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Emulgel structured with citrus fiber as potential delivery system of curcumin (Curcuma longa) for food application: viscoelasticity modelling, morphology and diffusive release

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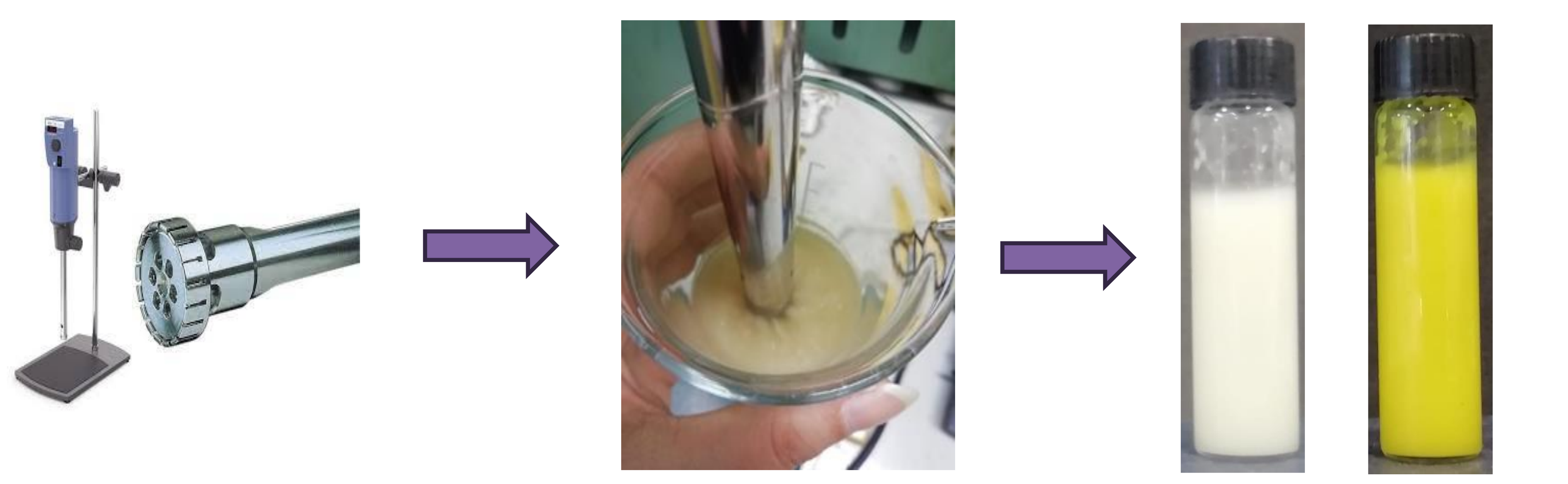
INTRODUCTION & AIM

Emulgels are recognized as well-know carriers of bioactive components, suitable for different food applications [1] . To date, the research on food emulgels is focused on both the utilization of novel and sustainable ingredients and the study and modelling of their rheological properties [2]. With the purpose to develop a novel basic formulations of food supplement able to release curcumin, emulgels containing citrus fiber and two different type of edible oils, i.e., rice oil and Miglyol® 812N, were produced with high shear homogenization. The oil phase was properly loaded with curcumin, which is recognized to be a lipophilic antioxidant with several nutritional benefits. The linear viscoelasticity of emulgel samples and single phases, i. e., hydrogel and oils, was investigated. The rheological data of emulgel were modelled according to weak gel model [3]. The capability of samples to release curcumin was evaluated by carrying out diffusive releases.

METHOD

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

Processing: High Shear Homogenization (Ultraturrax T25, IKA-Warke, Germany), 1 min at 3000 rpm, for oil phase addition, 3 min at 12000 rpm for emulsification/structuring.



