Characterization of water state and repartition during drying process of tomato with single sided nuclear magnetic resonance

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Drying is the most common form of food preservation and extends the food shelve-life, while allowing optimizations of packaging, storage and transportation (1). However, a better understanding of the physicochemical phenomena related to water loss remains necessary to adapt the drying process to the variability of the raw material, in order to preserve the nutritional characteristics and the quality of processed products, while optimizing the energy consumption of the operation. Here, we present a study aimed at demonstrating the ability of single-sided nuclear magnetic resonance (NMR) for noninvasive in-situ monitoring of the evolution of water properties during tomato drying. Two varieties of industrial tomatoes, namely H1311 and Terradou, were used. The upper and lower parts of fruits were cut and only the outer pericarp was kept. Sample was put on a plastic wire mesh support in the oven for drying at 45°C with controlled air flow. Fresh and three drying times, 4h, 7h and 16-18h, were used. NMR experiments were performed at 10° C in a climatic room using a Magritek Profile NMR-MOUSE PM25 with a ^{1}H resonance frequency of 13.29 MHz. Profiles, i.e., signal intensity in function of depth were then acquired at eighty 100µm-slice thick depths and 200 µm-step spanning the 16 mm height of the sample. CPMG pulse sequence was used with 256 echoes, TE=100µs, TR=2s and 4 scans for these profiles. T_2 relaxation measurement experiments were also recorded at three specific depths (top, middle and bottom), with the following parameters: 2048 echoes, TR=10s and 8 scans were used. To measure dry mater content, tomatoes were dried at 105°C for 12h just after the last NMR experiment.

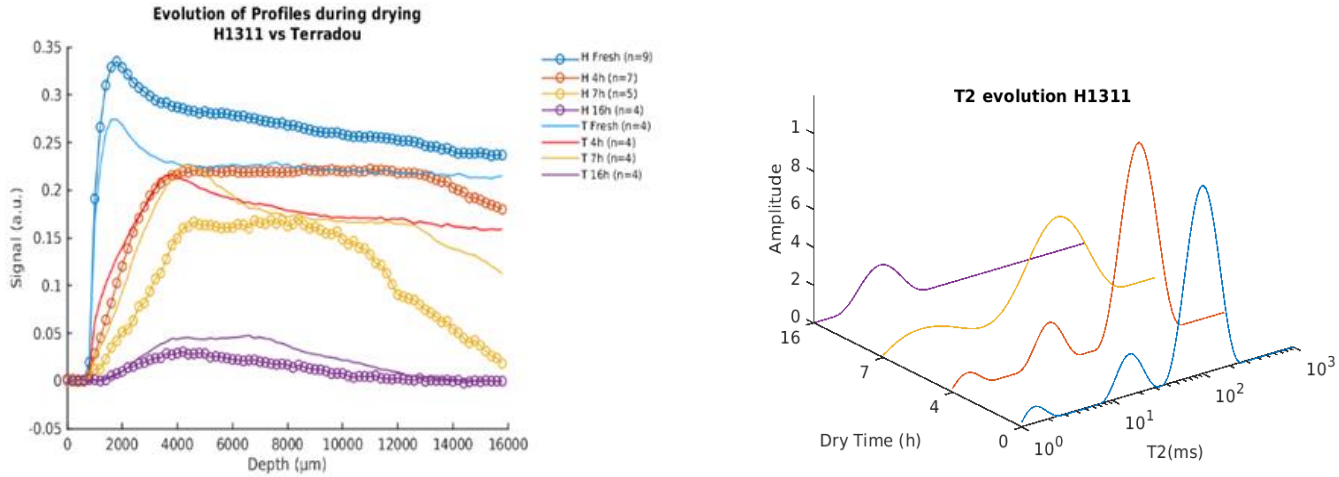

Figure 1 – Evolution of the signal profiles (left) and representative T_2 relaxation time repartitions measured at the central depth (~8000 µm; right) in function of the drying times.

Both tomato cultivars displayed depth profiles whose shape can be related to dehydration (Figure-left). The decrease of the signal during drying occurred gradually from the extremities corresponding to the cut surfaces. The integrals of these profiles were linearly correlated with the water amount of each sample. As shown in the figure-right, changes were observed in the T_2 pattern, the common 3 components of the fresh sample shifted to two after 7h and predominantly one after 16h of drying. This change in the number of components along with the decrease in the T_2 values were discussed in relation to the physicochemical changes related to water loss in the tomato tissues during drying.

Reference

[1]. Freire, F.B.; Vieira, G.N.; Freire, J.T.; Mujumdar, A.S. doi://10.1080/07373937.2014.925471