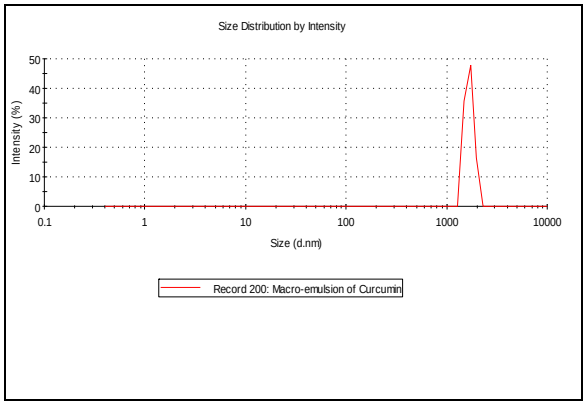
Nanocomplexes for Functional Micronutrients: Nanoemulsions for Increased Solubility and Bioavailability of Bioactives

Nanoemulsions generate significantly reduced particle size and increase zeta potential compared to a macro suspension emulsion control. Zeta potential measures the degree of repulsion and confers stability. When bioactive compounds are incorporated into nanoemulsions their bio-availability can be significantly enhanced. Many of the functional compounds of interest have problems with solubility, oral bio-availability or stability. The US Army, Natick Soldier Research, Development and Engineering Center research goals are to enhance the bio-availability and increase uptake of targeted performance optimizing compounds when consumed in a military ration. Formulation testing of oil carriers and emulsifiers were optimized to develop nanoemulsions containing the bioactives quercetin, curcumin and tyrosine. Enhancement of absorption will allow us to decrease the concentrations of the bioactive when added to a ration component and still obtain the target dosage. Nanoemulsions produced with a Microfluidizer Processor containing curcumin, quercetin or tyrosine all showed a reduction in particle size (40, 3 and 12 fold reduction respectively) as analyzed by a Malvern Zetasizer. The microfluidized nanoemulsion process has the capacity to increase the zeta potential for example, about 5 fold for curcumin and 3 fold for quercetin. A further reduction in particle size was achieved for curcumin and quercetin (300 and 35 fold decrease, respectively) using a Self-Assembly technique. Soybean oil was used to stabilize the microfluidized nanoemulsions for curcumin and quercetin, and rice bran oil for tyrosine. Coconut oil and rice bran oil were found to stabilize curcumin and quercetin nanoemulsions when using the self assembled procedure.

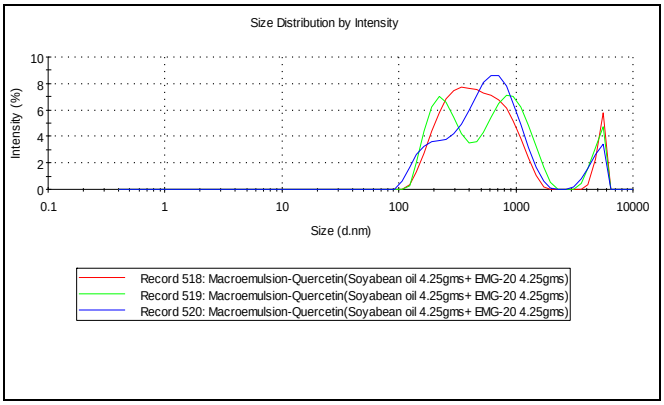
Feeding studies in rats are ongoing via collaboration with UMass Lowell to test bioavailability differences (bio-active measured in the blood at predetermined intervals after feeding) of nanoemulsions versus macro suspensions.

Also buccal tissue diffusion studies are ongoing via collaboration with Rutgers to test enhanced absorption (assessment of absorption in the mouth while consuming) of bio-active contained in nanoemulsions versus macro suspensions).

Macro Suspension Emulsion Controls

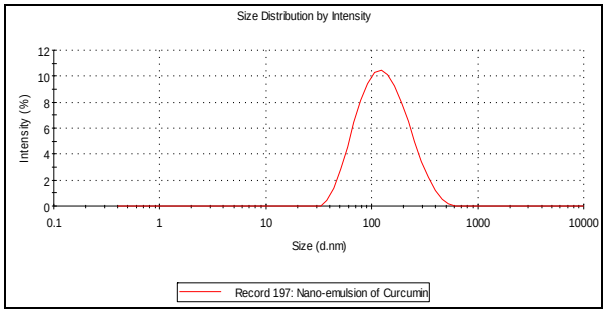


Curcumin
Diameter = 4530 nm
Zeta potential = - 525

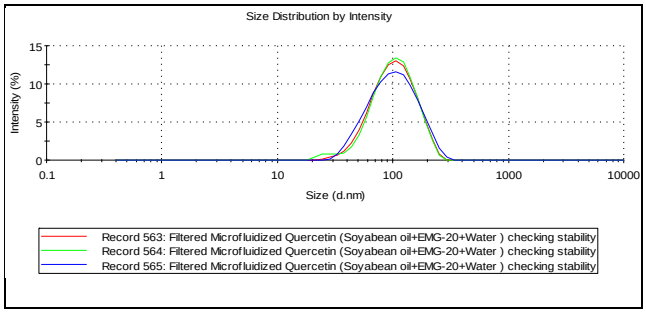


Quercetin
Diameter = 501nm
Zeta potential = 0.766

Micro Fluidizer Processor Nanoemulsions

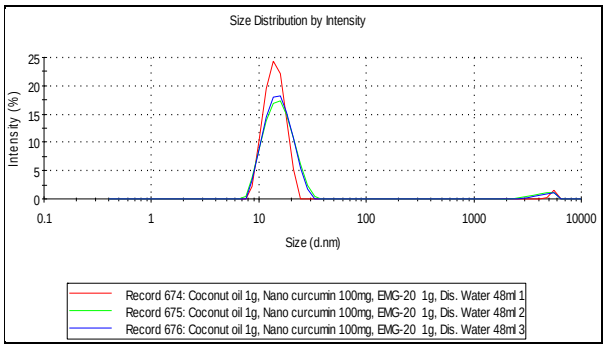


Curcumin
Diameter = 110 nm
Zeta potential = (-23.5)

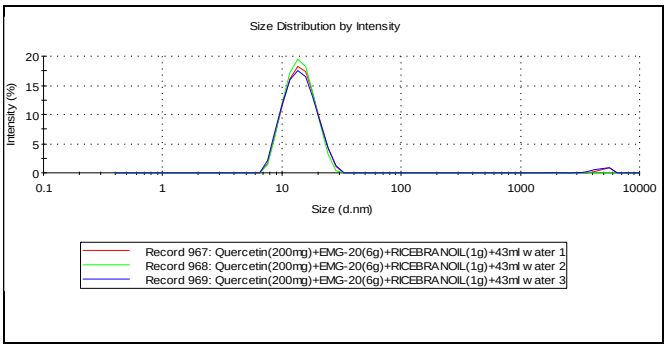


Quercetin
Diameter = 109 nm
Zeta potential = (-2.12)

Self-Assembly Nanoemulsions



Curcumin
Diameter = 16 nm



Quercetin
Diameter = 14nm

Nicilosi, B., and T. Wilson, UMass Lowell, *Progress Report for U.S. Army Natick Soldier Center*, DoD Combat Feeding Directorate, April 16, 2008

Future endeavors include studying other nano technology concepts such as cochleates, cyclodextrins and solid lipid nano particles to also enhance absorption of target bioactives. Nano compounds will be tested in model foods and then military ration components during storage for stability and availability.

Contributing Agency: DoD/NSRDEC