Impacts of the baking heating rate on the water mobility, starch microstructure and mechanical properties of degassed crumb during staling

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Introduction: Different parameters related to the baking process, such as the baking temperature, heating rate (HR), baking duration and temperature beyond the gelatinization temperature affect the texture and staling rate of bread.
Objective: The aim of this study was to assess the impact of the HR from 6 to 40 ?C/min on bread crumb staling in terms of the 1H proton water mobility, starch microstructure, texture, soluble amylose (AM), amylopectin (AP) retrogradation and AM crystallization. In addition to the large HR range tested, there is a novel focus on the amount of AM complexes formed during baking as a function of the HR.
Methods: A degassed breadcrumb baked in a miniaturized baking system was used to ensure better time-temperature control during baking permitting to obtain a large range of HRs (6 ?C/min, 20 ?C/min and 40 ?C/min). The properties of the crumb were evaluated to monitor different parameters related to the progression of staling, including the texture, AP retrogradation and AM crystallization. Water mobility was assessed by low field Proton nuclear magnetic resonance (1H NMR) , and environmental scanning electron microscopy was used to examine the extent of starch granule disruption.
Results: NMR data showed that the evolution of the proton T2 relaxation time decreased with increasing HR during staling. The amount of soluble AM, AP retrogradation degree, AM crystallization degree and crumb firmness tend to increase at higher HR. Microscopic observations demonstrated that most starch granules in crumbs treated at higher HR exhibited strong deformation and disruption.
Conclusion: These results confirmed that the increase in crumb firmness during staling with increasing HR was related to a higher level of starch disruption. This yielded a higher degree of separation between the AM and AP, which resulted in more pronounced water trapping in the starch crystals. The resulting dehydration of the matrix (gluten network, with AM gel surrounding of starch granules) yielded a loss in crumb softness, and crumb baked at higher HR tended to have a firmer texture and faster staling.