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Structure design in emulsions and foams: from model systems and quantitative methods to functional properties in real products and according knowledge transfer

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Lunteren, The Netherlands

Reducing oil droplet size restrictions

High shear
US, HP

reduce the viscosity of stabilizers (80-90%)

Effect of sonication on viscosity of Xanthan

- Viscosity properties as affected by sonication treatment

Sonication treatment	k (Pa-s^n)	n (-)
No Ultra	24.00	0.181
40%-1min	11.16	0.196
60%-1min	4.37	0.309
80%-1min	3.18	0.331
100%-1min	2.58	0.354
70%-1min	4.12	0.308
70%-2min	2.38	0.359
70%-3min	1.49	0.420
70%-4min	0.704	0.503

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Influence of sonication treatment on the viscosity of 1% XG solutions.

- (100%-1min) similar effect with (70%-2min)☐ 10 times reduction of K,
- 3 times increase of n (less shear-thinning)

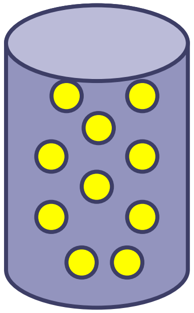
Objectives

- Minimize the size of olive oil droplets by WPI-Tween20 combinations/stability at low oil fractions
- Establish a z-potential value that pectin-WP electrostatic interactions could be favored
- Pectin addition: modifying aqueous phase viscosity against creaming/by dilution to overcome viscosity reduction during HP
- Assess the stability of prepared emulsions with different methods/MLS (Turbiscan) (storage).

Emulsion preparation

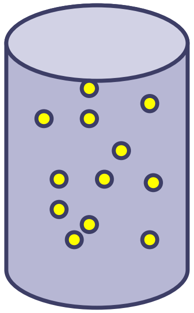
Coarse emulsion

(WPI)-Tween20
1:0, 3:1, 2:2, 1:3, 0:1
(1% total emulsifier)
+
Extra virgin olive oil 10%



(high shear 16.800RPM/2min)

Primary emulsion

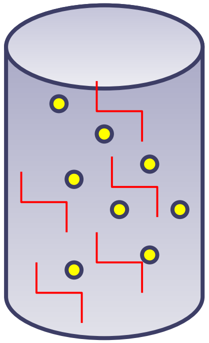


(HP 200 bar, 8.5 min)

\+ Pectin

Secondary emulsion

0, 0.2, 0.4 and 0.6%
Pectin
6% olive oil
pH 3.3



Droplet size of primary emulsions

- sub-micron emulsion produced for 2:2, 1:3 & 0:1 ratios (D90~600-700nm)
- Tween20□strongly decreased D32
- Monomodal distributions Tween ratios< 2:2
- 1:0 &3:1 ratios, high polidispersity (D90~2-5µm)

