

The Ultrastructural Examination of Spray-dried Microalgal Cells with Low Vacuum Scanning Microscopy and X-ray Microanalysis

Liang P. Lin and Ching B. Liu

Electron Microscopy Laboratory, Department of Agricultural Chemistry, National Taiwan University, Taipei, Taiwan 106, R.O.C.

A green alga, *Chlorella* is cultivated on large scales in Taiwan. Commercially, the harvested *Chlorella* cells are dehydrated by spray dryers and dried products are sold as the health foods. The microstructure of this powder reflects an important factor for the health food industry. This research was performed by using a low vacuum scanning electron microscope (LV SEM) with x-ray energy dispersive microanalyzer (EDX) as the important instrument to determine the fine structures and chemical elements of spray-dried microalgal cells. We mainly focused on the outer surface and inner structure of particles, and also determined the existence of some chemical elements.

Spray-dried *Chlorella* powders were mounted on an aluminum specimen stage (stub) by pressing on a double stick of 3M Scotch adhesive tape. The prepared specimens were examined in a JEOL JSM-5400LV at an accelerating voltage of 2 to 15 kV, and specimen chamber pressure of 14 to 140 Pa (0.1 to 1 Torr). The analysis of chemical ions was performed by a JEOL "Mini Cup" energy dispersive x-ray micro-analyzer. Most of the spray-dried cells showed the range of 20 to 60 μm in diameter with an irregular spherical shape (Fig. 1). At the higher magnification, it revealed that wrinkled surface structure possessing a smooth appearance (Fig. 2). This phenomenon was produced by elevated temperature treatments during the degradation and dehydration processes. The higher temperature was used, the more alteration was induced on the morphology of the particles. On some samples, the ash-like materials were clearly distributed on the surface of particles owing to unsuitable heat treatments. These results were not observed in our previous experiment (Lin 1985

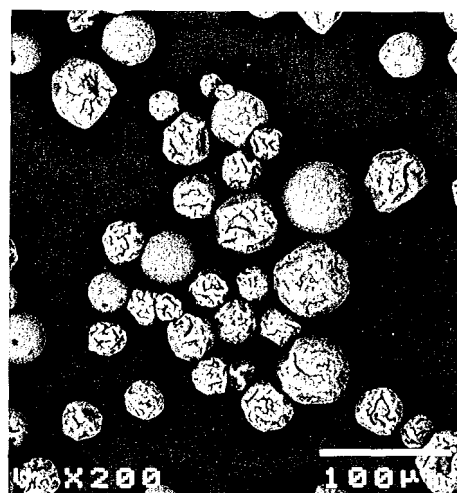


Fig. 1. A LV SEM photograph of spray-dried *Chlorella* cell-granules (particles).

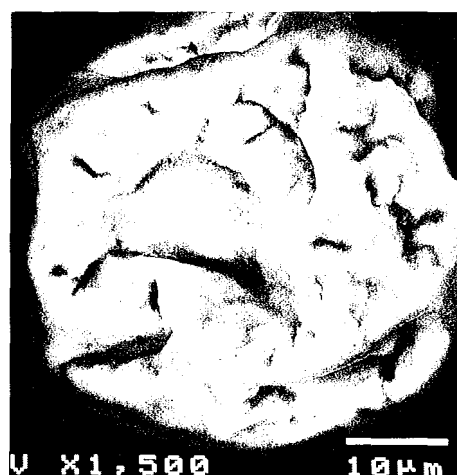


Fig. 2. A spray-dried *Chlorella* particle, showing a fused appearance.

Food Mic-rostruc. 4:341-348) by using the conventional SEM.

Some particles possessed the hole structure inside. This structure was formed during the evaporation of water from an algal droplet surface by spray-drying. The powder-particles of an acceptable for commercial uses were 50 to 80 μm in size with suitable hardness and dispersibility for tablet properties. Fig. 2. A spray-dried *Chlorella* particle, showing a fused appearance. Fig. 1. A LV SEM photograph of spray-dried *Chlorella* cell-granules (particles).

The x-ray microanalysis spectra indicated that Cu, Si, Mg, P, S, K, Ca, and Fe ions were present in the powders. There were no indications of heavy metal ions existing in significant amounts. Elemental analyses were carried out without in-

terference of coating materials as used in conventional SEM. The serious health effects from food stuffs and drinking water contaminated by heavy metals, such as lead (Pb) and arsenic (As) have become one of the major concerns of the people of Taiwan. The Pb and As contents of *Chlorella* powders examined in our laboratory by atomic absorption spectrometry were about 1 to 3 ppm and less than 0.5 ppm respectively. This content is in the safe level of food standards.

In conclusions, the LV SEM and x-ray micro-analyzer provide us to observe fine structure and elemental analysis for the food quality control. This method also allows us to observe specimens without any particular preparation, such as drying and coating required by the conventional SEM.