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STARCHES, GUMS AND STABILISERS IN BAKED PRODUCTS

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Fillings, toppings and decorations are an integral part of many bakery products. They have very different compositions and textures from the baked products which they are in contact with and to maintain their integrity it is important that such fillings and toppings remain stable over long periods of time and under a range of storage conditions. Common challenges for fillings and toppings are those associated with the migration of water, both to the surrounding atmosphere and to the bakery product base, and the need to remain unchanged under refrigeration or through a freeze-thaw process.

Starches

The Nature of Starch

Starch is a carbohydrate found in a wide range of cereals (wheat, barley, rye, maize, rice) and vegetables (potato, lentils, peas, cassava), and it one of the primary sources of food energy for human beings. The basic chemical formula for the starch molecule is $(C_6H_{10}O_5)n$. Its form is that of a chain of glucose molecules which are bound together, to form larger molecules with the length of the chain designated in the formula as *n*. The glucose monomers are joined in α-1,4 linkages. Because it is composed of many glucose sugar molecules, it is often referred to as a polysaccharide.

In the growing plant, the starch molecules arrange themselves in semi crystalline granules in which there may be two types of polysaccharides described as Amylose – mainly a linear chain of glucose, and Amylopectin – a highly branched chain of glucose. Amylose is the smaller of the two in size. The ratios of amylose to amylopectin vary according to the source of the starch and this variation affects the properties of the starch. Waxy starches are pure amylopectin, forming stable pastes with less retrogradation, while high amylose starches deliver strong gels but retrograde more readily.

As a raw material in baking, starch is commonly encountered as a soft, white, tasteless powder that is insoluble in cold water, alcohol, and other solvents. The size of the starch granules varies according to the plant source, ranging from 2µm for rice to 100 µm for potato. In size, wheat starch granules sit between the two ends of the range but unlike many other starches, they have a bimodal distribution of sizes.

A key property of starches is related to their behaviour when heated in the presence of water. In these circumstances a major change in the starch structure takes place. If the temperature of a mixture of starch and an excess of water is progressively raised, the initial change is the formation of a gel or paste, but as the temperature continues to climb the point is eventually reached at which the crystalline structure of the starch granule is lost, a process generally described by the term gelatinisation. At this time the crystalline form of the starch granule is lost, and an amorphous gel will form. The temperature at which gelatinisation occurs varies with the source of the starch. On cooling the gel which had formed during gelatinisation may begin to retrograde and a degree of crystallinity returns.

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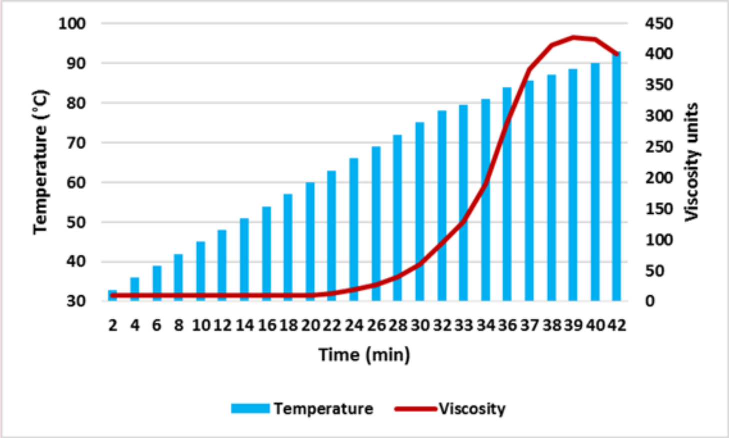
The behaviour of 'native' (i.e., unmodified) starch during heat processing varies according to it source. In particular, there are significant differences in the pattern of swelling, gelatinisation and retrogradation which will affect the performance of individual starches incorporated into a baked product formula. The unique nature of native starch in wheat flour makes it particularly relevant to the manufacture of bread and other baked goods. The changes in the wheat starch behaviour can be followed using devices which measure the changes in viscosity when a mixture of wheat flour and water are heated in a controlled manner while being constantly stirred. A common form of graph obtained when heating a mixture of wheat flour and water using this type of viscometer is illustrated shown below.



In this example, the temperature in the stirring viscometer is gradually raise at the rate of 1.5°C per minute. This rate roughly corresponds to the baking time of unit cakes in which the functionality of wheat starch is key to forming a 'normal' cake structure. For quite some time after heating has begun, there is not significant change in the viscosity of the mixture. With continued heating, the wheat starch granules begin to absorb water and swell, and there is a small increase viscosity of the mixture. With the onset of gelatinisation, the viscosity rapidly increases. With full gelatinisation and complete disruption of the granules, there is a small fall from the gelatinisation peak.

With wheat flour, the presence of cereal *alpha*-amylase (as measured with the Hagberg Falling Number test) will have a dramatic effect on the viscosity curve. Cereal *alpha*-amylase is able to breakdown gelatinising starch and in doing so, lowers the viscosity of a wheat flour-mixture. The final inactivation temperature is around 85°C which corresponds roughly with the peak gelatinisation temperature in the example above (the example is for wheat flour which has been treated with silver nitrate which has inactivated the cereal *alpha*-amylase activity).