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Osmotic Dehydration – A Pre-treatment for Pineapple Drying

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INTRODUCTION

Osmotic dehydration is widely used to remove part of the water content of fruit to obtain a product of intermediate moisture or as a pre-treatment (**1**). Osmotic dehydration is used as a pre-treatment for further drying to improve sensory, functional and even nutritional properties. The shelf life quality of the final product is better than without such treatment, due to the increase in sugar/acid ratio, the improvement in texture and the stability of the colour pigment during storage (**2**).

Vacuum impregnation is the application of a reduced pressure to a solid-liquid system, followed by restoration of the atmospheric pressure (**3**). Recently, osmotic dehydration at vacuum pressure has been studied, since a faster dehydration can be achieved with this treatment, as well as the controlled impregnation of active compounds into the material. An advantage of osmotic dehydration at vacuum pressures over atmospheric osmotic dehydration is that the solid-liquid interface area and the mass transfer between both phases can be increased (**4**).

Osmotic dehydration as a pre-treatment for further dehydration work was studied on South African grown Cayenne type pineapple. Osmotic dehydration was considered as a pre-treatment for pineapple with the final aim of obtaining high quality dried fruit products.

MATERIALS AND METHODS

Figure 1.

Pineapple cylinders of 2 cm in diameter and 1 cm thick were cut using a cork borer (**Figure 1**). The pieces were immersed in sucrose solutions of 45, 55 and 65 °Brix at 30, 40 and 50°C for 20, 40, 60, 120, 180 and 240 minutes. Experiments were conducted at both atmospheric pressure (OD) and applying a 200 mbar vacuum pulse (PVOD) during the first 10 minutes.

Analyses

- Three of the samples were marked so that the same samples were monitored for weight change throughout the process.
- The moisture content was determined using the oven drying method described in AOAC, Method 934.06.
- The soluble solids were measured by refractometry.
- The change in weight (ΔMt), the solutes/sugar gain (ΔMss) and the water loss (ΔMw) were calculated from simple mass balances:

$$\Delta M_t = \frac{M_t - M_o}{M_o} \qquad (1)$$

$$\Delta M_w = \frac{M_t x_{wt} - M_o x_{wo}}{M_o} \qquad (2)$$

$$\Delta M_{ss} = \frac{M_t x_{sst} - M_o x_{sso}}{M_o} \qquad (3)$$

Where:
M_o = initial weight (g)
M_t = weight at time t (g)
x_{wo} = initial mass fraction of water (g/g)
x_{sso} = initial mass fraction of soluble solutes (g/g)
x_{wt} = mass fraction of water at time t (g/g)
x_{sst} = mass fraction of soluble solutes at time t (g/g)

The data were analysed with an ANOVA multifactor design in StatGraphics (StatPoint Inc., Herndon, VI, USA).

