Electro-spraying – A novel coating technique for foods

Muhammad Kashif Iqbal Khan, Maarten Schutyser, Karin Schroën, Remko Boom

Wageningen UR

Novel and efficient methods for thin film coating are of continuous interest to food industry, since it allows control over the surface properties of the food. For example, there may be a need to coat a food with a water or oxygen impermeable barrier, or alternatively, a minor component may need to be distributed uniformly over the product. Spray coating is amongst the most commonly used application methods to coat foods. Conventional spraying methods are hydraulic spray nozzles, gas assisted, and ultrasonic atomizers. A less well-known atomization method for liquids is electro-spraying; electrostatic forces are utilized to overcome surface tension forces and disintegrate a jet liquid into diminutive droplets, and a fine jet is produced at some distance from the nozzle outlet. The technique has received significant attention in paint, pharmaceutical and other industries due to its ability to produce small droplets, even down to submicron size, but not yet in food.

The aim of this project is to investigate the formation of lipid-based coatings on foods using electro-spraying. The atomization process itself was investigated for its dependency on flow rate and liquid properties, such as conductivity. The distribution of diminutive droplets across the target surface and subsequent thin film formation is studied in detail.

Electro-spraying of food grade sunflower oil was carried out by a single nozzle system on a model target surface (aluminium foil) moving on a conveyor belt. The droplet size on target surface was analysed with microscopic analysis. This droplet size was compared to an established empirical model for predicting droplet size during electro spray atomization in cone-jet mode. Parameters such as liquid conductivity, flow rate, and nozzle height were varied. It was found that experimental data was in good agreement with model predictions.

This demonstrates that model could accurately describe the effect of flow rate and conductivity on droplet size for oils. In line with model predictions, it appeared that droplet size decreased with increasing conductivity and increased with increasing flow rates. Droplets produced were of uniform size and with narrow size distribution. However, droplet density on the target surface appeared to be relatively high in the middle of spray lane compared to outer region. At the lowest conveyer belt speed (4.4 mm/s), only about 60% of target surface was covered. Complete film formation was achieved after 2-3 passes.

In summary, electro-spraying of oil on aluminium could be well characterized by an empirical model predicting droplet size during electro spray atomization in the cone mode. Furthermore, preliminary results show that when using a single nozzle electro spray multiple passes are needed to achieve complete surface coverage. Future studies will focus on film formation and characterization of films with respect to their functionality (e.g. preventing gas or water migration).