Application Update

Thermal Analysis and Calorimetry as applied to Food Processing

by Setaram

SETARAM Instrumentation

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Thermal Analysis and Calorimetry as applied to Food Processing

Thermal treatment is at the heart of all food processes, whether for the preservation of product or to develop texture, flavors and colors. It is therefore essential for food scientists to develop these steps without causing any compromise in sensory or nutritional quality of the final product.

Setaram offers a comprehensive range of instrumentation that can simulate the conditions found in all food processes. This includes challenging conditions from the impact of low temperatures on protein denaturation to the new research area of high pressures as an alternative to prolonging food shelf life.

CHARACTERIZATION OF FOOD STUFFS

FOOD PROCESSING

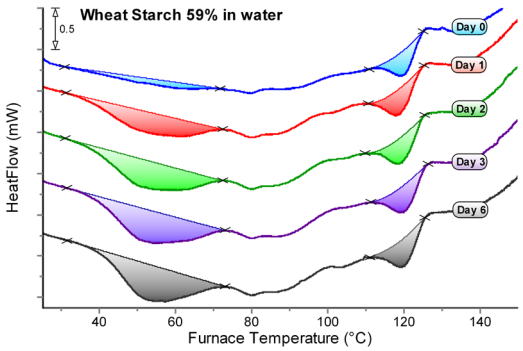
Characterization of Food Stuffs

RETROGRADATION OF STARCH (MicroSC in scanning mode)

Gelatinized starch goes through retrogradation, which involves recrystallization of amylose and amylopectin. Ageing of wheat starch dough was studied with the new MicroSC microcalorimeter.

Different thermal effects are detected:

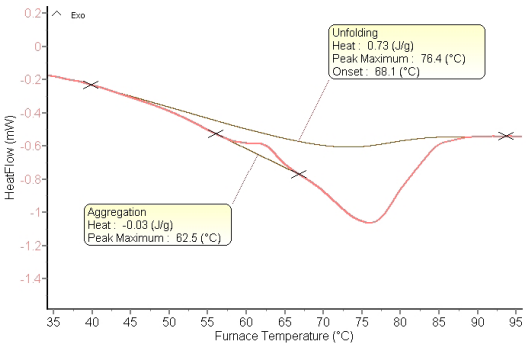
- Melting of recrystallized amylopectin (endotherm between 30 and 80°C). Heat of melting increases with the ageing of the dough and stabilizes with time, nicely fitted by an exponential law for wheat and maize.
- Melting of amylose-lipid complexes (endotherm at around 120°C). Heat of melting increases with the ageing of the dough and stabilizes with time.
- At higher temperature (around 160°C), melting of recrystallized amylase is detected (not on the figure)



DENATURATION OF ALBUMIN (MicroSC in scanning mode)

Albumins are major proteins which are found in many food products such as egg white, milk or meat. These proteins are able to coagulate under the influence of the temperature. This thermal property is commonly used in food processes, such as in sugar refining to clarify the solutions or as emulsifying and gelling agents.

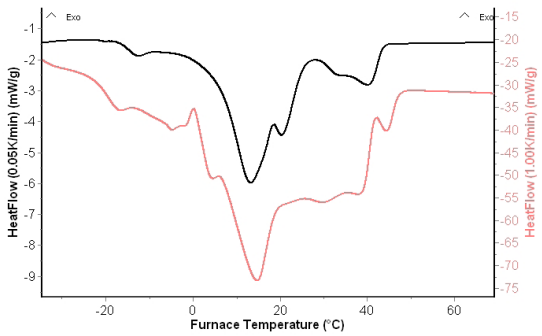
This phenomenon is detected using the MicroSC calorimeters on a sample mass of 550 mg of 10% albumin in a 0.1M NaCl solution pH 5. The temperature is programmed from 20°C up to 95°C at 1°C. min^{-1}. The aggregation transformation is clearly detected prior to the denaturation.



MELTING OF PALM OIL AT DIFFERENT SCANNING RATES (MicroSC in scanning mode)

Palm oil is mainly constituted of esters of glycerol and fatty acids named glycerides. The composition of glycerides in oil is an important characteristic to control its quality.

