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Comparative study of various drying processes at physical and chemical properties of strawberries (Fragariavarcamarosa)

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Abstract

The objective of this work was to study and compare different drying processes of strawberry. The impact of DIC as texturing process within a swell drying operation was quantified when inserted before the second stage of hot air drying (swell drying SD). The obtained results showed that DIC treatment has a great impact on drying kinetics and performances compared to those of classical hot air drying. The drying of DIC-textured strawberry was accelerated even under low temperature (soft conditions). That can be explained by the direct impact of swelling on diffusivity and starting accessibility. Indeed, the mechanical effect of pressure drop leads to a great expansion of the structure, while the short thermal treatment time can preserve the quality. Thus, the new modified texture makes the trapped water accessible for improving the diffusion especially in the second stage of drying after the shrinkage of product, as well as in the rehydration process; the water holding capacity can be much higher. So the necessary time to reach the optimum final water content for the storage is shorter in case of DIC-swell dried strawberry compared to the classical hot air dried products.

Keywords: Instant controlled pressure drop;capsicum; drying kinetics; rehydration kinetics;water holding capacity

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1. Introduction

Strawberry is one of the most delicate and highly perishable fruits, due to respiration, weight loss and susceptibility to fungal contamination. At the same time, they are sensitive to chemical and microbial deterioration during post-harvest storage and handling, therefore, they have a rather limited shelf life in a fresh form [1]. Hence, large range of unit operations have been proposed and used to preserve it. New operations such as swell drying and freezing of partially dried products were defined combined to Instant Controlled Pressure Drop (DIC).

DIC is a high temperature short time (HTST) treatment followed by an abrupt pressure drop towards a vacuum implying an auto-vaporization of small amount of water from the products. It hence induces an instant cooling of treated products preventing their thermal degradation. Such a cooling gotten by abruptly dropping the pressure from high saturated steam level (from 0.1 up to 0.6 MPa to about 5 kPa with a rate of $\Delta P/\Delta t>0.5$ MPa s^{-1}) [2, 3] allows the product to cross the glass transition border. Thus the new swelled/expanded texture obtained after DIC treatment can be maintained. Thus, DIC treatment has two effects: the thermal effect as a result of the short-time/high-temperature induced by saturated steam; and the mechanical effect, which is induced by the difference between the high pressure inside the product and the surrounding vacuum. DIC enhances many unit operations such as drying; freezing and even extraction may not only maintain valuable compounds found in fresh products but can also improve both of their availability and activity. Likewise, DIC process has been used to swell-dry, decontaminate, and texture various fruits and vegetables; it ensures a high quality by improving the kinetics and the capacity of both dehydration and rehydration processes as well as the possibility of preserving and even increasing the organoleptic content and the availability of bioactive compounds such as antioxidant activity [4-6]. Moreover, dried products could be directly consumed as snacking or in many other powder forms to produce high quality puree, jam, ice-cream, baby foods, breakfast cereals, possibly rehydrated with yoghurt and bakery products [7].

The aim of this study was to compare various drying techniques; Hot Air Drying (HAD), Freeze Drying (FD), and Swell drying (SD); coupling the traditional hot air drying to DIC treatment. A comparative study was conducted to evaluate the different drying techniques in terms of drying kinetics (drying time starting accessibility, effective water diffusivity), rehydration kinetics (rehydration time, starting accessibility, effective water diffusivity), and water holding capacity of dried strawberries (Fragaria Var. Camarosa).

2. Materials and Methods

2.1. Materials

The strawberries (Fragaria Var. Camarosa) were purchased from a popular local market of La Rochelle city, France. They were transported to the laboratory and stored at 5ºC for 24 h.

2.2. Methods

2.2.1. Sample Preparation

Strawberries were selected, cleaned and washed with potable water; they were subsequently cut with a hand knife into 4-5 slices. For the treatment, they were divided in three lots for being processed by hot air HAD, freeze-drying FD and swell drying SD.