Rotational rheology - Haake Mars III (Thermo Scientific, USA):

- Frequency sweep test (0.1-10 Hz) at 25°C

Release study – Modified Franz cell unit

- Diffusive Release (24 h) at 37°C

Emulgel ID	x_f (w/w)	Oil Type	Oil phase ID	Curcumin (mg/ml)
E2_R	0.02	Rice Oil	R	-
E2_M	0.02	Miglyol® 812N	M	-
E2.5_R	0.025	Rice Oil	R	-
E2.5_M	0.025	Miglyol® 812N	M	-
E3_R	0.03	Rice Oil	R	-
E3_M	0.03	Miglyol® 812N	M	-
E3_R/C	0.03	Rice Oil	R/C	2.67
E3_M/C	0.03	Miglyol® 812N	M/C	3.56

Rheological modeling

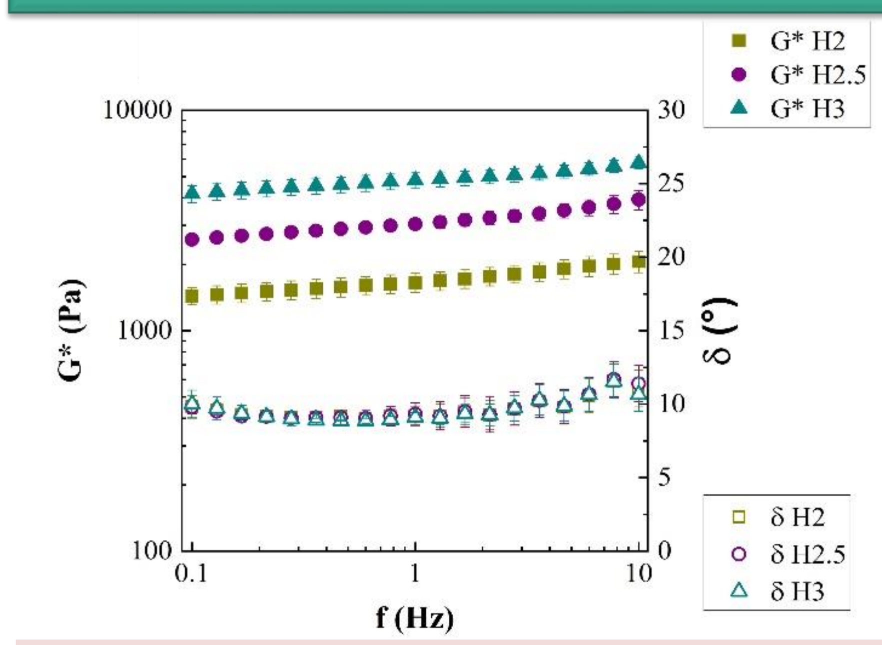
Weak Gel Model

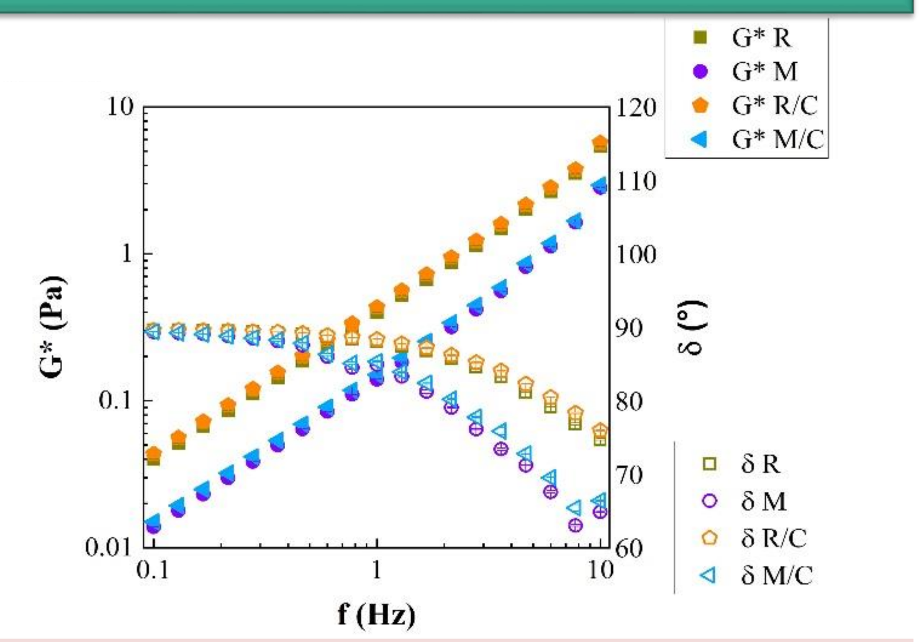
$$G^* = A\,\omega^{\frac{1}{z}}$$

A (Pa s^z) = gel strength

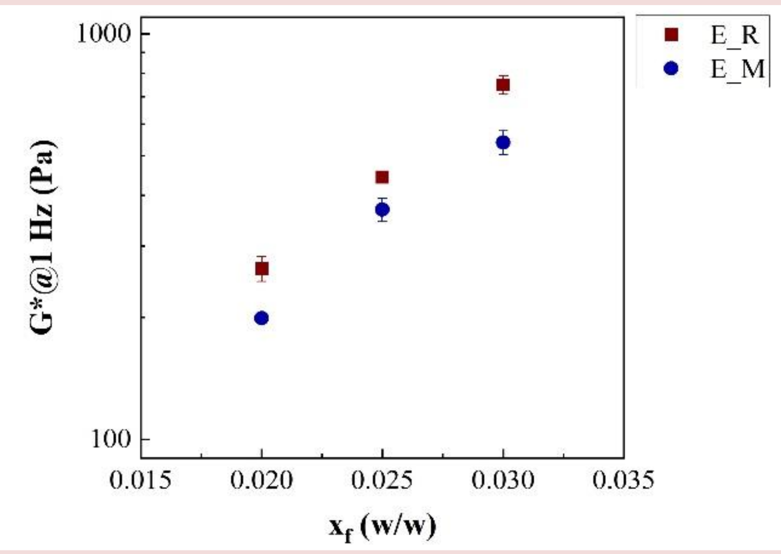
z (-) = coordination number

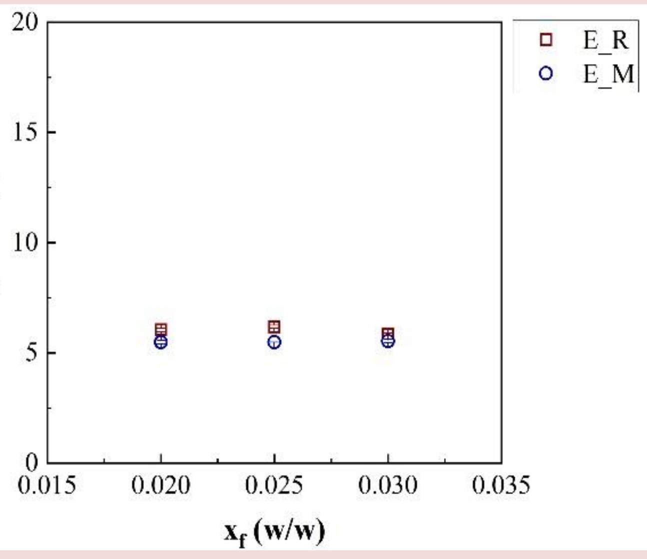
RESULTS & DISCUSSION





- Hydrogel: Solid-like
- Oil phase: liquid-like





- Emulgel samples with rice oil are the most "consistent" (i.e. greater G values) in agreement with consistency of oils;
- Structuring level is independent of x_f in agreement with the viscoelasticity of hydrogels;
