ENTHALPY OF DISSOLUTION OF MODEL FOOD POWDERS

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The dissolution of food powders is a complex and important process. The kinetics of the process was studied in the past, and the effects of some physico-chemical properties are well documented. However, little information is available concerning the thermodynamic effects that occur during the dissolution process. In the present work, isothermal solution calorimetry was utilized to study the thermodynamics of the dissolution process of model food powders. The effects of different moisture and fat contents in the model powders were elucidated. In addition, the dissolution kinetics of single particles was studied in-situ utilizing a real time video acquisition and a novel image analysis technique.

The rate of dissolution correlated highly with the measured enthalpy of dissolution, i.e., more exothermic responses corresponded to faster dissolution rates. Increasing the moisture content of the samples led to a significant reduction (less exothermic) of the measured heat of dissolution. A reduction of about 7 J/g was observed for every 1% increase in the moisture content (in the range of 0 to 10% dry basis) of the samples, independently of their fat content. A linear relationship was found between the amount of fat in the powders and the enthalpy of dissolution. Increased fat concentration also led to less exothermic responses, with a decrease from ca. -60 to -30 J/g for a for freeze-dried samples with 1 and 45% fat content, respectively. This effect was less pronounced as the moisture content of the samples increased, ranging from ca. 0.7 J/g for each 1% increase in fat for dry samples to 0.4, 0.3 and 0.1 J/g for each 1% increase in fat for samples equilibrated at relative humidities of 11, 22 and 33%, respectively.

In the present work the thermodynamic behavior of soluble model food powders showed that valuable information previously unavailable was obtained, and its integration with other common characterization techniques provides insight on the dissolution of powders. Higher exothermic responses were correlated with faster dissolution process. The quantification of the dissolution enthalpy of food powders provides an additional and significant parameter for designing products with specific dissolution requirements. The data also highlight that dissolution is a complex phenomenon, in which the local heat transfer probably plays an important role. The utilization of this new insight opens new avenues ultimately leading towards better understanding and the optimization of the dissolution process.