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Drying of Food Amorphous Matrices Containing Crystalline Materials such as Salts

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Summary

Foods contain both amorphous materials like sugars and crystalline materials like salts. When sugar solutions such as sucrose and maltodextrin are dried, they form an amorphous supersaturated solution. On the other hand, during drying salt solutions such as sodium chloride (NaCl) become a crystalline state when the concentration exceeds the saturated concentration. However, drying behavior of sugar solutions containing salts has not yet been examined thoroughly.

In this study, we have investigated the drying behavior and desorption isotherms of sugar solutions containing salts. For most experiments sucrose and maltodextrin were used as a sugar. KCl and NaCl were mainly employed as a salt. Na_2SO_4 was also tested as a comparison.

During drying of a sucrose solution containing NaCl or KCl, the crystallization of the salt was inhibited and the solution was dried as a supersaturated amorphous product.

The drying rate increased with increasing salt concentration. The drying rate was also different from salt to salt. For example, the drying rate of sucrose solution containing KCl was higher than that containing NaCl. The solution viscosity also became lower with increasing salt concentration. The viscosity of sucrose solution containing KCl was lower than that containing NaCl. This lowering of the viscosity corresponds to the increase in the drying rate of sucrose solutions containing KC.

The equilibrium water contents of NaCl in the desorption isotherms at 303K were close to zero below the water activity (a_w) = ca. 0.75, which corresponds to the saturated concentration. The desorption isotherm of sucrose showed a typical S-shaped isotherm, which can be described well by the Guggenheim-Anderson de Boer (GAB) equation. Like the drying experimental results, sugar-salt mixtures did not show crystals or solid phases until the end of the experiment (two to four days). When NaCl is added to a sucrose solution, the equilibrium water contents increased especially in the range of a_w>0.6. Other systems (KCl-sucrose, NaCl-MD, KCl-MD) also showed similar trends.

The isotherms of the mixtures were well described by the Ross model, which was originally develop for intermediate moisture foods.