RESULTS AND DISCUSSION

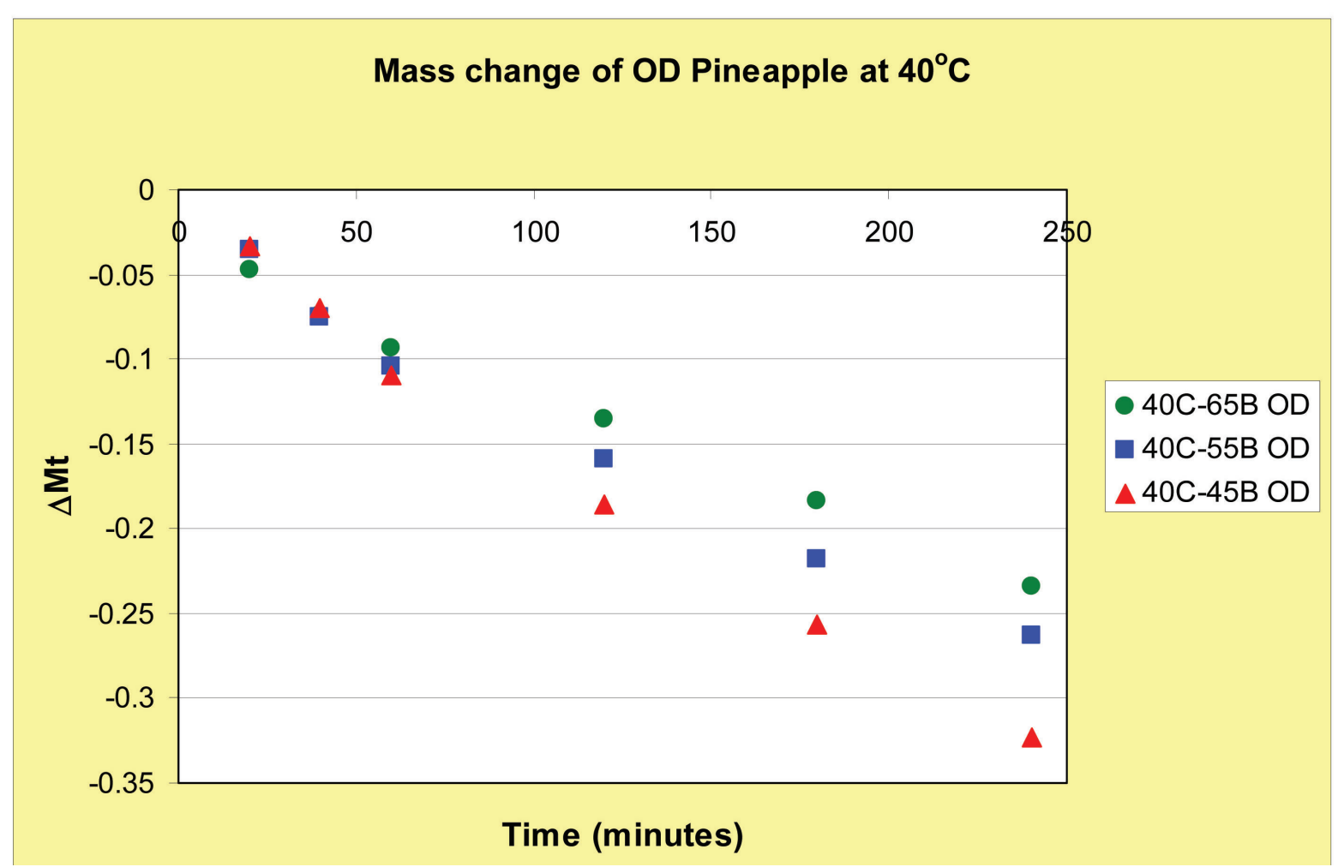

Figure 2.