- Curcumin does not affect consistency in agreement with the results on oil, but decrease the structuring.

Sample ID	A (Pa s^z)	Z (-)	Cur% (-)	Flux (mg/cm^2)
E2_R	260 ± 20^a	16 ± 1^a	-	-
E2.5_R	444 ± 7^b	13.53 ± 0.04^b	-	-
E3_R	750 ± 40^c	18 ± 2^c	-	-
E2_M	199.1 ± 0.7^a	16.9 ± 0.1^{abc}	-	-
E2.5_M	371 ± 1^b	15.0 ± 0.1^{abc}	-	-
E3_M	597 ± 2^d	14.8 ± 0.5^{abc}	-	-
E3_R/C	760 ± 40^c	14 ± 3^{abc}	18.3	0.17
E3_M/C	604 ± 4^d	12.0 ± 0.7^d	14.8	0.14

CONCLUSION

- G* of emulgel is affected by oil type and x_f whereas δ is independent of both these factors;
- In emulgels, curcumin does not modify G*, only δ is slight increased indicating a destructing.
- The decrease of δ caused by curcumin is due to some interfacial interactions.
- Emulgels behave according to weak gel model, gel strength increases with x_f while the network extension is concentration-independent.
- Curcumin release was promising in terms of percentage of release and flux.

REFERENCES

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