depending on the product – while being passed continuously through the pipe coils.

Downline from the mixer is a vacuum station, where the mixture is vented. The lowering of the boiling point causes a post-evaporation effect, which cools the mass down to the depositing temperature and even generates a small increase of the soluble solids content by 2-3%, something to be kept in mind when designing the formulation.

From the vacuum station, the mass is transported without further cooling via a buffer tank to the depositing machine. The addition of acid, colourants and flavours follows in the depositing machine, preferably continuously by means of static mixers. Then the product is transported to the dosage pump.

Depositing process

Moulding starch as well as metal or rubber moulds may be used for this purpose. The moulding in starch takes place in a so-called mogul plant.

In a mogul plant starch trays are filled with starch powder and the desired jelly shape is pressed into the powder with a stamp.

This procedure provides a maximum of flexibility. Important in this depositing procedure is the optimal conditioning and the age of the starch used. A good compactness of the starch, for example, guarantees an accurate and clearly outlined imprint of the stamp.

The hot preparation is deposited into the moulds. When depositing in mogul plants, post-drying is performed with the conditioned starch and the drying chambers. This can reduce the soluble solids during depositing and enhance the castability. After the gelation process the jelly products are again separated from the starch.

To prevent a sticky surface on the jelly products, these are coated or dusted with sugar or covered with chocolate or oil.

High methylester H&F Pectins for the production of gum and jelly products

Not only the optimal pectin choice but also the selection of the appropriate retarding agent is one of the most important quality defining factors for obtaining the desired gelling properties and special gel textures.

In case of the **Classic AS 501** and **Classic CS 501 Pectins** the confectionery manufacturer himself can determine the type and amount of the retarding agent. In order to manufacture an optimal product, it is necessary to know how the selected buffer substances work and how they are dosed.

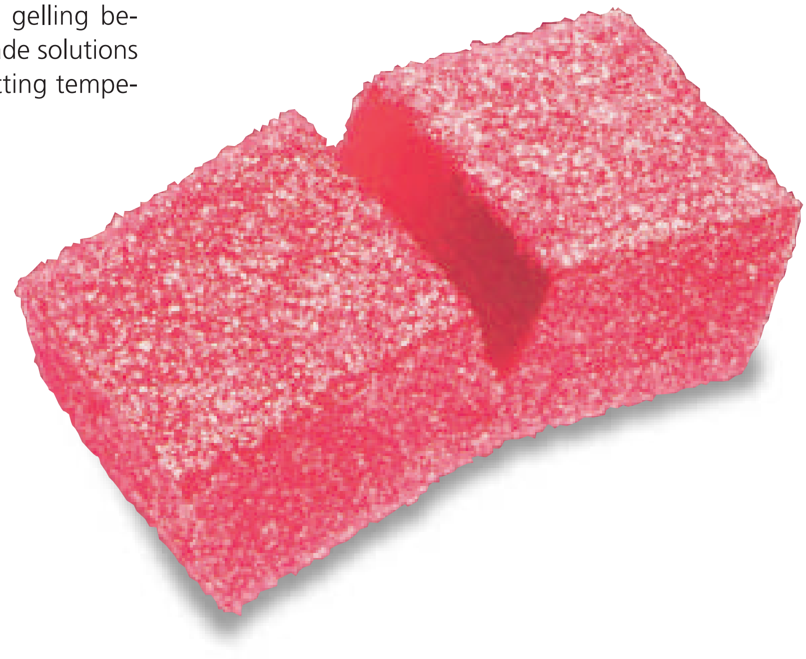
By selecting the appropriate buffer salts and dosing them correctly, the user is able to adapt the product individually to his existing technology. So these pectins are often used in combination with the retarding agent sodium citrate.

The jelly products produced in this way have an elastic-viscous texture with Pectin Classic AS 501; with Pectin Classic CS 501 the texture is elastic-brittle with a smooth, shiny cut.

Should the customer require pectins which are already standardized with a retarding agent to constant gelling behaviour, H&F offers ready-made solutions for different textures and setting temperatures.

