

Production and Characterization of Lutein Nano-emulsion

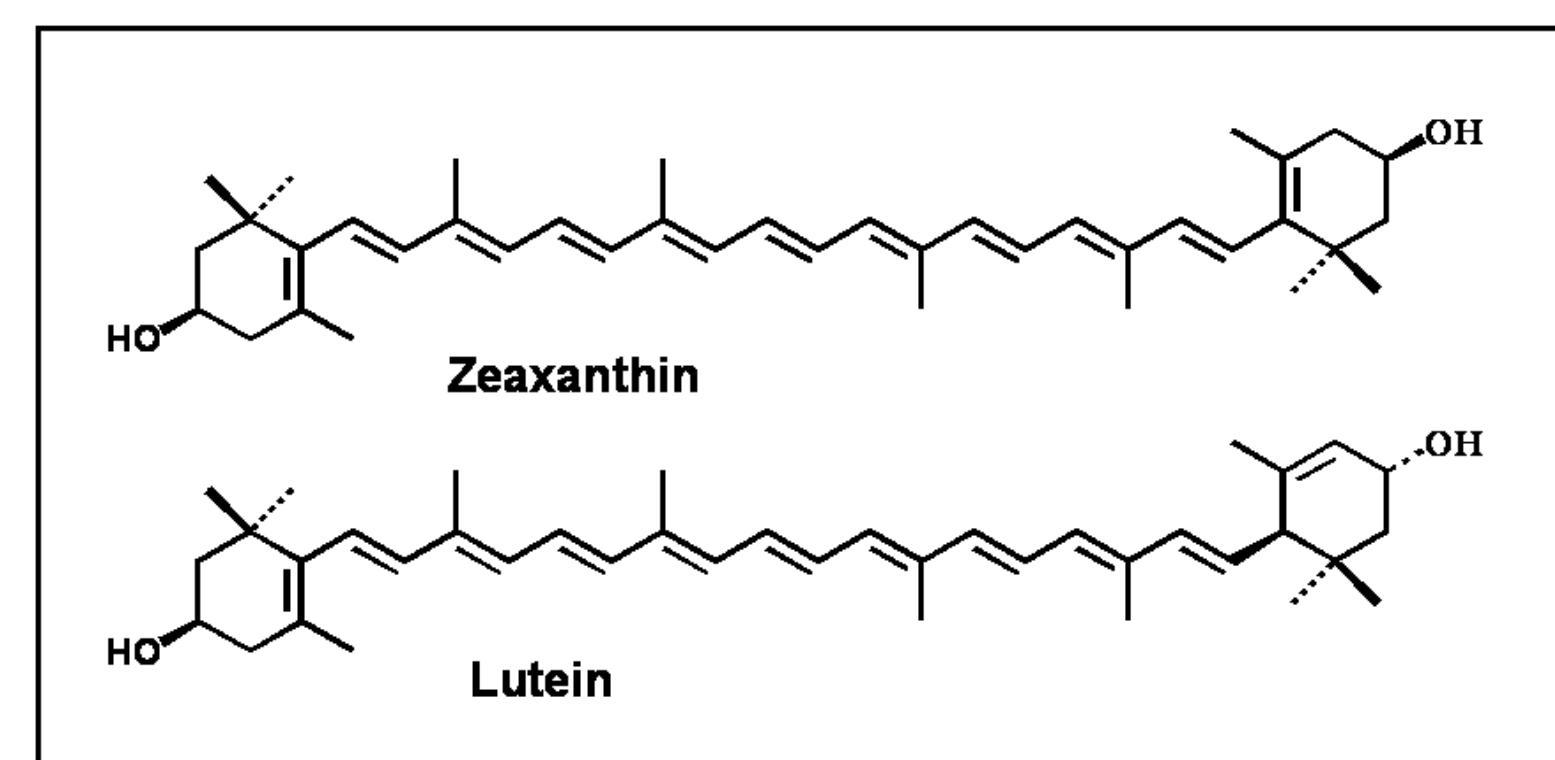
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Introduction

- Lutein, lipid soluble bioactive compound, can play an important role in eye health, including age-related macular degeneration and cataracts.
- Nano-emulsion technology incorporates lipid-soluble bioactive compounds like lutein in emulsion and enable the lipid-soluble compounds in various food matrices, including beverages.
- In addition, nano-emulsion (<100 nm droplet size) can improve the functional stability of lutein, which is sensitive to light and oxygen, and deteriorates easily during processing and storage.



