Plums and Prunes in the Variable Pressure Scanning Electron Microscope

Veitch, C.[1]

[1] CSIRO Manufacturing, Australia

Imaging plums and prunes in the Scanning Electron Microscope (SEM) has traditionally been done by freeze fracturing the fruit, subliming and then using a cryo-stage to allow the sample to be imaged[1]. In this work we look at the use of the Variable Pressure Scanning Electron Microscope (VP-SEM) to image the surface and skin structure of the fruit without the use of cryogenics or conductive coating.

The commercial production of prunes from fresh plums is a very time and energy intensive process; taking up to 35 hours to complete with energy costs making up around 50% of the total production cost. The water content of the plum is reduced from approximately 70% to 20 - 30% (approximately 40 - 50% mass loss) during this process[2]. New methods of production involving chemical treatments, ultrasound and heating are being used to reduce the amount of surface wax which forms a moisture barrier and hence reduce the amount to energy required to remove the moisture. In this work, plums (d'Agen variety - the most commonly used for prune production) were exposed to combinations of up to four treatments. The treatments were combinations of: ultrasonication, soaking in water, a chemical (Ethyl Oleate (EO)) treatment and drying (60 °C and 15% RH) for up to five hours. Drying data in figure 1 indicates a mass loss of approximately 40%, which is consistent with commercial processes.

For imaging in the VP-SEM, the skin of the fruit was cut and removed using injector blades (Diplomat Stainless Steel) and adhered to aluminium sample holders using double sided carbon tape. The samples were then imaged in a Hitachi S4300 SE/N SEM. The Environmental Secondary Electron Detector (ESED) was used with a pressure of 50 Pa, accelerating voltage of 20 kV, at room temperature and a working distance of 15 mm. The samples were mounted so that both the skin surface and cross-section could be imaged.

Images of the surface of the fruit (figure 2) show that the treatments have removed the waxy filaments (visible in figure 2A) on the surface compared to figure 2B after treatment. However, there is still wax present as can be seen in figures 2B and 3B. The remaining wax is in the form of small nodules on the surface as indicated by the arrows in the figures.

The author acknowledges Dr H Sabarez of CSIRO Food and Agriculture for the provision of the samples.

[1] R. Storey and W.E. Price, "Microsctructure of the skin of d'Agen plums," Sci. Hort., vol 81, pp. 279-286, September 1999.

[2] H.T. Sabarez, "Computational modelling of the transport phenomena occurring during convective drying of prunes," J. Food Eng., vol. 111, pp. 279-288, July 2012.