Pectin Classic AS 502 is a buffered pectin which can be used e.g. in a standard recipe with approx. 78-83% ss and a pH-value of 3.1-3.3. The texture of the gels is elastic and viscous with a smooth cut. If gels with an elastic texture are desired, **Pectin Classic AS 507, Pectin Classic CS 502** or **Pectin Classic CS 509** may be used.

Pectin Amid CS 005 is a high methylester, amidated citrus pectin which is used in jelly fruits particularly if the production process demands a low setting temperature and a long depositing time. Therefore Pectin Amid CS 005 is specifically suited for applications with very high soluble solids contents. Pectin Amid CS 005 can be used with and also without a separate addition of buffer salts resulting in products with very acidic or with low acidic taste. The texture of the gels produced with Pectin Amid CS 005 is elastic-viscous with very smooth fractured surface.



Individuality is our strength

Pectins by H&F have enjoyed a worldwide reputation for many decades. Advanced production methods and reliable high quality standards have decisively contributed to our present success in the world market. This development has always been characterized by innovative thinking and farsighted research.

Today, we are in a position to offer pectins which can be used in all imaginable areas of application. Consistent production and quality controls together with state-of-the-art analytical instruments guarantee the constantly high quality of our pectins.

Not only the challenges with which our staff in research and development regularly confront themselves but also the great variety of requirements brought to us by our customers contribute to this positive and continuous progress.

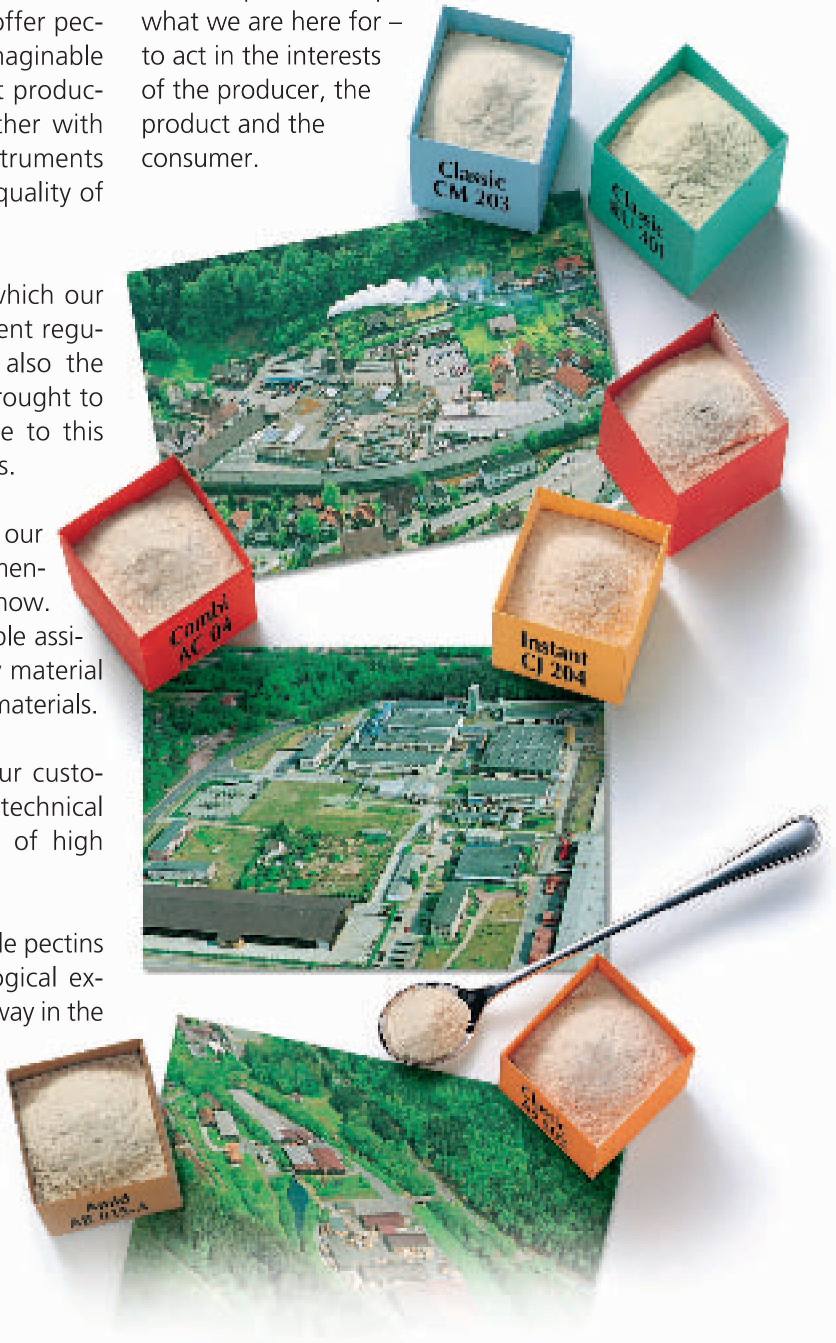
This successful cooperation with our customers is, of course, complemented by the transfer of our know-how. Our analysis can give you valuable assistance even at the stage of raw material assessment and control of raw materials.

