Starch retrogradation and bread staling

INTRODUCTION

Gelatinized starch goes through retrogradation, which involves recrystallization of amylose and amylopectin. Retrogradation characteristics depend on parameters like botanic specie or water content. It is the main source of bread staling effect. The ageing of maize, of wheat starch dough and of bread crumb, was studied with the MICROCALVET ULTRA 4C microcalorimeter.

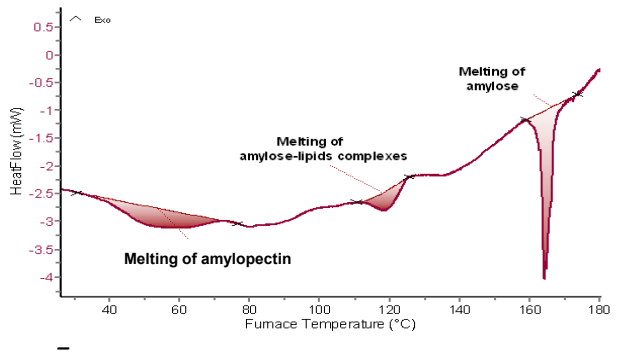

Figure 1 – Thermogram of the analysis of wheat starch dough at t = 0

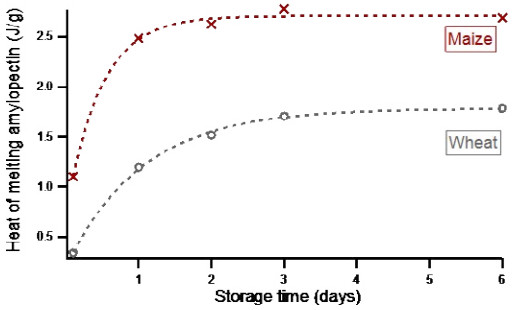

Figure 2 - evolution of the heat of melting of amylose with wheat starch storage time.

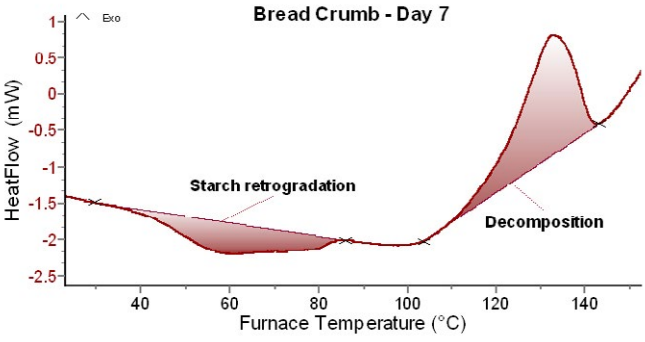

Figure 3 – Thermogram recorded during the analysis of bread crumb

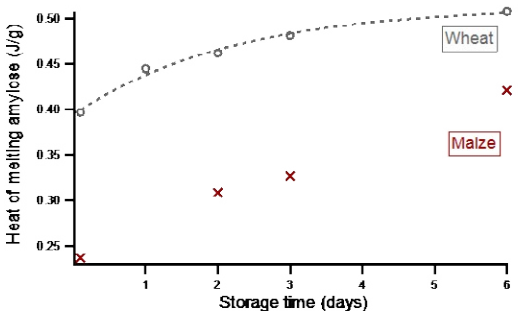

Figure 4 - evolution of the heat of melting of amylose with bread crumb storage time.

EXPERIMENT

• Dough are composed of maize and wheat starch (Merck) with deionized water (34% w/w), heated at 110°C for 1 hour. Bread crumb is freshly baked, wheat flour based.
• Test procedure: dough and bread were stored at ambient temperature in closed containers and sampled every day to be heated in a calorimetric vessel. Mass~ 400 mg, heating 10°C→180°C at 0.7 K/min

RESULTS AND CONCLUSION

Starches: Each starch exhibit three main thermal events (Figure 1):
- Melting of the recrystallized amylopectin (endotherm between 30 and 80°C). Heat of melting increases with the ageing of the dough and stabilizes with time (Figure 2)
- Melting of amylose-lipid complexes (endotherm at around 120°C). Heat of melting increases with the ageing of the dough and stabilizes with time .
- Melting of the recrystallized amylose (endotherm at around 160°C).

Bread crumb: Heat of melting of recrystallized amylopectin increases with ageing on the bread crumb thermogram (Figure 4). At higher temperatures a large exothermic effect occurs and could be linked with Maillard reaction occuring between the protein and polysaccharide contents of the crumb (Figure 3).

Starch retrogradation and to some extend bread staling can be monitored by microcalorimetric systems that allow a combination of a large sample mass, a high sensitivity and slow scanning rates that keep the tested samples close to thermal equilibrium.

INSTRUMENT

MICROCALVET ULTRA

-20 to 170°C

HIGHEST HEAT MEASUREMENT ACCURACY
3D sensor based on Peltier elements with Joule effect calibration.

MODIFIABLE TEMPERATURE CONDITIONS
for increased flexibility and replication of real life conditions.

CONVENIENT INTERCHANGEABLE CRUCIBLES AND CELLS
to perform even the most demanding experiments using one instrument :
- high pressure (1000bar) and high vacuum
- pressure measurement and control
- mixing experiment

EXTERNAL COUPLING CAPABILITY
designed to increase your research options including manometry, BET instrumentation, gas analyzers, humidity controllers and gas panels