INDUSTRIAL PILOT PROJECT

In situ microwave-convective baking of bread visualised by time-resolved synchrotron microtomography

THE INDUSTRIAL CHALLENGE

The main challenges in industrial baking of bread are related to achieving higher energy-efficiency while maintaining the desired bread volume and quality properties. Microwave-convective baking offers an energy-efficient way to bake bread in shorter processing time. The microwave technology also makes it possible to achieve good bread quality in terms of texture, mouthfeel and porosity, particularly for specific bread types. However, a remaining challenge is to deduce whether the time-dependent 3D bubble formation in the dough during baking will have time enough to take place. It is also unclear how the short processing time will affect the time-dependent distribution of water between starch granules and gluten. The water distribution will influence the elasticity and the bubble formation. Understanding of water migration can potentially also increase the valorization of bread products in terms of perceived freshness and extended shelf-life.

WHY USING A LARGE SCALE FACILITY

Synchrotron X-ray microtomography (SRμCT) with high temporal and spatial resolution is vital to perform in-situ experiments to understand the time-dependent volume expansion that takes place during bread baking.

HOW THE WORK WAS DONE

A microwave-convective oven was tailor-made, with Al-windows for the X-rays and opening for the rotation pin, to enable in-situ SRμCT experiments during baking at the TOMCAT beamline of the Swiss Light Source at PSI. A pre-study was made to sort out relevant process and formulation conditions before the three-day beamtime. Samples with three different flour types, varying in protein content, were analysed after different process conditions, using 1) microwave, 2) microwave-convective and 3) convective heating, respectively. The samples were prepared in advance, frozen and transported to Switzerland. Image analysis of the series of 3D structures was used to estimate quantitative image parameters, e.g. porosity, bubble size and shape.

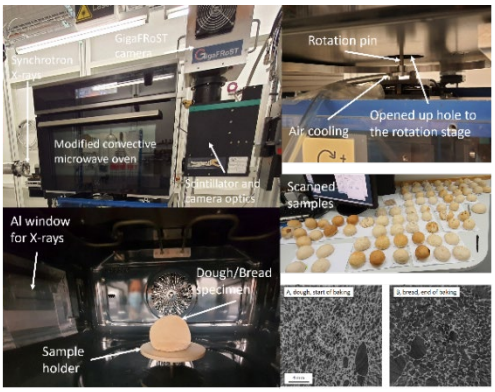

Figure 1. In-situ microwave-convective baking as studied using SRμCT at the TOMCAT beamline.

Results showed that it is possible to determine the time-dependent 3D bubble structure in the dough before baking, during baking and after baking at TOMCAT.

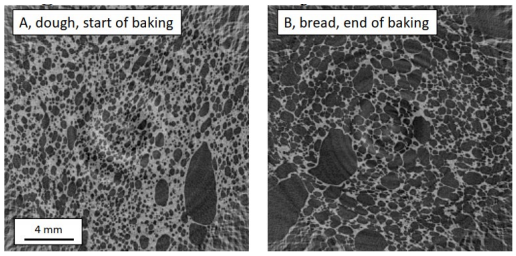

Figure 2. Reconstructed slices of the dough before baking (left) and the resulting convectively baked bread (right). F. Marone Welford, PSI, is gratefully acknowledged for beamtime support.

It was found that the type of baking and the flour type influence the bubble growth kinetics and the final bread structure considerably. In addition, initial results also show that further development of the oven and its process control is needed to image fast structure changes that occur during microwave baking.

Contacts: Foras Abduljabar – Finax foras.abduljabar@abdonfood.se
Birgitta Raaholt -RISE Research Institutes of Sweden birgitta.raaholt@ri.se
Rajmund Mokso –Lund University / MAX IV rajmund.mokso@maxiv.lu.se

Vinnova's project No: 2019-02572 **Duration:** June 2019 -- October 2021

Funded by Sweden's Innovation Agency, Vinnova, in order to build competence and capacity regarding industrial utilisation of large-scale research infrastructures such as MAX IV and ESS.