

Initial stages of the Scottish Oat Cakes and Suedtiroler Schuettelbrot hydration from gaseous phase as observed by hydration kinetics, sorption isotherm and proton NMR

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The study was to understand the initial stages of mild wetting of commercially obtained durable bread (Sample HOc = Highlant Oatcakes, Walkers, Aberlour on Spey, Scotland, and Sample SBr = Preiss Suedtiroler Schuettelbrot).

Wetting was performed from the gaseous phase over the surface of water (the relative humidity, $p/p_0 = 100\%$), over the surfaces of several supersaturated salt solutions ($p/p_0 = 93\%$, 88% , 76% , 52% , and 32%). The dehydration of the samples was performed over phosphoric acid ($p/p_0 = 9\%$) and over silica gel ($p/p_0 = 0\%$). For both substances either the hydration or the dehydration kinetics was sufficiently well described by the single exponential functions with the average hydration time (15.9 ± 5.7) h and (22.0 ± 5.4) h, and dehydration time (12.9 ± 0.3) h and (32.0 ± 0.9) h for HOc sample and for SBr sample, respectively.

The equilibrium values of the hydration levels were used to construct the sorption isotherms, which exhibited a sigmoidal form for both samples tested. Thus, the Dent sorption isotherm [2] was successfully fitted the data, with the mass of water saturating the primary water binding sites expressed in units of dry mass equal 0.035 and 0.041 for HOc and for SBr, respectively. The population of $(n+1)$ -th in units of n -th layer was 0.938 and 0.960 for HOc and for SBr, respectively, which suggests that the discrepancy from the full wetting case (BET approach [1]) is low.

The proton FIDs recorded at 30 MHz and $\pi/2 = 1.4 \mu\text{s}$ are the superpositions of solid Gaussian component [3], the solid component fitted by Gaussian damped Sincus function [5] and the liquid exponential component, L. Both solid components come from solid matrix and semi-crystalline protons of starch, respectively. The amplitude of the exponential part increases linearly with the increasing hydration level of the sample.

Using the parameters obtained from the gravimetric sorption isotherm, the NMR hydration data (the amplitudes of liquid signal in units of solid) were fitted leading to an NMR-isotherm (L/S versus p/p_0), which shows the absence of water fraction trapped in pores of the structure, as it was observed for lyophilized wheat photosynthetic membranes [4].

References

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