Furthermore, we also supply our customers with formulations and technical solutions for the manufacture of high quality confectionery.

For this purpose the most suitable pectins are integrated by our technological experts in the most advantageous way in the composition and optimisation of formulations.

Also the analysis of your final products contributes successfully to assuring a high and consistent quality and even provides input on potential improvements to your final products.

New and promising product ideas should not be allowed to fail because of formulation or production problems. This is what we are here for – to act in the interests of the producer, the product and the consumer.



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Recipe

Product	**Jelly fruit (Pectin Classic AS 501)**

	13g	pectin (= 1.3%)
	500g	sucrose, crystalline
	330g	glucose syrup (C*Sweet M 01535, company Cerestar)
	220g	water
		colour, flavour
	3.3g	tri sodium citrate x $2H_2O$
approx.	15ml	citric acid solution 50% (to adjust the pH-value)

Input:	approx. 1080g	Output:	approx. 1000g
SS:	approx. 78%	pH value:	approx. 3.2-3.4

Manufacturing

A Mix pectin and sodium citrate with approx. 100g sucrose (taken from the total amount).
B Stir mixture A into the water and boil while stirring until the pectin is completely dissolved.
C Add the remaining sucrose and the glucose syrup and cook to final soluble solids.
D Add colour and flavour.
E Add citric acid solution to adjust the pH-value.
F Depositing temperature approx. 95°C.

Jelly fruits with Pectin Classic AS 501

Jelly fruits with Pectin Classic AS 501 produced on the basis of this recipe have an elastic-viscous texture with a smooth cut.

Herbstreith & Fox KG

Recipe

Product	**Jelly fruit (Pectin Classic CS 501)**

13g	pectin (= 1.3%)
500g	sucrose, crystalline
330g	glucose syrup (C*Sweet M 01535, company Cerestar)
220g	water
	colour, flavour
2.5g	tri sodium citrate x $2H_2O$
approx. 11ml	citric acid solution 50% (to adjust the pH-value)

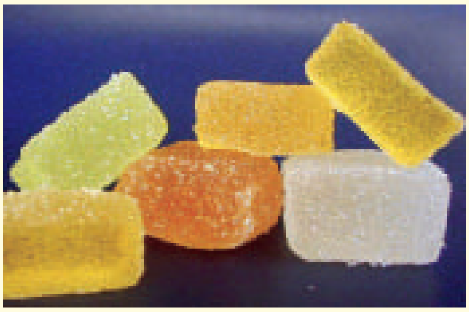
Input:	approx. 1080g	Output:	approx. 1000g
SS:	approx. 78%	pH value:	approx. 3.2-3.4

Manufacturing

A Mix pectin and sodium citrate with approx. 100g sucrose (taken from the total amount).
B Stir mixture A into the water and boil while stirring until the pectin is completely dissolved.
C Add the remaining sucrose and the glucose syrup and cook to final soluble solids.
D Add colour and flavour.
E Add citric acid solution to adjust the pH-value.
F Depositing temperature approx. 95°C.

Jelly fruits with Pectin Classic CS 501

Jelly fruits with Pectin Classic CS 501 produced on the basis of this recipe have an elastic-brittle texture with a smooth cut.



