Crystallization and Drying During Hard Panning

The hard sugar shell is typically made by a repetitive process of spraying and drying. A measured portion of saturated sugar syrup is applied to centers tumbling in a rotating pan. The syrup must have sufficient viscosity to adequately coat these centers and provide a smooth, uniform film. As the film is spread, it begins to dry and crystallize. These two processes, drying and crystallization, occur simultaneously and interact with each other to determine quality of the final product. Drying too fast causes problems, as does drying too slowly. Ideally, the rates of crystallization and drying are balanced to provide optimal conditions for both processes to occur satisfactorily. The interval between applications depends on the rates of drying and crystallization. Ideally, crystallization occurs nearly as rapidly as the drying process so that each layer is set before the next layer is sprayed on.

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Structurally, the hard panned shell is a very densely packed layer with very small sugar crystals embedded in an uncrystallized matrix of highly concentrated solution. The shell has an extremely high viscosity to resist flow and is sufficiently brittle to provide a sharp snap upon eating. Water content is sufficiently low that migration of remaining water during shelf-life is limited, as this can impact dye migration. The size of sugar crystals in this shell has not been determined accurately due to the dense nature of the shell. However, the sugar crystals are likely to be less than 5 μm since they cannot be readily observed using optical microscopy techniques and there must be large numbers of these small crystals. Figure 1 shows schematically the structure of a hard sugar shell. Again, the structure of each layer should be set before the next syrup layer is applied.

In order to better control the hard panning process, we need to understand the principles of drying and crystallization, and how they impact the continual build-up of a hard sugar shell. In this paper, after a brief review of drying and crystallization, the application of these principles to hard panning will be discussed. These principles apply equally well to all hard panning, whether sucrose, glucose or sorbitol.

FUNDAMENTALS

Crystallization

The principles of sugar crystallization have been previously reviewed (Hartel, 1991; 1993). However, some fundamental principles as related to hard panning need to be mentioned here for completeness.

We generally define crystallization based on an equilibrium condition, where molecules in solution have the same thermodynamic energy as molecules in a crystalline lattice. This occurs at the saturation concentration (solubility), which can be defined for each substance and depends on temperature, as shown in Figure 2 for substances used in hard panning. When the concentration exceeds this solubility, there is a driving force for crystallization and a supersaturated condition exists. Crystallization occurs when nuclei are formed at some elevated concentration and then grow to become product sized crystals. Controlling the relative rates of nucleation and growth is critical to producing a crystal size