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The Effects of Porosity and Permeability on Stress-Strain Plots of Bread Crumbs

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Abstract. The pore structure of bread and the structure's relationship to mechanical properties is one that is not fully understood. We have examined breads made from four differing types of flour - bakers, cake, hi-ratio, and high protein - focusing specifically on the effects of permeability, porosity, and the ratio of open versus closed cells on stress-strain curves. Results are compared with commercially available breads made with US flour and sold in S E Asian markets. We used micro-CT and the Avizo® visualization package to investigate the internal structure of the breads by generating 3-D models[1]. The models were then used by the porp7 package to obtain descriptors[2][3]. We calculated permeability from experimental data via Darcy's Law and obtained stress-strain curves via mechanical testing using an Instron® material tester. Our analysis shows that porosity in general is the result of one interconnected open cell, with other cells that are not connected to the main cell accounting for less than 5% of total pore space. This implies that stress-strain curves are more dependent on porosity and the characteristics of the main cell, and not so much on the ratio of open and closed cells.

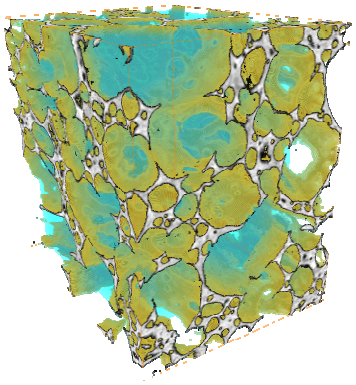

FIGURE 1. 3-D volume rendering of bread crumb made from cake's flour. Gold indicates cell walls, teal indicates pore space, and the whitish color is the original CT scan image with pore space removed.

REFERENCES

1. AD Lape, S Jensen, VL St. Jeor and CA Lendon (2008). Use of X-ray Micro Computed Tomography in the Evaluation of Bread Crumb Structure. Microscopy and Microanalysis, 14 (Suppl. 2) , pp 700-701, doi:10.1017/S1431927608081889
2. Liu, J., K. Regenauer-Lieb, C. Hines, K. Liu, O. Gaede, and A. Squelch (2009), Improved estimates of percolation and anisotropic permeability from 3-D X-ray microtomography using stochastic analyses and visualization, Geochem. Geophys. Geosyst., 10, Q05010, doi:10.1029/2008GC002358.
3. Falcone, P.M., Baiano, A., Zanini, F., Mancini, L., Tromba, G., Dreossi, D., Montanari, F., Scuor, N. and Del Nobile, M.A. 2005. Three-dimensional quantitative analysis of bread crumbs by X-ray microtomography. J. Food Sci. 70(4), 265–272.