

Investigation of the dehydration behavior of bread crumb and crust by DVS analysis

– Application Note 20-04

Data were kindly provided by Yi Chen, Laboratory of Food Process Engineering, ETH Zürich

Introduction

Bread can be divided into two distinct regions: crust and crumb. Crust, which is the upper part of the bread formed during baking, is comprised of a network of denatured gluten proteins and partially gelatinized starch granules [1]. In general, the crust has a low moisture content and a dense structure. On the other hand, the crumb consists of primarily gluten proteins and gelatinized starch. It possesses a high moisture content and a porous cellular structure. The differences in composition and morphology might result in different drying behaviors of crumb and crust during storage.

Therefore, this study aims to investigate and compare the moisture desorption isotherms and desorption kinetics of crumb and crust.

Knowledge of the individual drying characteristics is an important indicator to understand the aging of bread and, if necessary, to adjust recipes, processes and packaging accordingly.

Analysis

The determination of the moisture desorption isotherms was conducted using a gravimetric vapor sorption analyzer (SPSx-1 μ , proUmid, Ulm, Germany). The measurements were performed in triplicates at a constant temperature of 23 °C. The tests were started at a relative humidity (RH) of 90 % and then progressively reduced in 10 % steps to 0 % RH.

Results

As illustrated in Fig. 1, the crust and the crumb have similar moisture desorption isotherms at isothermal conditions despite their structural differences (porosity, pore size, pore size distribution etc.). The comparable desorption behavior is likely due to the similar ingredient composition, as both contain primarily starch and gluten.



Fresh (left) and aged bread (right)

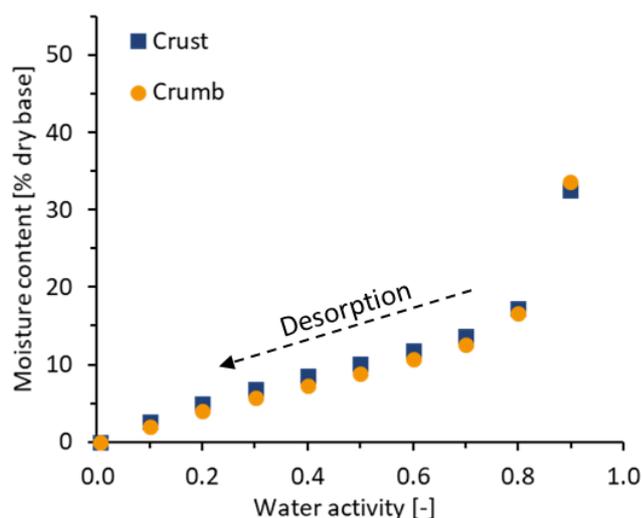


Fig. 1: Moisture desorption isotherms of crumb and crust

Fig. 2 depicts desorption kinetics of the crumb and the crust. Even though the bread crust and crumb have quite similar moisture desorption isotherms, their desorption kinetics are different. When the water activity is reduced from 0.9 to 0.8, the crumb experiences moisture desorption, on the contrary, the crust undergoes moisture sorption.

Moreover, the crust reaches the equilibrium moisture content at a faster rate than the crumb, in particular in the water activity range from 0.9 to 0.7. This could be attributed to the differences in initial moisture content, initial water activity and structural properties.

Conclusion

Dynamic water vapor sorption analysis is a sensitive method which can be used to differentiate between the dehydration behavior of crumb and crust. As different bread components and structures affect the water transport, this method can be used to study and compare the moisture sorption and desorption dynamics of breads made with different recipes.



Bread crust and crumb in SPS sample dishes

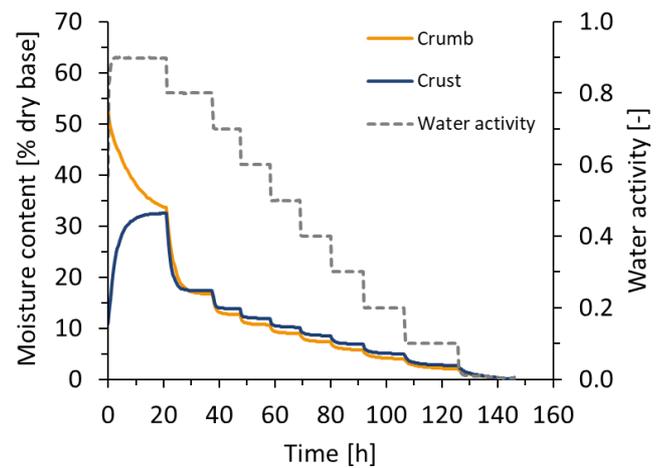


Fig. 2. Desorption kinetics of crumb and crust

References

- [1] Altamirano-Fortoul, R., Hernández-Muñoz, P., Hernando, I., & Rosell, C. M. (2015). Mechanical, microstructure and permeability properties of a model bread crust: Effect of different food additives. *Journal of Food Engineering*, 163, 25–31. <https://doi.org/10.1016/j.jfoodeng.2015.04.019>