

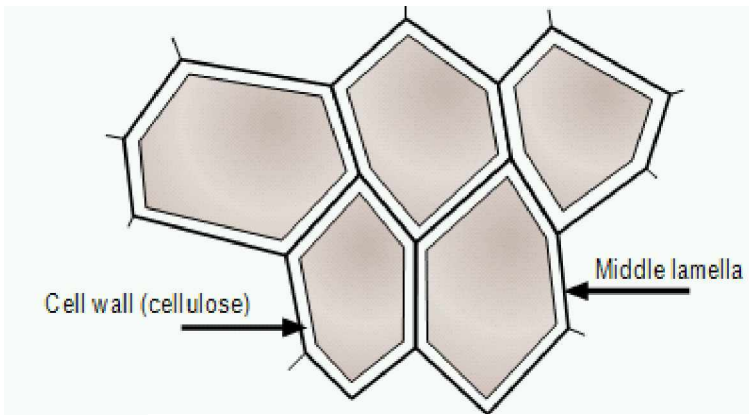
## G2. An introduction to pectin

Answers to questions on Pupil activity sheet G2:

Some can be found in the text, others require research.

1. poly = many, saccharide = sugar units; a polysaccharide is a long chain carbohydrate, i.e. it consists of many sugar units joined together. Other well known plant polysaccharides are cellulose and starch.

2.



3. Cellulose

4. As fruit ripens, enzymes begin to break down the pectin; less pectin will result in a poorer set to the jam. Jam made from very ripe fruit will be difficult to set.
5. This will vary; an example is included on a separate sheet.
6. *Filtration* - the separation of insoluble/suspended solids from a solvent/liquid/solution by means of some sort of 'sieve', e.g. filter paper, strainer.

*Evaporation* - heating a solution/liquid to remove some or all of the solvent/water by turning it into a vapour/gas so as to leave a more concentrated solution or a solid.

*Distillation* - a method of separating a mixture of liquids with different boiling points; liquids within boiling ranges are collected separately; the mixture is heated to a specific temperature so that one of the liquids boils and changes to a vapour/gas; the gas is then cooled so that it condenses, returns to a liquid and can be collected.

*Precipitation* - exemplified by the mixing of two solutions so that a reaction takes place which produces an insoluble substance which will sink to the bottom of the reaction vessel.

7. 'Commercially viable' - capable of producing an actual, useful, practicable product at a profit
8. Small quantities of other fruits, such as blackcurrants, can be added to supplement the pectin (and acid) present in the

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*Timing* - an extension exercise with some revision points; suitable as a homework

Two pupil activity sheets G2 accompany this activity.

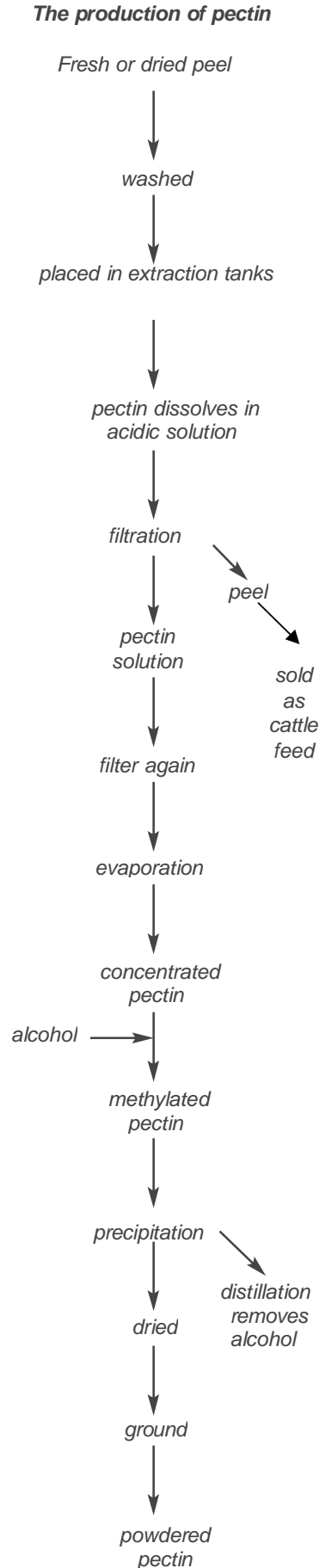
9. Powdered pectin is extremely difficult to dissolve in ordinary circumstances (last paragraph). If powdered pectin is available this could be demonstrated. It would be virtually impossible to successfully use the lumpy, very viscous mass that is produced. Pectin is very **hydrophilic** and is therefore water soluble but its affinity for water means that unless high speed mixing (high shear mixing) and increased temperatures are used it is difficult for it to fully hydrate without the formation of lumps.
10. Pectin in a liquid state has had a quantity of water added to it. This greatly increases its mass and bulk compared to the powdered pectin alone. In the quantities used by industry this would increase transportation, storage and handling costs. This is particularly important when considering goods which are to be exported.

There are other less obvious reasons as to why pectin, as a powder, is used in industry. Many more types of pectin can be produced in powdered form. Different products require pectin with different properties. For example, jams with large pieces of solid require a very quick setting pectin to ensure that the fruit pieces do not all sink to the bottom before the jam has set. Other products, which may be needed to be packed in very large quantities, require a slower set to prevent the jam setting whilst still in the machinery.

