

Characterizing the micro-structure of food

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Introduction

MicroCT is becoming an important tool for analyzing the micro-structure of food and the spatial distribution of food components. The micro-structure has a large impact on the physical, textural and sensorial properties of the food. Hence, a better understanding of the micro-structure and how it changes during processing is of large interest to the process industry and food manufacturers in order to optimize their products. Areas of applications are for instance mixing and dispersing of industrial chocolate, breakfast cereals and snacks but also in manufacturing of ice cream where the microstructure dramatically changes due to temperature variations [1]. Non-destructive methods for characterizing the mechanical properties such as pore size distribution and cell wall thickness are therefore necessary.

In a paper by Horvat et al. [2], microCT is compared to magnetic resonance imaging for the characterization of corn extrudates. Whereas both methods are applicable to support the non-destructive analysis of the inner structure of extrudates, microCT offers a higher resolution and requires no sample preparation. The results of pore size distribution obtained by both methods were comparable within the statistical and methodical expectations.

Methods

To demonstrate the capacities in food characterization, two commercially available twigs (snacks in shape of salty sticks) were scanned using the SCANCO μ CT 50. The scans were made at 70 kVp with an integration time of 1 s at a resolution of 5 μ m.

The samples were segmented based on their gray scale value in the CT slices. The wall thickness was computed from the segmented sample using the maximum fitted spheres methods [3]. The pore diameters were then computed applying the same method on the inversed segmented image. The script for performing the analysis was started with a one-click operation in the SCANCO Evaluation program.

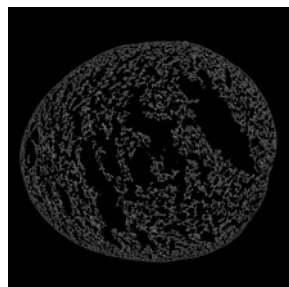


Figure 1: Gray scale image of twig, sample A.



Figure 2: Segmented twig

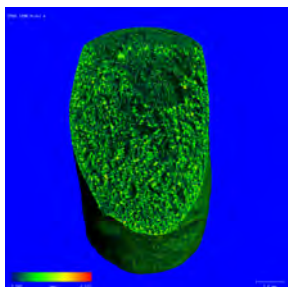


Figure 3: Wall thickness

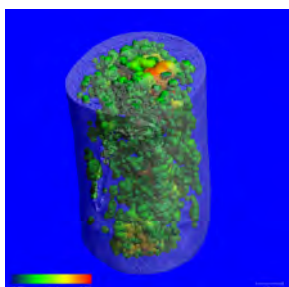
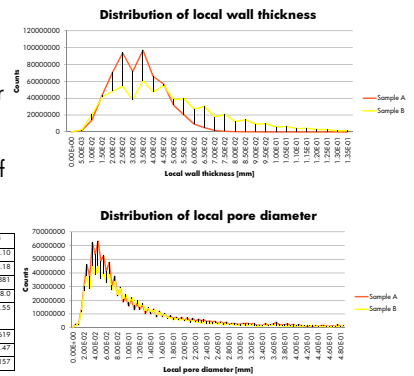


Figure 4: Pore thickness

Results

MicroCT together with the SCANCO Evaluation software provide not only a visualization of the inner micro-structure of the food samples but also a numerical quantification of the structure.

	Sample A	Sample B
Object Volume (OV) [mm ³]	72.28	76.10
Total Volume (TV) [mm ³]	222.82	256.18
OV/TV [%]	0.327	0.381
Object Surface (OS) [mm ²]	5459.7	5028.0
OS/OV [1/mm]	72.13	62.55
Porosity [%]	0.673	0.619
Mean Local Thickness [mm]	0.033	0.037
Mean Pore Diameter [mm]	0.176	0.157



Other applications in food imaging

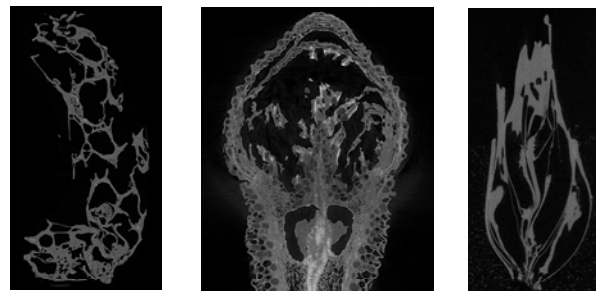


Figure 5: Gray level slices of : Left: Oat cereals Middle: Clove Right: Wheat

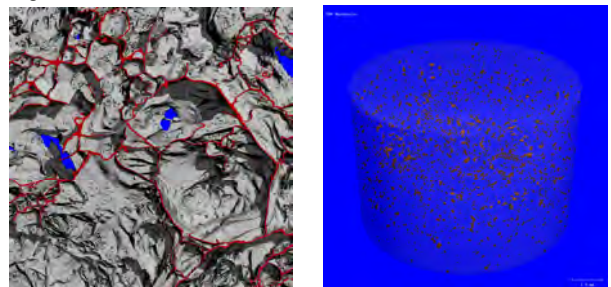


Figure 6: Left: 3D visualization of corn extrudates. Right: Mayonnaise with segmented inclusions of fat.



Figure 7: Visualization of composition of chocolate praline (left) and distribution of air bubbles (right)-

References

- [1] Pinzer et al. 3D-characterization of three-phase systems using X-ray tomography: tracking the microstructural evolution in ice cream. *Soft Matter*, 2012,8, 4584-4594
- [2] Horvat et al. Non-destructive, quantitative characterization of extruded starch-based products by magnetic resonance imaging and x-ray microtomography. *Journal of Food Engineering*, In Press
- [3] Hildebrand. et al A new method for the model-independent assessment of thickness in three-dimensional images, *J. Microscopy*, 185 pp. 67-75, 1997.