Objective

The objectives of this study were to evaluate 1) the optimal conditions for lutein nano-emulsion production, and 2) the physico-chemical properties of lutein nano-emulsion.

Material and Methods

Preparation of lutein nano-emulsion

- Two lutein extracts, 95% purity (5 mg, powder form, Caymen Co.) and 20% purity (dissolved in safflower oil, 25 g, Kemin Co.), were purchased.
- Various emulsifiers were tested as surfactants and co-surfactants to establish the optimum formula.

*HLB: Hydrophilic/Lipophilic Balance

Emulsifiers	HLB*
Medium-chain triglycerides (MCTs)	-
Polyoxyethylene sorbitan monooleate (Tween 80)	15
Propylene glycol (PG)	2.5
Ethanol	-
Lecithin (extracted from soybean)	4
Sucrose monostearate (SM)	5.9

- Lutein extract (95% or 20% purity), Tween 80, water, MCT, and ethanol were mixed as a pre-mixture prepared by modified self-assembly emulsification method.
- The mixture was stirred under moderate magnetic stirring for 12 hrs added with 0.01% butylated hydroxyanisole (BHA) and 0.05% sodium azide to prevent oxidation and deterioration.
- Pre-mixture was added in drops into aqueous phase with moderate magnetic stirring and then kept stirring for 1 hr.

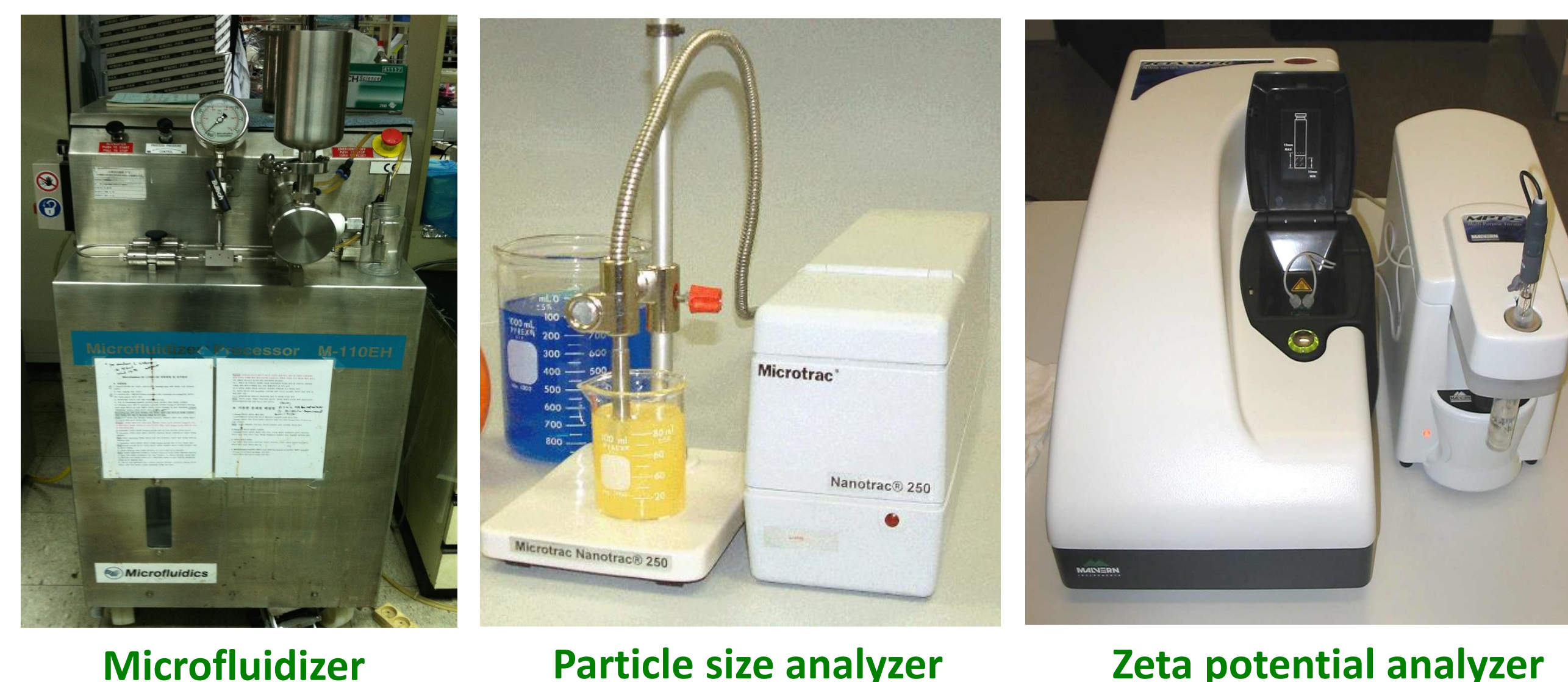
- The coarse emulsion was passed through an air-driven microfluidizer (high-pressure homogenizer, model M-110L; Microfluidics, Westwood, MA, USA) operating at 25,000 psi for three cycles.

