



HAL
open science

CHARACTERIZATION OF WATER STATE AND REPARTITION DURING DRYING PROCESS OF TOMATO WITH SINGLE SIDED NUCLEAR MAGNETIC RESONANCE

Amidou Traoré, Guilhem Pagès, Sylvie Clerjon, Alexandre Leca, Nadia Bertin, Guylaine Collewet, Maja Musse

► **To cite this version:**

Amidou Traoré, Guilhem Pagès, Sylvie Clerjon, Alexandre Leca, Nadia Bertin, et al.. CHARACTERIZATION OF WATER STATE AND REPARTITION DURING DRYING PROCESS OF TOMATO WITH SINGLE SIDED NUCLEAR MAGNETIC RESONANCE. 16th Biennial International Bologna Conference Magnetic Resonance In Porous Media, Aug 2024, Tromso, Norway. 2014. hal-04683948

HAL Id: hal-04683948

<https://hal.inrae.fr/hal-04683948v1>

Submitted on 2 Sep 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

CHARACTERIZATION OF WATER STATE AND REPARTITION DURING DRYING PROCESS OF TOMATO WITH SINGLE SIDED NUCLEAR MAGNETIC RESONANCE

Amidou Traore ^{a,b}, Guilhem Pages ^{a,b}, Sylvie Clerjon ^{a,b}, Alexandre Leca ^c, Nadia Bertin ^d, Guylaine Collewet ^e and Maja Musse ^e

^aUniversité Clermont Auvergne, INRAE, UR QuaPA, 63122, Saint-Genès Champanelle, France;

^bINRAE, PROBE research infrastructure, AgroResonance facility, 63122, Saint-Genès-Champanelle, France,

^cINRAE, (SQPOV), 84914 Avignon, France,

^dINRAE, (PSH), UR1115, 84914 Avignon, France,

^eINRAE, (OPAAL), 35044 Rennes, France

AgroResonance

Introduction

Drying is the most common form of food preservation and extends the food shelf-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 aim to demonstrate the ability of single-sided nuclear magnetic resonance (NMR) for noninvasive in-situ monitoring of the evolution of water properties during tomato drying.

Materials

Two varieties of industrial tomatoes: H1311 and Terradou. The upper and lower parts of fruits were cut and only the outer pericarp was kept. Drying was performed in an oven (Froilabo-AP120[®]) at 45°C with controlled air flow. Fresh samples and three drying times, 4h, 7h and 16-18h (~ 40% water loss), were analyzed.

Method

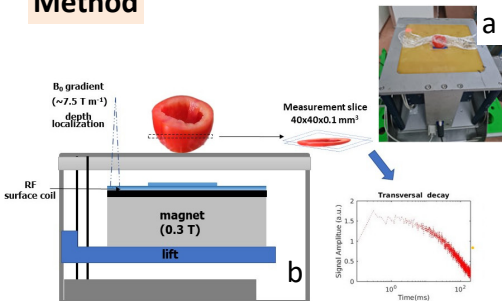


Figure 2 : (a) Tomato sample in plastic wrap on MOUSE[®] during experiment in climatic room. (b) Schematic representation of depth profiling experiment.

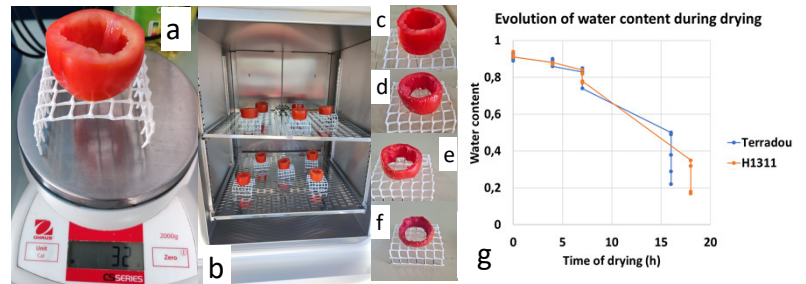


Figure 1 : Example of fresh prepared tomatoe samples (a, c) in the oven before drying (b) and after 4 hours (d) 7 hours (e) and 16 hours (f) of drying at 45°C. Plot of the evolution of tomato water content during drying (g).

