An Overview of Water-Solid Interactions

As a solid interacts with water, significant changes in physical and chemical properties can occur, which can influence the performance of ingredients.

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Water is ubiquitous and abundant in the environment in which foods and ingredients are processed, stored and used. Because of this widespread presence, the small size and mobility of water molecules, and the ability of water to act as both a hydrogen bond donor and acceptor, there are numerous opportunities for water to interact with food solids.

There are five major mechanisms of water-solid interaction (Figure 1). These can be divided into three categories: surface interactions (adsorption), condensed water (capillary condensation and deliquescence) and internalized water (crystal hydrate formation and absorption into the bulk of amorphous solids).

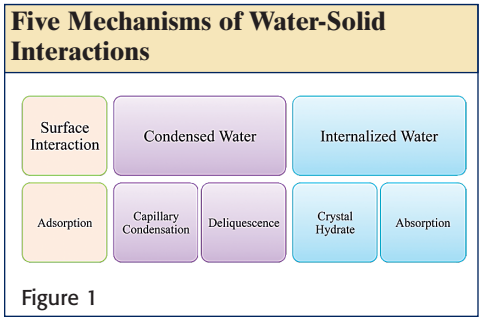

Figure 1

The physical state of the solid will influence the observed water-solid interaction mechanisms. There are two main categories of the physical state of solids: crystalline and amorphous. Crystalline solids exhibit long-range, three-dimensional order in the molecular arrangement of the crystal lattice structure and have a characteristic melting temperature, T_m. Amorphous solids lack this ordered molecular arrangement, instead having a more disordered molecular arrangement that exhibits the properties of a liquid at the microstructural level while maintaining a solid state at the macrostructural level. Amorphous solids have a characteristic glass transition temperature (T_g), and are said to be *glassy* below this temperature and *rubbery* above it. Many ingredients, including sugars, can solidify in either crystalline or amorphous structures depending on the conditions used.

As a solid interacts with water, significant changes in physical and chemical properties can occur, including phase transformations, changes in mechanical properties and compaction, changes in powder flow and caking, and degradation of bioactive and ➤

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