Preparation and characterization of emulgel structured with citrus fiber as potential carrier of curcumin (Curcuma longa): rheology, physical stability encapsulation efficiency and loading capacity

D. Mammolenti[a], P. Formoso[b], F.R. Lupi[a], N. Baldino[a], D. Gabriele[a]

[a]Department of Information, Modeling, Electronics and Systems (DIMES), University of Calabria, Via P. Bucci, Cubo 39C, 87036 Rende, Italy
[b]Department of Pharmacy, Health and Nutritional Sciences, University of Calabria, via A. Savino, Polyfunctional Building, 87036 Rende, Italy

INTRODUCTION & AIM

Emulgels are recognized to be very effective for several food applications as carrier of bioactive components [1]. Nowadays, the research on food emulgels is focused on both the utilization of new gelling agent and new bioactive substances. Citrus fiber is very effective structuring agent of water phase suitable for emulgel formulation [2]. Curcumin is polyphenolic compound with notable antioxidant properties, responsible of different health benefits [3]. Aiming at carrying out the fundamental development of a novel formulation of food supplement, emulgels containing citrus fiber, potentially able to carrier curcumin, were produced using two different methods: high shear homogenization (HSH) and ultrasound assisted emulsification (UAE). The characterization of samples was carried out by evaluating linear viscoelasticity and physical stability. Furthermore, aiming at assessing their ability to carrier curcumin, loading capacity and encapsulation efficiency were determined.

METHOD

Components: Vitacel 312 ® (Citrus fiber), water, Miglyol® 812N, curcumin.

Process 1: High Shear Homogenization (Ultraturrax T25, IKA-Warke, Germany), 1 min at 3000 rpm, for oil phase addition, 3 min at 15000 rpm for emulsification/structuring.

Process 2: Ultrasound Assisted Emulsification (Ultrasonic UP400S, Hielscher, Germany), 400 W and 24Hz.

High Shear Homogenization (HSH)

Ultrasound Assisted Emulsification (UAE)

Rotational rheology - Haake Mars III (Thermo Scientific, USA):
- Frequency sweep test (0.1-10 Hz, LVR) at 25°C

Physical stability:
- Optical microscopy at 10X at 24 h and 4 weeks after preparation - BA300POL, Motic (China).
- ζ-Potential at 25°C, 37 °C and 50 °C, at 24 h, 1, 2, and 4 weeks after preparation - Zetasizer ZS (Malvern, USA).

Emulgel ID	x_f (w/w)	Process Type	Curcumin (mg/ml)
E2_UAE	0.02	Ultrasound Assisted Emulsification	-
E2_HSH	0.02	High Shear Homogenization	-
E2.5_UAE	0.025	Ultrasound Assisted Emulsification	-
E2.5_HSH	0.025	High Shear Homogenization	-
E3_UAE	0.03	Ultrasound Assisted Emulsification	-
E3_HSH	0.03	High Shear Homogenization	-
E3_UAE/C	0.03	Ultrasound Assisted Emulsification	3.34
E3_HSH/C	0.03	High Shear Homogenization	3.34

Loading capacity

$$LC = \frac{m_c}{m_e}$$

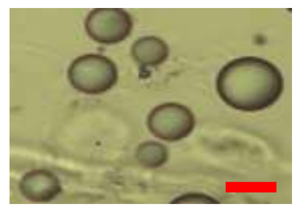
Encapsulation efficiency

$$EE\% = \frac{C_{tot} - C_{ext}}{C_{tot}} \times 100$$

- UV/Vis spectrophotometry at 424 nm - Evolution™ 201 (Thermo Fisher Scientific, USA)