Particle Size Distribution

- Determined by Nanotracer 250 (Microtrac Inc., Montgomeryville, PA), which is a photon correlation spectroscopy and analyzes the fluctuations in light scattering due to the Brownian motion of the particles. Light scattering was monitored at 25 °C and an angle of 90°.

Electrophoretic Mobility

- Determined by Zetasizer Nanoseries ZS (Malvern Instrument, Worcestershire, UK) to measure the direction and velocity that the nanoemulsion moved in the applied electric field at 633 nm for 1 min. The Smoluchowsky mathematical model was used to convert the electrophoretic mobility into zeta potential values.



Results and Discussion

- The most stable primary emulsion using 95% lutein purity was produced when lutein, Tween 80, water, MCT and ethanol ratio was 0.1 : 5.9 : 47.0 : 35.2 : 11.8 (w/w).
- Lutein nano-emulsion appeared semi-transparent with light yellow color and high fluidity.
- The average particle size of lutein nano-emulsion was 65.8 nm, 77.9 nm, 80.2 nm, 81.5 nm, 87.0 nm and 99.0 nm at 0, 1, 2, 3, 4, and 5 week of storage, respectively.



Figure 1. Nano-emulsion prepared with 95%-pure lutein



Figure 2. Particle size distribution of nano-emulsion prepared with 95%-pure lutein during storage

- The zeta potential was -12.5, -11.4, -19.1, and -33.6 mV at 0, 1, 2, and 3 week of storage, respectively. (unmeasurable after 4 wk).

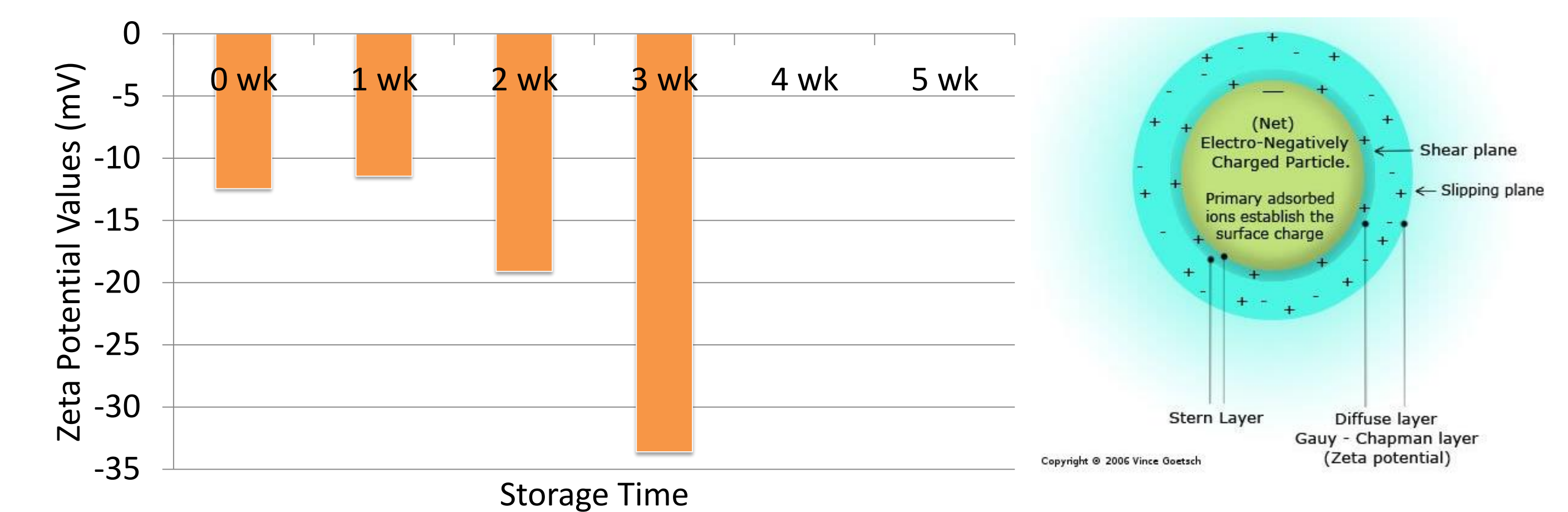


Figure 3. Zeta potential values of nano-emulsion prepared with 95%-pure lutein during storage

- Nano-emulsion prepared with 20% purity lutein product showed natural orange carotenoid color, indicating that it requires different surfactants and co-surfactant formula than that prepared with 95%-pure lutein.

