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Estimation of the diffusivities of sodium chloride, potassium sorbate and sodium bisulphite in mango slices processed by hurdle technology

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ABSTRACT

The fractional amount of sodium chloride, potassium sorbate and sodium bisulphite were evaluated in mango slices immersed in limited volumes of syrup at 25, 50 and 70 °C. The syrup contained 250 g sucrose, 1.5 g sodium chloride, 0.5 g potassium sorbate and 0.25 g sodium bisulphate per kilogram of solution. The sodium chloride concentration in the syrup was confirmed with a flame photometer, and the concentrations of potassium sorbate and sodium bisulphite were determined using high-performance liquid chromatography (HPLC). Fick's second law was used to calculate effective diffusion coefficients and to predict solute content in the mango slices. Diffusion coefficients were affected by temperature and were correlated by the Arrhenius equation. The experimental data fit the proposed mathematical model well, allowing prediction of the system's behavior at different temperatures. The resultant diffusivities ranges were 2.63–3.54 × 10^{-9} m^2/s for sodium chloride, 3.88 × 10^{-9}–8.3 × 10^{-10} m^2/s for potassium sorbate and 1.83 × 10^{-7}–5.98 × 10^{-8} m^2/s for sodium bisulphite.

1. Introduction

Mango (*Mangifera indica* L.) is one of the most important tropical fruits. This fruit is relished for its succulence, exotic flavor and delicious taste; moreover, mango is a rich source of carotenoids and provides high vitamin A content (Pott et al., 2003). According to FAO (2007), more than 26.5 millions of metric tons of mango were produced worldwide, with México as the fourth most important producer after India, China and Thailand, but being the major exporter country in the world, providing about 29.7% of the exportation volume. Most mangoes are consumed fresh, but some non fibrous pulpy mango varieties are used for processing. However, substantial quantities of mangoes are wasted because of poor post-harvest management and lack of appropriate facilities in developing countries. Therefore, development and application of inexpensive preservation techniques to produce high quality and acceptable products of mango could be valuable, allowing a better use of the fruit (Ulloa et al., 2008). Hurdle technology, characterized by an intelligent combination of some soft treatments, or hurdles (Leistner, 1995; Leistner and Gorris, 1995), has confirmed to be an economic and useful method in production of processed fruit. If the process conditions are appropriately selected, microbial quality and good appearance of the products during storage may surely guaranteed (Alzamora et al., 1995; Tapia de Daza et al., 1996).

Solute diffusion phenomena through inside or outside of the processed material, plays an important role in a variety of unit operations of the food industry, such as dehydration (Daudin, 1983), osmotic treatments (Karel, 1976) and leaching processes (Schwartzberg and Chao, 1982). Due to its effects on quality characteristics, texture, flavor, color and microbial stability, the diffusion mechanism of certain additives has been researched for some foods (Rosselló et al., 1993; Lombardi and Zaritzky, 1997; Han and Floros, 2000; Souza-Filho et al., 2000; Sacchetti et al., 2001; Sereno et al., 2001; Franssen et al., 2004; Choi et al., 2005; Haros et al., 2005). The classical method of processing fruits by hurdle technology consists in taking the blanched fruit to a stage of water activity depression in a vessel containing syrup. This syrup is generally prepared using sucrose, citric acid (pH 3.0–4.1), potassium sorbate or sodium benzoate, and sodium bisulphite; the container with the fruit and syrup is then kept at room temperature for a period of 3–5 days. When concentration reaches a pseudo-equilibrium stage, fruit slices are drained and packed in glass jars, or high density polyethylene bags, with enough syrup to cover them up (Alzamora et al., 1993, 1995; Tapia de Daza et al., 1996). This minimum process is important not only because its simplicity and energy efficiency, but also because it generates products with

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