NMR experiments were performed at 10° C in a climatic room using a Profile NMR-MOUSE[®] PM25 (Magritek, Germany) with a ¹H resonance frequency of 13.23 MHz. A depth signal intensity (SI) was obtained by summing the 256 echoes acquired in the 100µm thick measurement slice (figure 2) using a CPMG pulse sequence with TE=100µs, TR=2s and 4 scans. Depth profile was then obtained by spanning the 16mm-height (80 depths and 200µm-step) of the sample thanks to the high precision lift. Transversal echo decays were also recorded at three specific depths (top, middle and bottom) for T2 measurements, with the following parameters: 2048 echoes, TE=100µs, TR=10s and 8 scans. Multiexponential analysis with NLS algorithm was used to extract multicomponent T2 distribution.

Results and Discussion

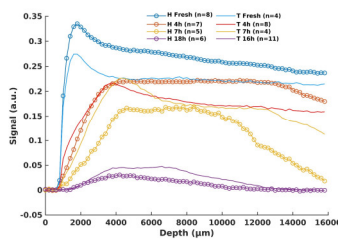


Figure 3 : Mean depth signal profiles in function of drying time of H1311 (circle) and Terradou (line) tomatoes.

Both tomato cultivars displayed depth profiles whose shape can be related to dehydration (Figure 3). 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 (Figure 4).

Both anatomical and water amount of tomatoes during drying are displayed in depth signal profiles

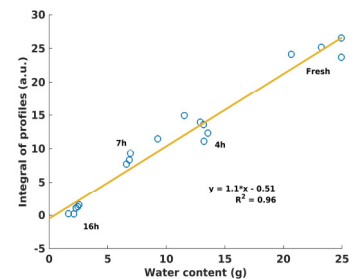


Figure 4 : H1311 integral of signal profile vs water content at each drying time.

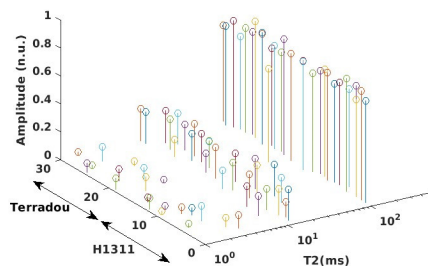


Figure 5 : T2 distribution of H1311 (1-15) and Terradou (16-30) fresh samples.

The common 3 (vacuolar, cytoplasmic and parietal) components distribution as the result of water compartmentation in fresh samples (Figure 5) (2) changed progressively to both a decrease and a great dispersion of T2 values by 7h (figure 6) of drying and to predominantly one short and unique T2 component after 16h of drying (figure 7).

These changes are attributed to both solute concentration (water loss) and physical changes (shrinkage and/or disruption) of cell membranes.

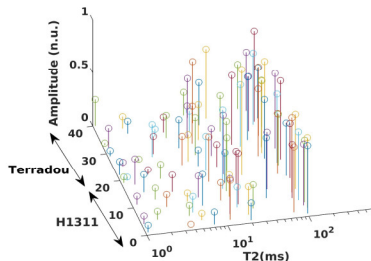


Figure 6 : T2 distribution of H1311 (1-20) and Terradou (21-40) samples after 7h of drying.

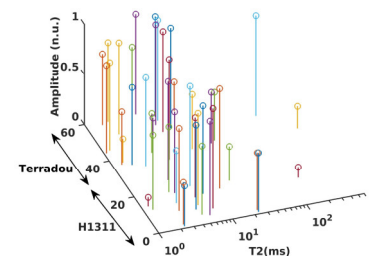


Figure 7 : T2 distribution of H1311 (1-30) and Terradou (31-60) samples after 16-18h of drying. Note that only samples displaying a sufficient SN ratio (18 for Terradou and 16 for H1311) are presented.

Conclusions

This study demonstrates the capability of single-sided nuclear magnetic resonance (NMR) to monitor the state of water in tomato during drying. Changes in tomato morphology along with its water content are faithfully displayed in depth signal profiles, whereas multiexponential T2 analysis allow to follow-up the changes in water mobility and compartmentation related to physicochemical changes associated to drying process.