ANNOUNCEMENT
Final Examination for the Degree of MSc

ALEXIA BLAKE
Date: March 27, 2015
Time: 1:30 p.m. to 4:00 p.m.
Location: FS128

Examining Committee
Dr. Michael Rogers, Chair
Dr. Alejandro Marangoni, Advisor
Dr. Sandy Smith, Advisory Committee Member

TITLE: The Microstructure and Physical Properties of Plant-Based Waxes and their Relationship to the Oil Binding Capacity of Wax Oleogels

ABSTRACT: Optical light microscopy, differential scanning calorimetry, powder x-ray diffraction, and small deformation rheology were used to determine the microstructure and physical properties of rice bran (RBX), sunflower (SFX), candelilla (CLX), and carnauba (CRX) wax. Chemical homogeneity was found to be a main factor affecting the morphology of the wax crystal network, which was determined to be platelet-like using cryo-scanning electron microscopy for all waxes. In order to elucidate the relationship between wax microstructure and gel oil binding capacity, oil loss values were compared to microstructural features such as crystal size, pore area, and mass distribution. Linear correlation analysis indicated that pore area fraction increases as the fractal dimension of a network decreases, correlating to a lower oil binding capacity. Thus, these two parameters can be modified to tailor the oil binding capacity of wax oleogels. A significant reduction in oil loss was observed when the pore area fraction was below 96%.

Under static cooling, CLX and SFX exhibited the greatest oil binding capacity. Rapid cooling decreased crystal length, increased the pore area fraction, and increased the fractal dimension of the crystal network, causing the oil binding capacity of wax oleogels to increase. Shear during crystallization under low cooling rates increased the oil binding capacity of RBX gels and decreased the oil binding capacity of SFX and CLX gels due to shear-induced crystal aggregation for RBX and SFX gels, and an increase in CLX platelet size. Wax oleogels retained more oil than gels containing a commercial peanut butter stabilizer, demonstrating their impressive oil structuring ability. Waxes were also added to the oil phase of a structured oil-in-water emulsion. Modifying the emulsion to include 10% (w/w) wax, palm oil, the gelation of the oil phase with 5-7.5% (w/w) RBX, or the use of C-18 or C-22 saturated monoglyceride at 6% or 4% (w/w), respectively, increased the elastic modulus of the original emulsion from 8.42x103+11.3 Pa to 1.55x106+2.1x105 Pa, and the yield stress from 112+2.31 to 835+227 Pa so that it can be used as a zero trans and reduced saturated fat laminating shortening substitute for puff pastry products.