RESULTS & DISCUSSION

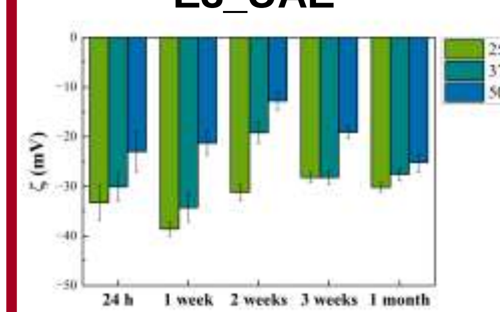
E3_HSH at 24 h



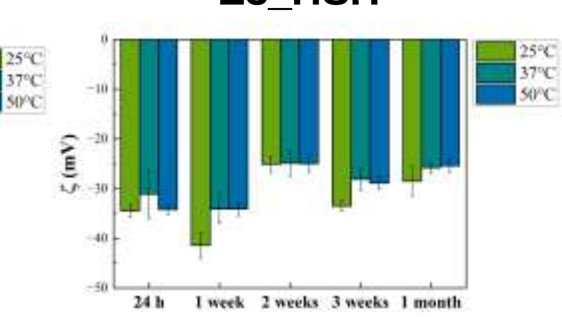
E3_HSH at 1 month

100 μm

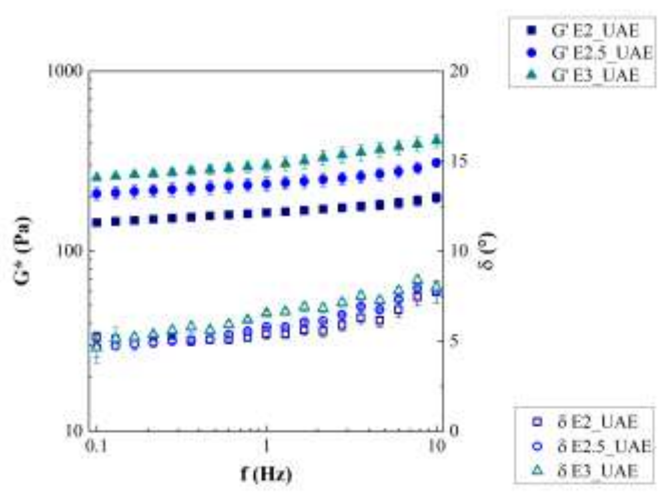
E3_UAE

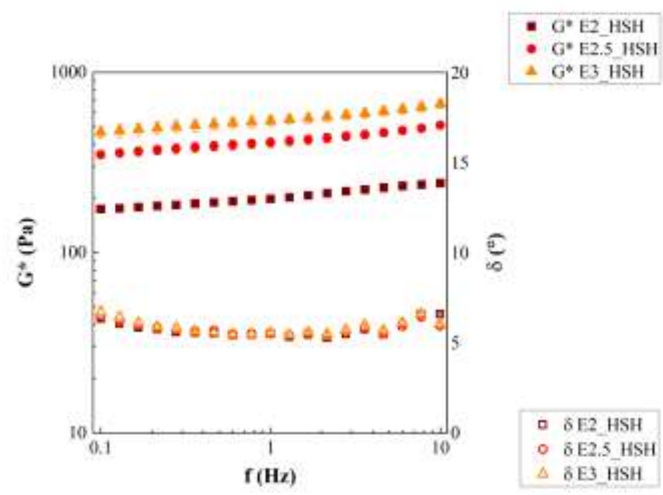


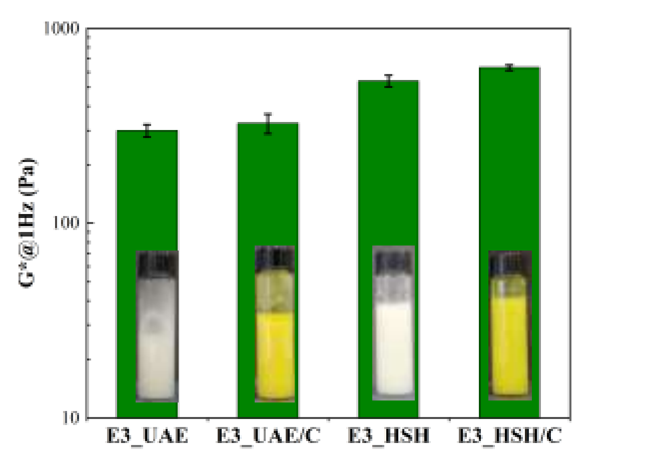
E3_HSH

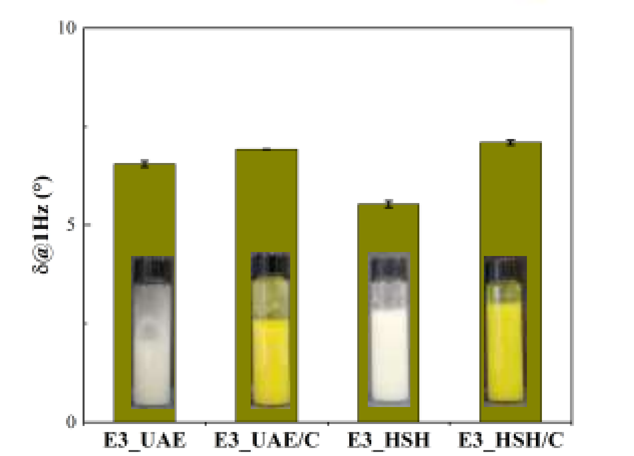


- ζ-Potential remains close to -30 mV for 1 month, higher values were found for temperature higher than 37°C.
- Droplets size does not change, in a relevant way, over 1 month (10-100 μm).









- Consistency increases more than linearly with fiber fraction;
- Samples produced by HSH resulted more consistent than sample produced with UAE;
- Curcumin addition decreases structuring but not consistency.

Emulgel ID	Encapsulation Efficiency (-)	Loading Capacity (mg/g)
E3_UAE/C	96.21	1.23
E3_HSH/C	91.90	1.29

CONCLUSION

- Samples are physically stable over 1 month of storage (5°C);
- Samples with 3% w/w of fiber resulted notably more consistent and suitable for food applications;
- The rheology of all samples follows weak gel behavior;
- HSH resulted the most effective production techniques (also easy to scale-up);
- Curcumin do not affect G*, only δ is slight increased, suggesting some sort of microstructural change.
- According to EE and LC samples are good curcumin carriers.

REFERENCES

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