The quality of performance for an industrial operation is much better when using powder rather than a liquid.

Less powder needs to be used compared to liquid.

Since the powdered form contains no water there is no need to preserve it in any other way.

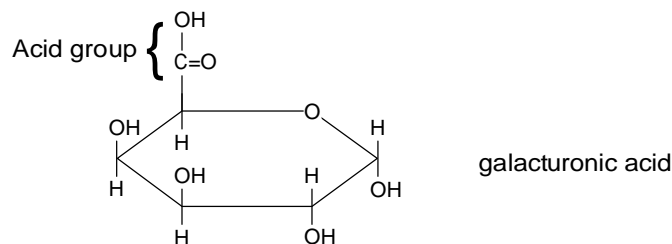


Pectin is used to produce a wide range of preserves, jams, jellies and spreads, that is those sweet, fruit products which need to set. Some of these products are made in the home as well as on a commercial basis.

Pectin is not a single substance. The word describes a group of **polysaccharides** which are present in the cell walls, particularly near the middle lamella, of most land plants. In the intact plant, pectin is a very large molecule and is not soluble in water. Although its distribution among plants is widespread, there are only a few commercially viable sources from which pectin can be extracted. These are from the peel of citrus fruits and apple pomace (this is a pulpy residue from apples which have been pressed for cider making). Both of these sources are leftovers from the fruit juice industry.

Ripe fruit is used in the fruit juice industry. However, when ripening begins, enzymes in the fruit begin to break down pectin and it becomes soluble. This process decreases the quantity and quality of pectin obtainable from the fruit. Therefore, it is important for the pectin manufacturer to process the fruit obtained from the fruit juice industry as quickly as possible.

Like all natural materials, the molecules of pectin, within the same plant and between different plants, vary considerably. The major constituent of pectin is galacturonic acid.



Several hundred of these units are linked together to form a long chained molecule of polygalacturonic acid. A certain number of the acid groups,  $-\text{COOH}$ , are methylated, i.e. contain a methyl group,  $-\text{CH}_3$ . It is the number of these methyl groups which strongly influences the performance of the pectin in practical situations.

### The production of pectin

Fresh or dried fruit peel is washed with water. It is then put into a series of extraction tanks. The conditions inside the tanks are carefully controlled with respect to acidity and temperature. The peel softens and swells due to the break down of the cell walls. The pectin is released and dissolves into the acidic solution. The peel is separated from the pectin extract by filtration. It is washed and sold as cattle feed.

The solution of pectin is filtered again in a special way to make a clearer solution. Some of the liquid is then evaporated so that the product is more concentrated. To produce a pectin with many methyl groups attached, the pectin liquid passes into the precipitation stage. In this, the pectin extract is mixed with alcohol. Pectin is insoluble in alcohol and so is precipitated. The alcohol is then recovered by distillation. Following precipitation, the pectin is dried and then ground or milled to a powder before the final stage of blending.

## The use of pectin

Long before the development of chemical preservatives and the invention of the refrigerator, we had been using high concentrations of sugar to improve the keeping qualities of seasonal fruits. The boiling of fruit with added sugar forms the basis of all commercial jam making. This type of industry can be found in nearly every country in the world.

Home-made jam and marmalade making is still quite popular despite the readily available products from the supermarket shelves. As any home jam maker will tell you, it is easier to make jams and marmalades from fruits such as blackcurrants, damsons, gooseberries, plums, lemons and bitter oranges than it is from cherries, pears, peaches or strawberries. This is because the former contain large amounts of pectin and the conditions inside the fruit are acidic. Both of these are important factors in the production of a set. Liquid pectin, which can be bought from shops and supermarkets, can be used to assist in jam making, particularly when using the latter fruits.

In large scale commercial jam making, pectin is used in addition to the pectin already present in the fruit. The manufacturer is able to manipulate the production conditions so that a huge variety of different preserves can be made according to fruit type, desired set strength, quantity of product, quantity of sugar, type of sugar and many other factors. Most of the pectin used commercially is in the form of a powder rather than a liquid.

It is extremely difficult, using ordinary methods, to dissolve powdered pectin in water. Industry makes use of high speed mixers and raised temperatures in order to dissolve it. A powder form is preferable in industry where very large quantities of pectin are used.

## Questions

1. What is meant by a polysaccharide? Name two other polysaccharides, apart from pectin, that are found in plants.
2. Draw a diagram of three or four simple plant cells to show the position of the cell wall and the middle lamella.
3. What material makes up the greatest proportion of plant cell walls?
4. Jam recipes always advise that fruit to be used in jam making should be only just ripe. Use the information in the third paragraph to explain this.
5. Using the information in 'The production of pectin' section, draw a flow chart which shows the stages in pectin production.
6. Explain the scientific processes of filtration, evaporation, distillation and precipitation.
7. Explain what is meant by 'commercially viable'.
8. Liquid pectin is readily available in shops so that making a jam such as strawberry at home now presents few problems. How else can a strawberry jam be produced without the use of liquid pectin?
9. Why would powdered pectin be unsuitable to use in home jam making?
10. Industry uses large quantities of powdered pectin. Suggest some reasons why industry does not use liquid pectin.