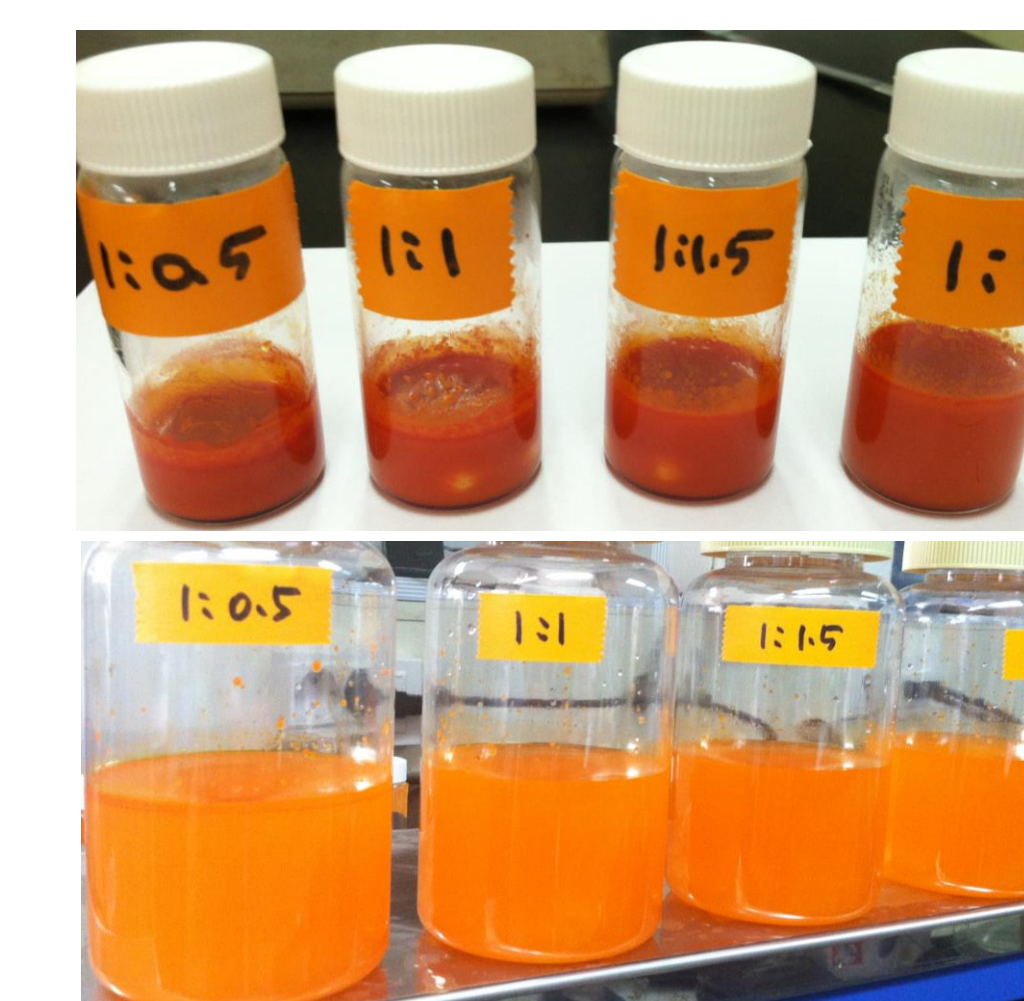


Figure 4. Pre-mixture (up) and nano-emulsion (down) of lutein (20% purity) prepared with different concentrations of Tween 80



Figure 5. Pre-mixture of lutein (20% purity) with PG (left) and lutein:MCT (right) (1:1 w/w)



Figure 6. Nano-emulsions of lutein:MCT:Tween80 (up) and lutein:MCT:SM (down) (1:1:1 w/w)

Conclusion

- Lutein nano-emulsion prepared with 95 %-pure lutein was relatively stable during the 3-week storage at 22°C and has a high potential to apply in cold-beverage production.
- However, further study is needed to improve the storage stability of lutein nano-emulsion to be used in beverages that require longer storage time.

Acknowledgement

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