Effect of pulsed electric field pre-treatment on microstructure and internal transport throughout osmotic treatment of organic kiwifruit

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Plant cellular structure could be considered a complex organized system where flows are carried out by different solutes or solvents transports systems. Passive transports, which is based on the free energy gradients, involve symplastic, apoplastic and aquaporins transmembrane transports. During osmotic dehydration (OD) treatment the semipermeable membranes such as plasma membrane and tonoplast, are forced to separate, due to the water losses from the vacuoles, starting the process known as plasmolysis, characterized by the loss of the turgor pressure. In the last years, OD has been extensively studied for the partial dehydration of fruits and vegetables in order to obtain semi-moist products; however, it presents some limitations such as the low dehydration rate and the high solute content in the final product. Therefore, the use of pre-treatment such as Pulsed Electric Fields (PEF) has been reported to facilitate water removal and to improve the quality of the dried or osmo-dried products. PEF is a non-thermal technology which involves the application of short and repeated voltage pulses to a biological tissue placed between two electrodes; it induces changes and reorganization in the electric conformation of the cell membrane, modifying the normal fluxes during drying process when it is used as a pre-treatment. In present work PEF has been applied as a pre-treatment prior OD of organic kiwifruits (*Actinidia deliciosa* cv Hayward) in order to evaluate its effect on the internal structure and internal water transport. PEF pre-treatments were performed using the following parameters: E= 100, 250 and 400 V/cm, 60 near-rectangular shape pulses, pulse width of 100 ± 2 μs and a repetition time of 10.0 ± 0.1 ms). The OD was carried out by immersing the samples in 61.5% sucrose solution at 25 °C for different time period (0-120 min). The samples were analyzed in terms of microstructure by Cryo-SEM microscopy and internal water transport by Time Domain Nuclear Magnetic Resonance (TD-NMR). The results showed that the application of a PEF pre-treatment before the OD produces a process of plasmolysis proportional to the electric field strength applied. It is because the PEF removes the mobile charges of the medium, such as

electrolytes, organic acids, amino acids; Ca^{+2} is the major culprit of the plasmolysis because it fixes some of the junctions of the microtubules between the cell wall and the membrane.

In addition, the process of plasmolysis induced by the electric field changes the behavior of kiwifruit tissue during the OD process. In a standard OD without any pretratment, the main transport is the symplastic, whereas if previously treated with PEF, the apoplastic transport is as important as the symplastic, considerably increasing the rate of dehydration.

Keywords: osmotic dehydration, PEF treatment, internal water transport, microstructure.

Classification: Pulsed Electric Fields Technology for Food Pasteurization, Dehydration, Extraction, and Structure Modification

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