Abstract

Nanoemulsions, kinetically stable suspensions of immiscible liquids, are utilized in the pharmaceutical and food-and-beverage industries to incorporate lipophilic bio-actives or ingredients into an aqueous environment and improve their bioavailability. Lycopene, an anti-carcinogenic, lipophilic, carotenoid suffers from low bioavailability upon ingestion and, therefore, cannot be delivered to humans effectively. Incorporating lycopene into a nanoemulsion could overcome this issue in delivery. A common method of preparing nanoemulsions is high-power, probe ultrasound that promotes intense cavitation in a liquid mixture of water, oil and surfactants. While ultrasonic nanoemulsification has been performed on the laboratory-scale for decades, scaling limitations prevented this method from use at the industrial-scale until recently. To that, considerations about ultrasonic processing of nanoemulsions was, until this work, largely unexplored.

In this thesis, formulation development and ultrasonic processing parameter evaluation was performed on several nanoemulsions containing different surfactants and oils. Two primary conclusions, among many other secondary ones, were drawn. Firstly, a linear relationship between increasing surfactant-to-oil ratio (Φ) and decreasing nanoemulsion droplet diameter was observed, indicating that ultrasonic nanoemulsification may be superior to alternative high-energy nanoemulsification methods which exhibit limiting behavior in nanoemulsion droplet diameter reduction as Φ increases. Secondly, the nanoemulsion droplet diameter could be reversibly modulated with the processing temperature, suggesting that nanoemulsification is a more chemically driven process than previously believed. After completing these studies, lycopene-loaded nanoemulsions were formulated and compared to non-emulsified lycopene in the treatment of human chronic myelogenic leukemia cancer cell line (K562) in vitro. Lycopene-loaded nanoemulsions decreased k562 proliferation by 75% compared to non-emulsified lycopene and, further, it was revealed that lycopene-loaded nanoemulsions limited k562 cell proliferation in a dose, time and droplet diameter-dependent manner.