This composition can be determined following the specific phase transitions between polymorphic forms and solid-liquid phases of the constituents using the new MicroSC calorimeter. When heating, different endothermic effects are detected corresponding to the different crystal forms. By lowering the scanning rate (down to 0.05°C.min^{-1}), a better separation of the different effects is reached, providing a better identification of the different fractions without affecting the quality of the heat flow signal.

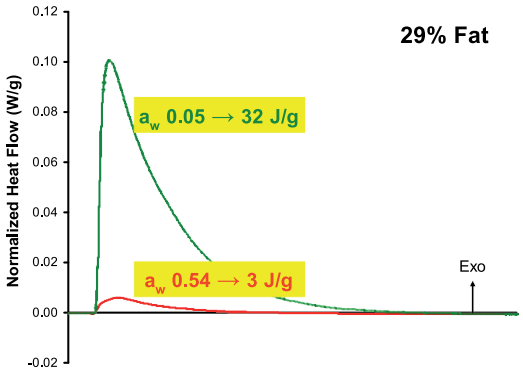


Food Processing

DISSOLUTION OF FREEZE-DRIED POWDERS (C80 in isothermal mode)

The C80, as a mixing calorimeter, is especially adapted for the simulation of food processing such as dissolution, dilution, reaction, neutralization. The reversing mixing vessel is used to investigate the dissolution of freeze-dried powders. The dissolution of food powders is a complex and important process. Isothermal solution calorimetry is very useful to determine the thermodynamics of the dissolution process.

Typical dissolution calorimetric curves are shown for freeze-dried (aw=0.05) and equilibrated skim milk powder (aw=0.54) showing that the moisture content influences the dissolution process.

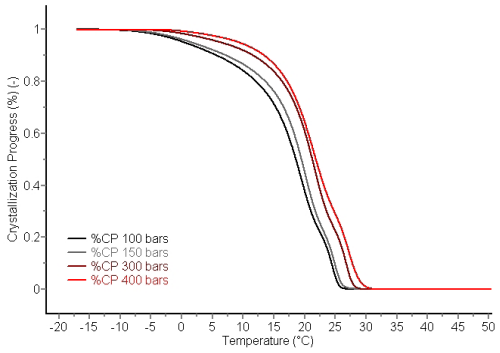


CRYSTALLISATION OF MARGARINE UNDER PRESSURE (MicroDSCVII under high pressure)

An industrial process of margarine crystallization was simulated by using MicroDSCVII at a controlled cooling rate of 1K.min^{-1} under isobaric conditions.

Experiment pressure has no influence on the enthalpy of crystallization of margarine. The maxima of the two characteristic crystallization peaks were shifted to higher temperatures when pressure increased.

The results show that the temperature shift becomes less significant when reaching pressures close to 400bar. Mathematical calculation of the integral functions of heatflow data allows plotting the crystallization progress vs. temperature.

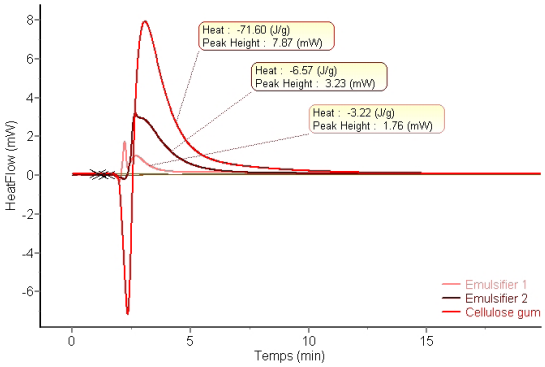


WETTING OF CELLULOSE GUM WITH EMULSIFIERS (MicroSC in mixing mode)

Cellulose gum (or carboxymethylcellulose) is an ingredient in a wide variety of products (yogurt, jelly, ice cream…). Its emulsifying properties make it especially useful for products with ingredients that tend to separate. According to the applications, other emulsifiers are added to the cellulose gum.

The new mixing vessel designed for the MicroSC calorimeter is well designed to investigate the wetting between the cellulose gum and different emulsifiers.

The interaction of the cellulose gum with water provides a large exothermic effect. As soon as an emulsifier is added to water, the effect is decreased, counterbalanced by an endothermic effect corresponding to the wetting. The wetting effect is depending on the type of emulsifier.



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