Herbstreith & Fox KG

Recipe

Product	**Jelly fruit (Pectin Amid CS 005)**

15g	pectin (= 1.5%)
500g	sucrose, crystalline
330g	glucose syrup (C*Sweet M 01535, company Cerestar)
220g	water
	colour, flavour
4.5ml	citric acid solution 50% (to adjust the pH-value)

Input:	approx. 1070g	Output:	approx. 1000g
SS:	approx. 78%	pH-value:	approx. 3.2-3.4

Manufacturing

A Mix pectin with approx. 100g sucrose (taken from the total amount).
B Stir mixture A into the water and boil while stirring until the pectin is completely dissolved.
C Add the remaining sucrose and glucose syrup and cook to final soluble solids.
D Add colour and flavour.
E Add citric acid solution to adjust the pH-value.
F Depositing temperature approx. 80°C - 95°C.

Jelly fruit with low acidic taste with Pectin Amid CS 005

Jelly fruit masses produced with Pectin Amid CS 005 show a low setting temperature and sufficently long depositing times also without separate addition of retarders. The jelly fruits are furthermore characterized by a very smooth and firm gel texture.

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Recipe

Product	Pectin Bears (Pectin Classic AS 507)

25g	pectin (= 2.5%)
320g	sucrose, crystalline
50g	fructose, crystalline
475g	glucose fructose syrup (C*TruSweet 01732, company Cerestar)
200g	water
	colour, flavour
2g	tri sodium citrate x $2H_2O$
approx. 15ml	citric acid solution 50% (to adjust the pH-value)

Input:	approx. 1090g	Output:	approx. 1000g
SS:	approx. 78%	pH value:	approx. 3.4-3.5

Manufacturing

A Mix pectin and sodium citrate with approx. 100g sucrose (taken from the total amount).

B Stir mixture A into the water and boil while stirring until the pectin is completely dissolved.

C Add the remaining sucrose, fructose and the glucose syrup and cook to final soluble solids.

D Add colour and flavour.

E Add citric acid solution to adjust the pH-value.

F Depositing temperature approx. 95°C.

Pectin bears with Pectin Classic AS 507

Pectin bears with Pectin Classic AS 507 produced on the basis of this recipe can, on the one hand, be deposited sufficiently long. On the other hand they can be taken out of the form after a relatively short time. The products have a firm, gum-like elastic texture.

Herbstreith & Fox KG

Recipe

Product	Pectin pastilles (Pectin Classic CS 502)

40g	pectin (= 4.0%)
360g	sucrose, crystalline
475g	glucose fructose syrup (C*TruSweet 01732, company Cerestar)
200g	water
	colour, flavour
2g	tri sodium citrate x $2H_2O$
approx. 17ml	citric acid solution 50% (to adjust the pH-value)

Input:	approx. 1090g	Output:	approx. 1000g
SS:	approx. 78%	pH-value:	approx. 3.4-3.5

Manufacturing

A Mix pectin and sodium citrate with approx. 100g sucrose (taken from the total amount).
B Stir mixture A into the water and boil while stirring until the pectin is completely dissolved.
C Add the remaining sucrose and the glucose syrup and cook to final soluble solids.
D Add colour and flavour.
E Add citric acid solution to adjust the pH-value.
F Depositing temperature approx. 95°C.

Pectin pastilles with Pectin Classic CS 502

Pectin pastilles produced on the basis of this recipe can, on the one hand, be deposited sufficiently long. On the other hand they can be taken out of the form after a relatively short time. The products have a very firm, elastic texture.

Herbstreith & Fox KG

Recipe

Product	Jelly fruit with fruit pulp (Pectin Classic AS 502)

13g	pectin (= 1.3%)
200g	fruit pulp
480g	sucrose, crystalline
320g	glucose syrup (C*Sweet M 01535, company Cerestar)
approx. 10ml	citric acid solution 50% (to adjust the pH-value)

Input:	approx. 1030g	Output:	approx. 1000g
SS:	approx. 78%	pH-value:	approx. 3.2-3.4

Manufacturing

A Mix pectin and approx. 100g sucrose (taken from the total amount).
B Stir mixture A into the fruit pulp and boil while stirring until the pectin is completely dissolved.
C Add the remaining sucrose and the glucose syrup and cook to final soluble solids.
D Add citric acid solution to adjust the pH-value.
E Depositing temperature approx. 95°C.