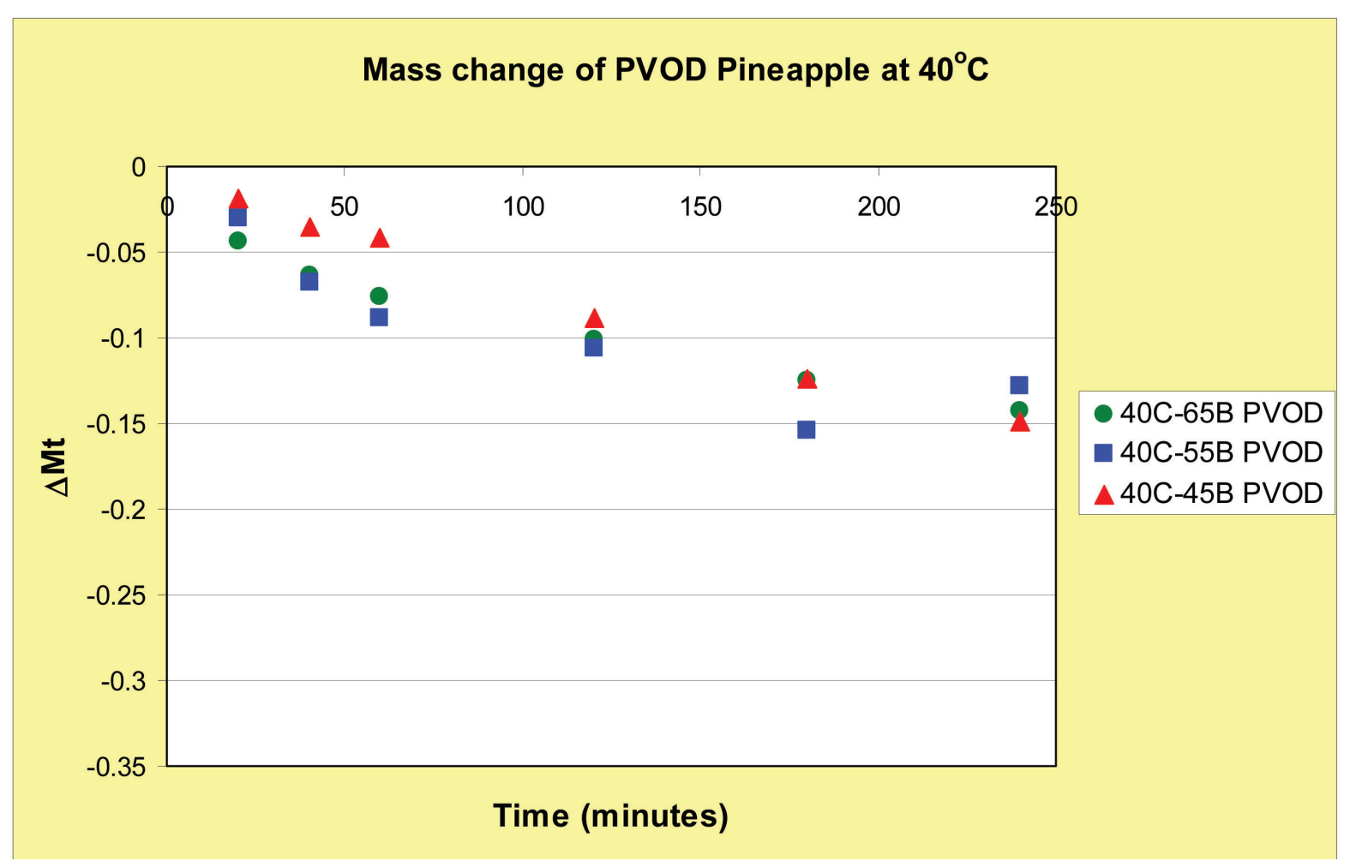

Figure 3.

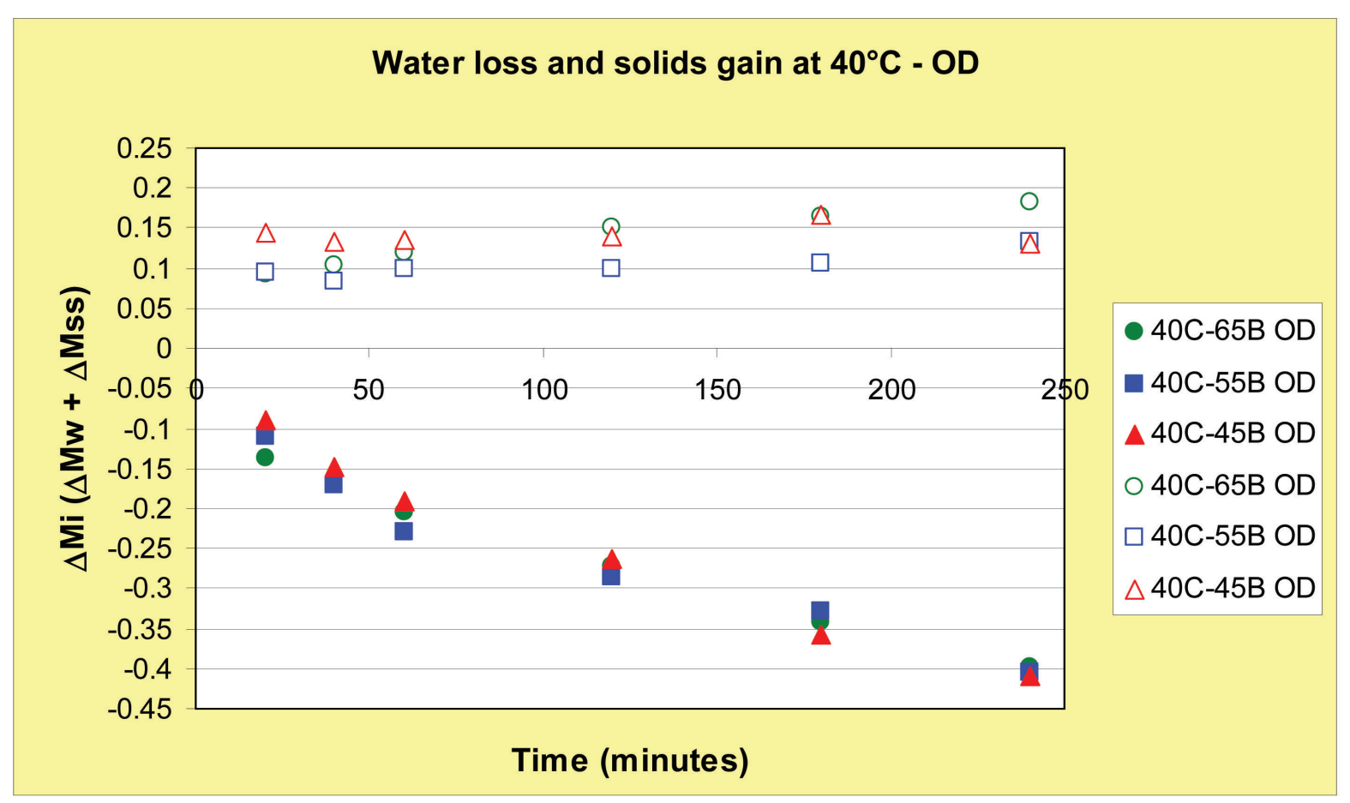

Figure 4.

