2002 MAFMA Final Report

Project Title	**Liquid Electrostatic Coating Using Oil and Water Based Coatings**
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1. Objective Summary

The objective of this project is to improve the application of oil or water soluble colors, flavors and vitamins onto foods using electrostatic coating. The effect of the liquid physical properties on coating transfer efficiency and reproducibility was tested.

2. Objective Accomplishments

Effect of physical properties on coating reproducibility

The viscosity, conductivity, surface tension, voltage, and flow rate were measured on a range of liquids and correlated to their transfer efficiency and reproducibility when coated electrostatically and nonelectrostatically onto various snacks. Electrostatic coating almost always produced significantly more efficient and reproducible coating than nonelectrostatic coating. Voltage had the most significant effect on reproducibility, followed closely by conductivity, and then flow rate. Viscosity had the least significant effect on coating reproducibility and was only significant through interaction with other factors. Surface tension was not a significant effect. Knowing the values of these parameters enables us to predict how efficiently and reproducibly the oil will coat the food item.

Voltage is the most important factor to coating reproducibility in electrostatic coating. Coating was the most reproducible in the 32.5-35kV range. As voltage increased or decreased outside of this range, reproducibility decreased. This is because an optimal charge concentration must be present to produce reproducible coating.

Conductivity had no effect on reproducibility at high voltages. At low voltage, increasing conductivity decreased reproducibility. Increasing conductivity decreases the momentary charge concentration, decreasing efficiency of atomization and therefore decreasing reproducibility.

Increasing flow rate made coating less reproducible. This is because increasing the flow rate increased the amount of solution passing through the system without changing the amount of

charge being delivered to the system. As the flow rate of the product through the system increased, the concentration of charge decreased, which decreased the reproducibility.

Viscosity alone did not have a significant effect on reproducibility, but it did interact with voltage. As viscosity increases, the mobility of the charge-carriers decreases, resulting in more reproducible coating because the local charge concentration is increased.

Atomization of water-soluble additives

A water-in-oil emulsion was developed that can be electrostatically atomized. Typically, only oil can be electrostatically atomized because the conductivity of other fluids is too high. However, we were able to form a liposome using lecithin which restricts the conductivity of the solution into the range necessary for atomization. Water and ionic additives can be added into the emulsion and still produce good atomization. The resulting emulsion produces very even, reproducible coating.

3. Unexpected findings, if any

A method was developed to allow water and ionic solutions to be atomized electrostatically. This was unexpected because conventional wisdom is that only oils and low conductivity materials can be electrostatically atomized. We were able to develop an emulsion with low conductivity that atomizes electrostatically.

4. Practical impacts of research efforts.

Short term impacts:

This information has been given to the equipment manufacturer who makes electrostatic coating equipment, Terronics. We and they have both demonstrated the electrostatic spraying of emulsions to a number of food companies. These companies have expressed interest in the technique and at least one is pursuing the technology privately with the equipment manufacturer.

The program that was developed based on the physical properties of the oil is being used in our laboratory to predict and optimize test runs. The physical properties of the oil to be sprayed are measured and adjusted based on the results of the computer predictions before tests are run.

Long Term Impacts:

The results of this study have expanded the applications for liquid electrostatic coating. The emulsion technique allows water as well as oil to be coated onto foods electrostatically. Since electrostatic coating is more even, targeted and reproducible than nonelectrostatic coating, this expands the options for the food industry to produce good coating. They are now able to electrostatically spray emulsions as well as oils.

Ongoing research:

This research area continues to be an active one in my lab. The emulsion technique is being used in most tests. Future work will focus on specific applications of colors and flavors to quantify the improvement in evenness of the process.

5. Two manuscripts are submitted, but not yet accepted.