Protein Aggregation in High-Protein Caramel

The current trend of increasing protein content in caramel to enhance nutrition can cause protein graining. Certain process steps can help.

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Caramel is unique among confections in that it calls for a dairy ingredient. Through a series of complex reactions and processes, the proteins in the dairy ingredient help provide a unique color, flavor and texture in caramel. From a structural standpoint, caramel is made up of an amorphous sugar (sucrose, corn syrup, lactose) continuous phase with fat globules homogeneously dispersed throughout. Lecithin is often used to help create small fat globules, although proteins and the high-viscosity amorphous phase help prevent lipid coalescence. By varying water content, caramels can be made with textures from soft and runny to hard and glassy.

Proteins from the dairy ingredient are a critical component of caramel, providing color, flavor and structure through changes that take place during cooking. Proteins participate in Maillard browning, reacting with reducing sugars to provide the desirable caramel flavor and brown color. Some of them also undergo thermal denaturation and aggregation to form structures around the fat globules and throughout the amorphous phase to provide standup properties. However, when the extent of protein aggregation is excessive, the proteins actually coagulate and the result is *protein grain*. Here, the caramel takes on a tapioca-like structure, with large visible aggregates of protein structures (Figure 1), as it loses its desirable smooth texture.

There are two general categories of proteins in milk — the caseins (≈80%) and the serum proteins (≈20%). The various casein proteins form into small (10 – 30 nm) micelles in milk in order to protect the hydrophobic components from interacting with water. The hydrophilic segment that forms the outer surface of the casein micelle, κ-casein, provides steric protection against aggregation of micelles. It is believed that colloidal calcium phosphate (CCP) contributes to hold the casein micelle together. However, the balance between calcium in the serum phase and the CCP is dynamic and depends on conditions like temperature, pH and addition of other salts. This balance is key to controlling protein aggregation during heating.

Serum proteins include the two main whey proteins, α-lactalbumin and β-lactoglobulin, as well as numerous other proteins,

Protein Grain in Caramel

Figure 1