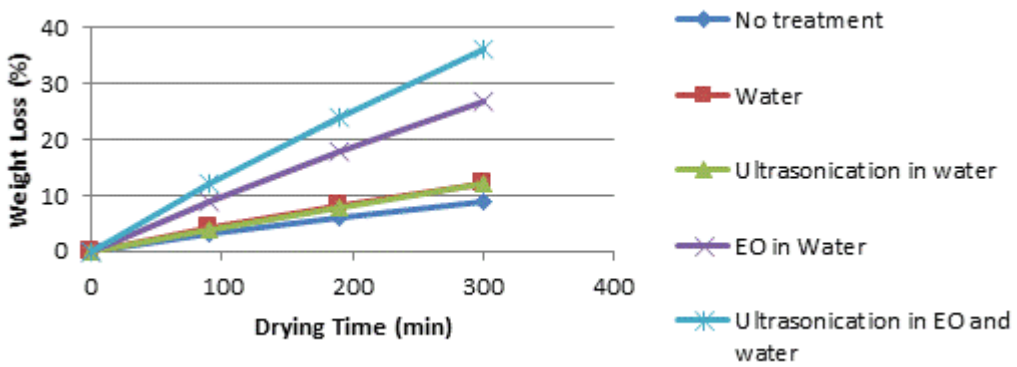

Figure 1. Drying data

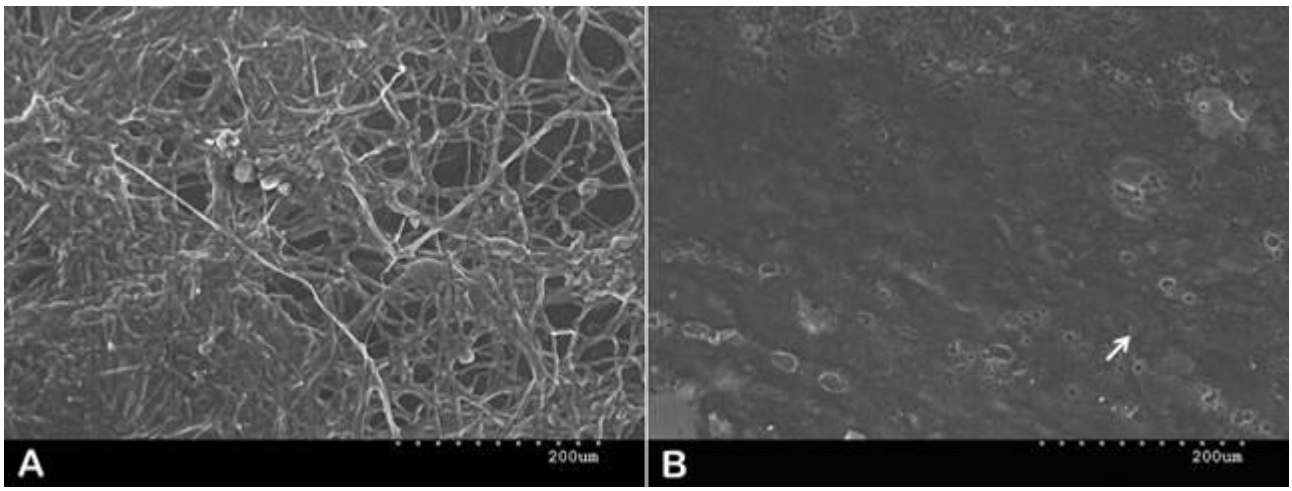

Figure 2. ESED images of the skins of untreated (A) and fully treated (B) plums.

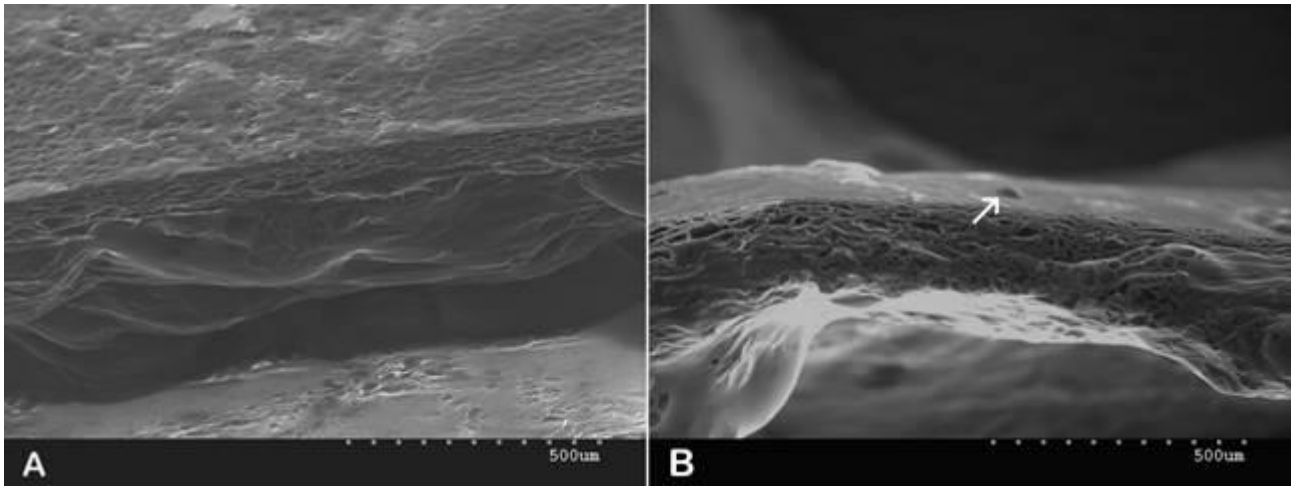

Figure 3. ESED images of the cross-section untreated (A) and fully treated (B) plums (the surface of the plum is to the top of the image)