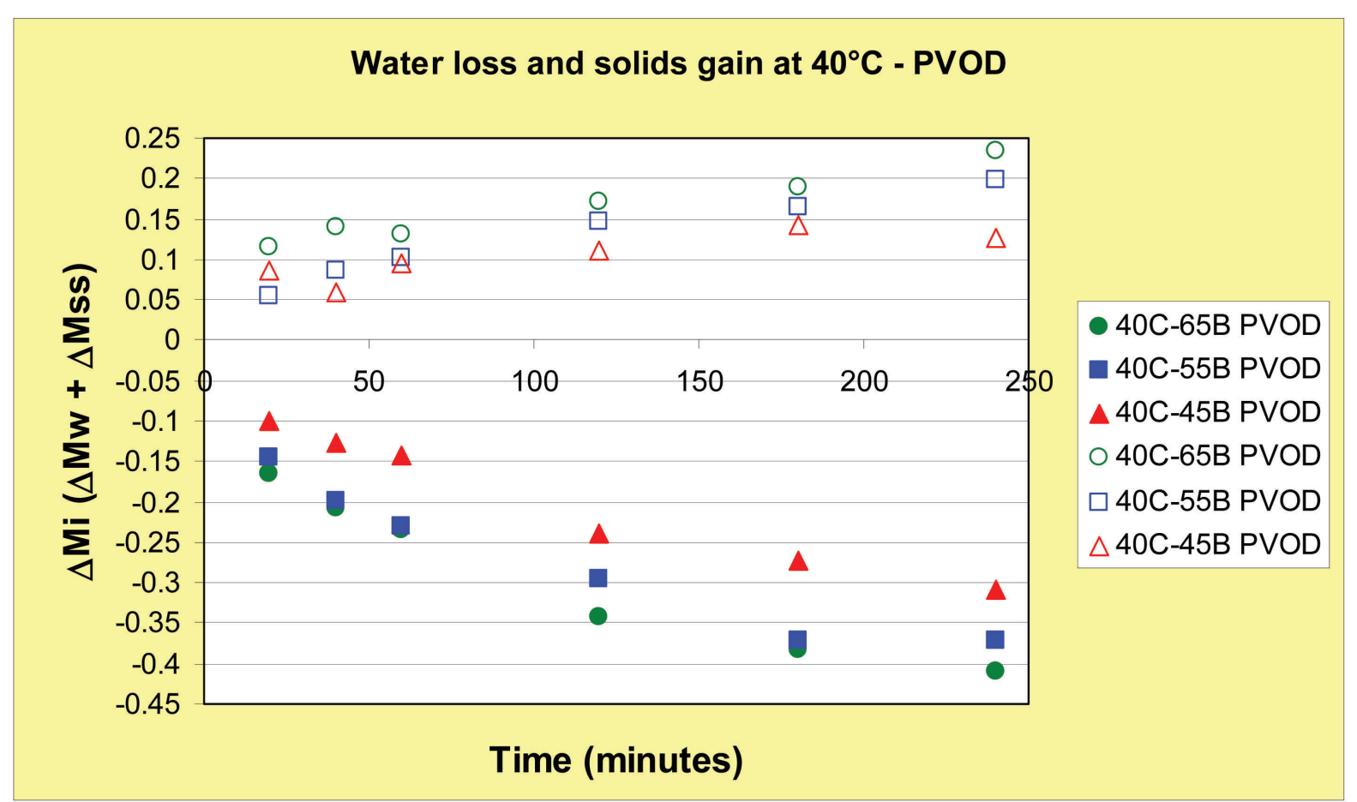

Figure 5.

