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A NEW EXPERIMENTAL DEVICE TO MONITOR MASS AND DIMENSIONS OF SAMPLES DURING CONVECTIVE DRYING

Giana Almeida^{1,2}, Julia Parlatore^{1,2}, Floran Pierre³, Joel Casalinho³ and Patrick Perré³

¹AgroParisTech, UMR 1145 Genial, 1 av. des Olympiades 91744 Massy Cedex, France

²INRA, UMR 1145 Genial, 1 av. des Olympiades 91744 Massy Cedex, France

³CentraleSupélec, Université Paris-Saclay, LGPM, Grande Voie des Vignes, Châtenay-Malabry, France

Abstract: This article presents the results obtained from an experimental device designed for the accurate determination of hygroscopic and dimensional properties during convective drying. During drying, the mass and dimensions of the sample are continuously measured with a suspension magnetic balance and a digital camera, respectively. Experiments were carried out on cylindrical samples of potatoes. Three drying kinetics were tests. Potato samples showed values of isotropicity always around 1.2, meaning that shrinkage was slightly more important in the longitudinal direction.

Keywords: continuous measurement, convective drying, magnetic suspension balance, image analysis, physical properties, potato

Introduction

Convective air-drying affects the cellular structure of fruits and vegetables and generates extensive shrinkage (Aguilera and Stanley, 1999; Bai et al., 2002), mostly because of its high water content (Yan et al., 2007). Shrinkage influences water and heat transfer phenomena, which are useful information in order to develop equipment and processes as well as to predict quality losses during storage. The present work describes a new experimental set-up specially designed to acquire mass and dimensional data of samples during convective drying.

Material and method

To reach the purposes of this work a specific device was developed. The main dispositive was described by Hougan (2008) and has a mass system, based on a magnetic suspension balance (“Rubotherm” – maximum mass: 80g, with a resolution of 0.01mg), a humid air production system (“MHG 32” ProUmid GmbH & Co), a heat system and a data acquisition system. In addition to that, an image acquisition system was used in this study to allow the evaluation of shrinkage. The dispositive is shown in Fig. 1 (left).

The balance allows acquiring data of water loss, while the camera provides data of the shrinkage of the sample. Fig. 1 (right) shows an example of pictures taken by this system.

Images taken during the experiment were analysed with the software MeshPore to establish the height and diameter of the sample during the process. In order to observe the shrinkage at the cell level, images coming from an environmental scanning electron microscope were acquired on samples before and after drying.

Potatoes (variety “Agata”) analysed in the present work were bought in a retail shop in Paris, France. Samples were all cut in cylinders (8mm of diameter, 10mm of length) with the aid of samplers. Samples were suspended with a Molybdenum wire (0.25mm of diameter) connected to the balance by a hook, with total length of 60.37mm. Mass values were acquired each 30 seconds and photos were taken each 5 minutes.

Several drying kinetics were tests (drying temperature: 30, 50 and 70°C ; relative humidity of the air: 40 and 70%). Experiments were conducted until reaching a constant mass, which

depended on the conditions applied.

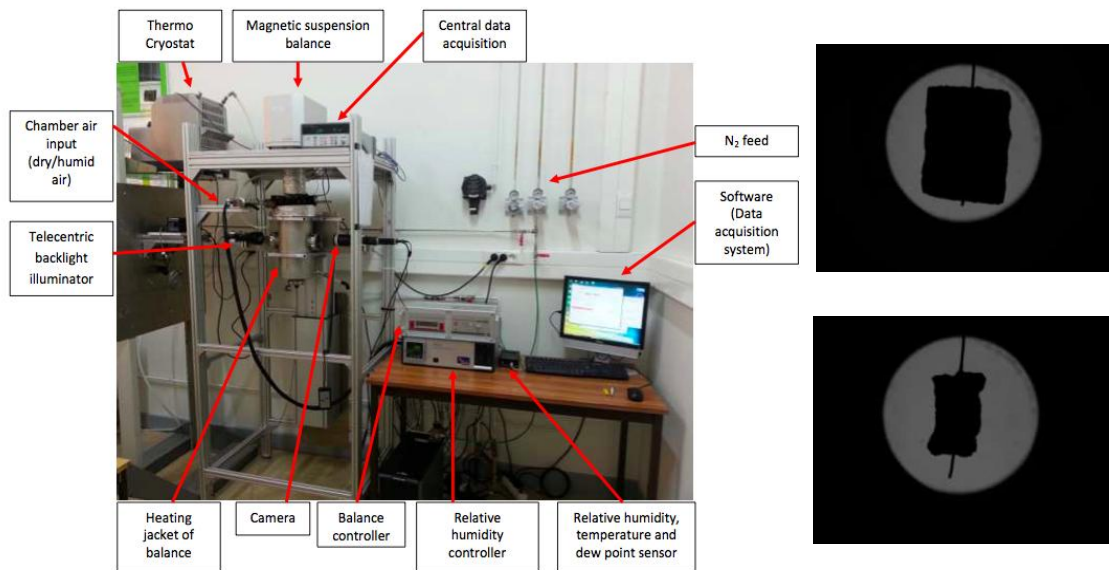


Fig. 1. Left: Equipment set-up. Right: Images of potato taken by the system before (up) and after (down) drying

Results

Mass and dimensional variation during drying allowed obtaining the following analysis:

- rate of change (dm/dt) of the mass versus time;
- mass flux versus moisture content (based on initial surface area and actual surface area);
- shrinkage coefficient and isotropicity versus moisture content;
- change of volume (ΔV) versus loss of water $\Delta m/\rho$.

Conclusion

The present work shows an innovative equipment specially designed to make continuous measure of mass and dimensions during convective drying. Several drying kinetics were applied on potato samples. Taking the changes in surface area into account for the evaluation of mass flux, a first drying period for potato could be found. Potato samples showed values of isotropicity always around 1.2, meaning that shrinkage was slightly more important in the longitudinal direction.

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