Pectin and Starch in Preheating Firming and Final Texture of Potato Products

Firming of potatoes heated between 50 and 70° recently has been related to action of pectin methylesterase and migration of Ca and Mg to cell walls. These biochemical effects were produced under conditions different from those used in earlier studies by other workers, who concluded that properties of gelatinized starch were very important to textural qualities of different potato products. A brief review of pertinent literature is presented to show that textural qualities depend upon changes in both pectic substances and starch.

A recent paper by Bartolome and Hoff (1972) on firming of potatoes by heating at 50 to 70° describes the action of pectin methylesterase and migration of Ca and Mg to cell walls as biochemical effects involved. It is unfortunate that certain passages in their report negate the role of physical characteristics of gelatinized starch in the textural qualities of potato products. The authors cite Potter *et al.* (1959) and a review paper by Reeve (1967) concerning precook heating on texture. They do not cite original studies in which both precook heating and chilling were employed (Potter, 1954; Reeve, 1954) and which described marked changes in the physical properties of the gelatinized starch.

Precook heating treatments for 30 to 90 min at 75 to 90° were used in the original studies by Reeve. Although these temperatures are above that at which pectin methylesterase is destroyed, it is likely that some initial activity must occur before the tissue reaches 70°. However, it is important that, following these treatments at 75 to 90°, the potato samples were chilled and the most pronounced firming effect was observed after chilling. In his studies, Potter (1954) found that retrogradation of gelatinized potato starch was much more pronounced at 5° than at higher temperatures, including 55°.

There is little doubt that the firming action described by Bartolome and Hoff (1972) relates to pectin methylesterase activity and migration of Ca and Mg to cell wall sites when potatoes were heated at temperatures from 50 to 70°. However, conventional cooking of potatoes (as done at 88 to 100°) results in fairly rapid dissolution of the middle lamella substances between cell walls and the rate of dissolution increases with increase in cooking temperature. Microscopic observations (Reeve, 1954) made during the course of such cooking of thick sections having intact cells very clearly showed cell separation was accompanied by a "rounding off" of the cells so that walls of adjacent cells pushed apart. Other observations showed the "rounding off" to be the result of swelling of the gelatinized starch. For example, overcooking results in further swelling and cell wall rupture of some of the cells. Moreover, in potato tissue not cooked sufficiently to cause sloughing (as in blanched french fry cuts) the cells remain in their original angular or polyhedral shapes. In fact, low temperature heating to gelatinize the starch contents has been used as an aid in microscopic determinations of cell size (Reeve *et al.*, 1971). Also, cells of blanched and par-fried french fry cuts remain polyhedral even after freezing, thawing, and finish frying (Reeve, 1970; Reeve *et al.*, 1968); even when soaked in water such cells undergo little, if any, swelling.

Physical measurements have been made microscopically with a micropressurometer (Kruger *et al.*, 1961; Kruger, 1963) showing that cells from cooked potato ruptured when subjected to pressure only $^1/_3$ of that required to rupture cells from cooked, frozen, and thawed potato. Also, much more gelatinized starch was extruded from the ruptured cells of potato only cooked than from ruptured cells of cooked, frozen, and thawed potato tissue. Such microscopic observations clearly demonstrate the importance of gelatinized starch properties to textural qualities.

Obviously, there are many different textural qualities of cooked potatoes, ranging from firmness and cohesiveness in some to qualities of mealiness, sogginess, stickiness, or gumminess in potatoes cooked to sloughing or ready mashing. Both pectic and starch changes are involved and may be further influenced by metallic ions. Firming treatments (or delay of cell separation or sloughing) are very important to the textural qualities of the finished products. The studies of Bartolome and Hoff, showing the role of pectin methylesterase in firming of preheated potatoes, constitute important contributions to understanding the complexity of texture and texture problems encountered in the potato processing industry.

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