Jelly fruit containing fruit pulp with Pectin Classic AS 502

In this recipe no retarding agent needs to be added. Due to the fruit pulp added, the texture of the final product is not comparable to the texture of the preceding recipes.
The fruit fibres make the product less elastic.
The fruit pulp can be substituted by fruit juice with appropriate adjustment of the pectin dosage.

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Recipe

Product	**Fruit gums (Pectin Classic AS 502)**

7g	pectin (= 0.7%)
330g	sucrose, crystalline
480g	glucose syrup (C*Sweet M 01535, company Cerestar)
200g	water I
120g	water II
50g	gelatine, 240° bloom (= 5.0%)
	colour, flavour
approx. 25ml	citric acid solution 50% (to adjust the pH-value)

Input:	approx. 1210g	Output:	approx. 1000g
SS:	approx. 78%	pH-value:	approx. 3.2-3.4

Manufacturing

A Let the gelatine swell in water II and dissolve in the waterbath.
B Mix the pectin with approx. 100g sucrose (taken from the total amount).
C Stir mixture B into water I and boil while stirring until the pectin is completely dissolved.
D Add the remaining sucrose and the glucose syrup and cook to final soluble solids of approx. 86% ss and cool to approx. 95°C.
E Stir the dissolved gelatine (approx. 80°C) into the cooled formulation.
F Add colour and flavour.
G Add citric acid solution to adjust the pH-value.
H Depositing temperature approx. 85°C.

Fruit gums: Combination Pectin Classic AS 502 / gelatine

The fruit gums with a combination of Pectin Classic AS 502 and gelatine produced on the basis of this recipe have a firm, long texture typical of gum bears and wine gums. The texture can be regulated with the pectin/gelatine ratio.

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Recipe

Product	**Jelly layer for bakery products (Pectin Classic AS 501)**

170g	pectin solution 5% (= 0.85%)
25g	orange juice concentrate, approx. 65% ss
340g	sucrose, crystalline
470g	glucose fructose syrup (C*TruSweet 01732, company Cerestar)
50g	water
3g	tri-sodium citrate x $2H_2O$

Input:	approx. 1060g	Output:	approx. 1000g
SS:	approx. 75%	pH-value:	approx. 4.0 in semi-finished/ 3.0 in final product

Manufacturing of the semi-finished product

A For details on manufacturing the pectin solution see "Technical Application Information".

B Mix the fruit juice concentrate, sucrose, glucose syrup, water and sodium citrate and heat to approx. 90°C.

C Add the hot pectin solution and cook to final soluble solids.

D Cool down the mass and pour off.

Manufacturing of the final product

Heat the cold semi-finished product to min. 80°C. Add 15ml citric acid solution per 1000g semi-finished product and mix well. Process the preparation quickly as the gelation is initiated irreversibly after the addition of acid.

Jelly fruit layer for biscuits with chocolate cover using Pectin Classic AS 501

A gel preparation with Pectin Classic AS 501 produced on the basis of this recipe results in a viscous, well processable semi-finished product which can be deposited sufficiently long after the addition of acid at approx. 80°C, which however also sets relatively quickly resulting in a product with elastic texture.

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Recipe

Product	**Aerated product zefir (Pectin Classic AS 401)**

12g	pectin (=1.2%)
200g	apple pulp (10% ss)
670g	sucrose, crystalline
140g	glucose syrup (C*Sweet M 01535, company Cerestar)
70g	egg white solution, approx. 12% ss
50g	water
3g	tri-sodium citrate x $2H_2O$
	colour, flavour
10ml	citric acid solution 50% (to adjust the pH-value)

Input: approx. 1155g (= 72% ss),
Output: approx. 1000g (= 82% ss) pH-value: 3.5-3.8

Manufacturing

A Mix the pectin with 50g sucrose (taken from the total amount) and sodium citrate.
B Stir mixture A into the apple pulp and let it swell overnight.
C Mix the egg white solution with 270g sucrose (taken from the total amount).
D Heat the sugar solution (350g sucrose, 140g glucose syrup and 50g water). For a better solubility of the sugar more water can be added. The mass must be boiled until 540g (= 85% ss) is reached.
E Mix mixtures B and C and aerate cold.
F Add the hot sugar solution to the aerated mass while stirring.
G Add colour and flavour.
H Add the citric acid solution while stirring.
I Form the mass at approx. 55°C and dry on soluble solids of 82%.