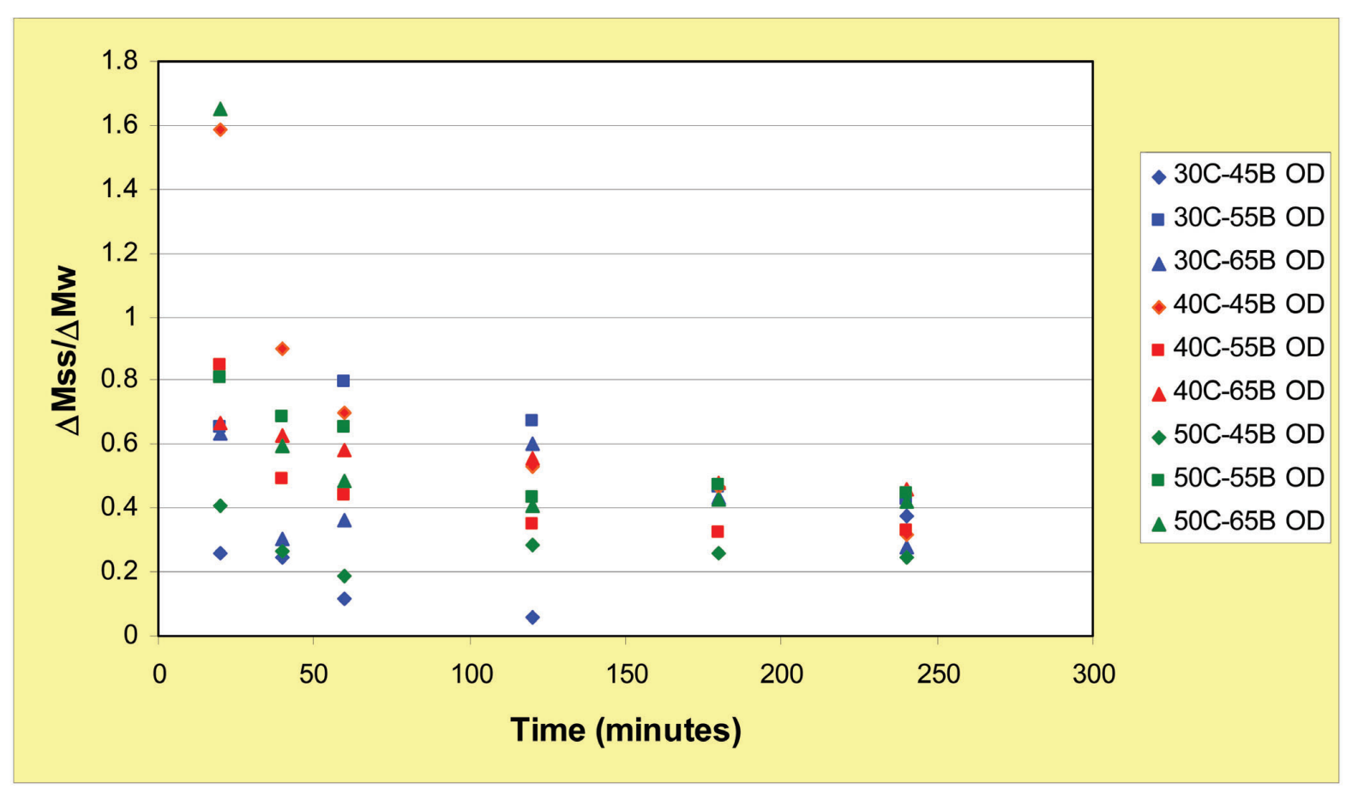

Figure 6.

Figure 3 shows the effectiveness of the vacuum pulse, since lower values of ΔM_t are obtained vs. that of OD treatment in **Figure 2**. The mass loss was lower when treated with a vacuum pulse due to the action of the hydrodynamic mechanism. The pressure gradients established during the vacuum pulse promote the outflow of the internal gas. A compression of the residual gas takes place when restoring the atmospheric pressure, which is coupled with an inflow or uptake of external osmotic solution, and thus higher ΔM_{ss} are obtained (**Figure 4 & 5**).

Figure 6, showing the $\Delta Mss/\Delta Mw$ ratio, is used to evaluate the process conditions. The points showing the lowest Mss/Mw ratios are the ones indicating an optimal water loss without excessive sugar gain, and this will be advantageous in terms of energy saving. In pineapples the purpose is to impregnate just enough sugar so that an expectable structure and taste is maintained after further final drying.

Water loss and solutes uptake will not only affect the final composition, but also the sensorial quality and stability of the product. The sum of these two counter current fluxes will result in a net mass change that has an influence on the yield of the osmotic process.

In this case, a vacuum pulse is recommended for processes where the objective is to maximise the yield or to increase the sugar content. Although there are no significant differences in water loss, it is well known that water activity (a_w) can be decreased by removing water, but also by adding solutes, therefore, in terms of stability, samples treated with a vacuum pulse will have a lower a_w value for the same amount of water loss.

CONCLUSIONS

The yield of the process was improved by applying a vacuum pulse, since mass loss was less in those cases. It also facilitated the process of solids gain, especially at the higher concentration and temperature.

Water loss increased mostly by increasing temperature and was less sensitive to changes in the concentration of the solution.

Solids gain increased mostly with concentration, being less sensitive to temperature.

ACKNOWLEDGEMENT

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