Zefir with Pectin Classic AS 401

Zefir is an East European aerated confectionery product which is traditionally produced with pectin. The pectin here acts as a foam stabilizer and provides the required overrun. Often apple pulp is used in the recipe, resulting in a fruity, slightly sour egg white foam.

H&F Pectins for confectionery

Pectin	DE°	A°	Standardization with neutral sugars + composition	Charact. + properties of the manufactured confectionery products	Main application
Classic AS 401	61-64%	–	150±5°USA-Sag const. breaking strength constant setting time E 440	**apple pectin,** medium rapid set, addition of buffer salts usually necessary	jelly fruits, jelly fillings, aerated products (SS 68-80%, pH 2.8-3.4)
Classic AS 501	56-60%	–	150±5°USA-Sag const. breaking strength constant setting time E 440	**apple pectin,** slow set, addition of buffer salts usually necessary	jelly fruits, jelly fillings, jelly layers, aerated products (SS 68-80%, pH 2.8-3.4)
Classic AS 502	56-60%	–	const. gelling strength constant setting temperature E 440, E 331	**apple pectin,** slow set, elastic-viscous texture smooth cut	jelly fruits, jelly fillings, jelly layers, jelly fruits with fruit pulp, aerated jelly fruits (SS 68-80%, pH 2.8-3.4)
Classic AS 507	58-65%	–	const. gelling strength constant setting temperature E 440, E 337, E452	**apple pectin,** medium set, firm, short, elastic texture, smooth cut	jelly fruits, jelly fillings, pastilles, gum articles (SS 68-80%, pH 2.8-3.4)
Classic AS 509	56-62%	–	const. gelling strength constant setting temperature E 440, E 337, E 331	**apple pectin,** extra slow set, tender texture, smooth, shiny cut	jelly fruits, jelly fillings, gum products (SS 68-80%, pH 2.8-3.4)
Classic CS 401	61-65%	–	150±5°USA-Sag const. breaking strength constant setting time E 440	**citrus pectin,** medium set, addition of buffer salts usually necessary	jelly fruits, jelly fillings (SS 68-80%, pH 3.0-3.6)
Classic CS 501	56-62%	–	150±5°USA-Sag const. breaking strength constant setting time E 440	**citrus pectin,** slow set, addition of buffer salts usually necessary	jelly fruits, jelly fillings, jelly layers (SS 68-80%, pH 3.0-3.6)
Classic CS 502	58-64%	–	const. gelling strength constant setting temperature E 440, E 337, E 452	**citrus pectin,** medium set, firm elastic-brittle texture, smooth cut	jelly fruits, jelly fillings, pastilles, gum products (SS 68-80%, pH 3.0-3.6)
Classic CS 509	56-63%	–	const. gelling strength constant setting temperature E 440, E 337, E 452	**citrus pectin,** extra slow set, tender elastic-brittle texture, smooth cut	jelly fruits, jelly fillings, gum products (SS 68-80%, pH 3.0-3.6)
Classic CS 510	58-64%	–	const. gelling strength constant setting temperature E 440, E 337, E 452	**citrus pectin,** slow set, medium firm, elastic texture, smooth cut	jelly fruits, jelly fillings, gum products (SS 68-80%, pH 3.0-3.6)
Amid CS 005	51-59%	4-9%	const. gelling strength constant setting time E 440	**amidated citrus pectin,** extra slow set, addition of buffer salts not necessary, long depositing time, suitable for high SS contents	jelly fruits, gum products, pastilles (SS 68-85%, pH 2.8-3.6)

Revised: July 2004 *DE° = Degree of esterification* *A° = Degree of amidation*

Herbstreith&Fox

Company Group

Herbstreith & Fox KG · Turnstraße 37 · 75305 Neuenbürg/Württ. · Germany
Phone: +49 (0) 7082 7913-0 · Fax: +49 (0) 7082 202 81
e-mail: info@herbstreith-fox.de · Internet: www.herbstreith-fox.com

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