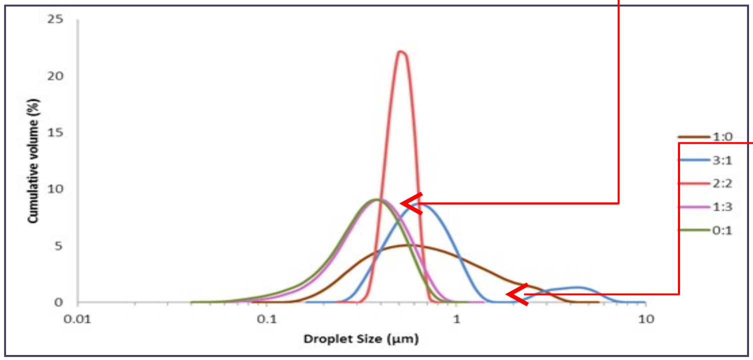
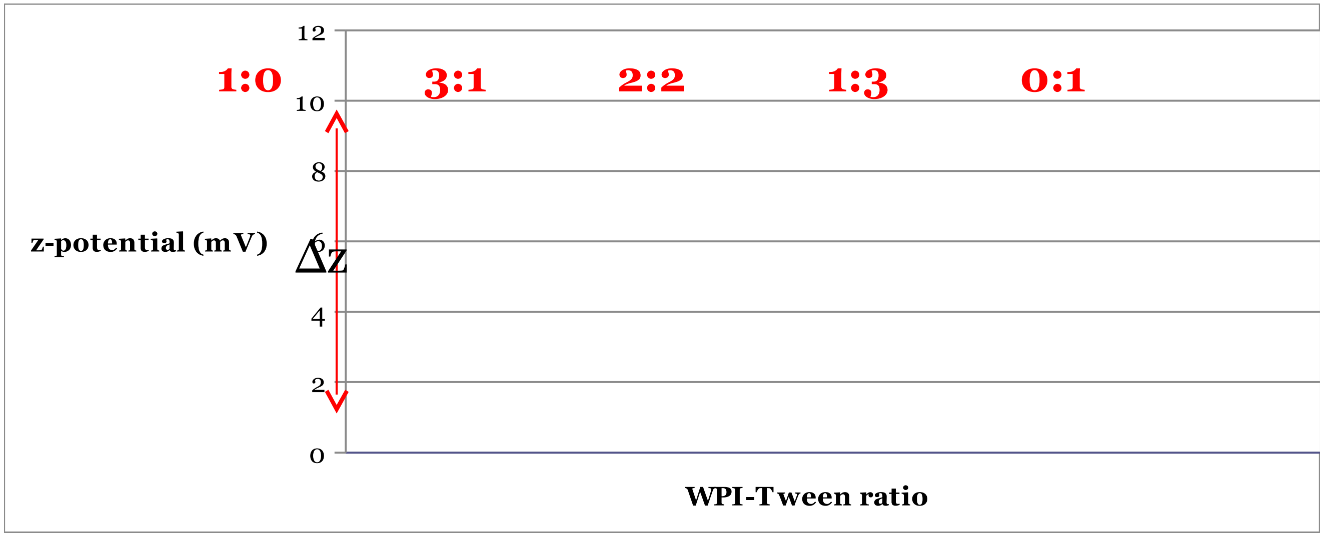


Fig. Influence of WPI-Tween combinations on particle size of primary emulsions

Surface charge



Influence of pectin concentration on surface charge per combination of WPI-Tween20

- 0% Pectin:WPI decrease□z-potential +36.2mV to -2.5
- Pectin addition
  - negative surface charge,
  - concentration□minor influence per ratio
  - Δz decreased per ratio□less pectin attached to protein

Creaming stability (by MLS*)

high WP

Influence of pectin concentration on phase separation

Phase separation evolution during cold storage for 2:2 WPI-Tween20 ratio

- 0% pectin□creaming = *f*(droplet size & z-potential)
- (2:2) □max. stability at 0.4% pectin
- 1:3 & 0:1□ high instability depletion flocculation, improved by viscosity increase

*Multiple Light scattering (Turbiscan)

Creaming rate (centrifugation)

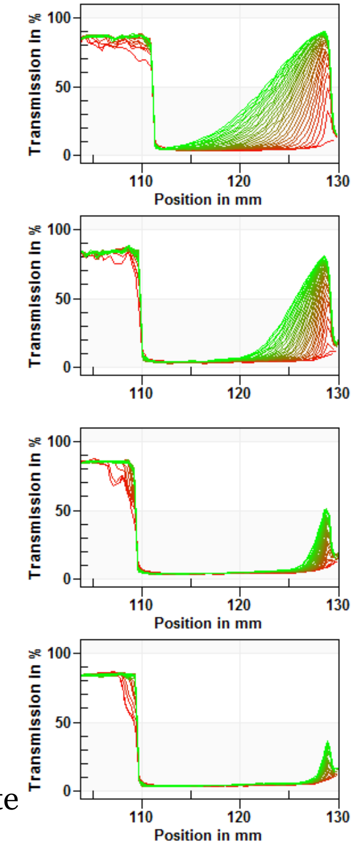
Influence of pectin concentration on creaming rate of 1:0 & 0:1 WPI-tween20 ratios

- 1% WPI☐high pectin concentration decreased creaming
- 1% Tween20☐ opposite effect, depletion flocculation

Creaming rate (centrifugation)

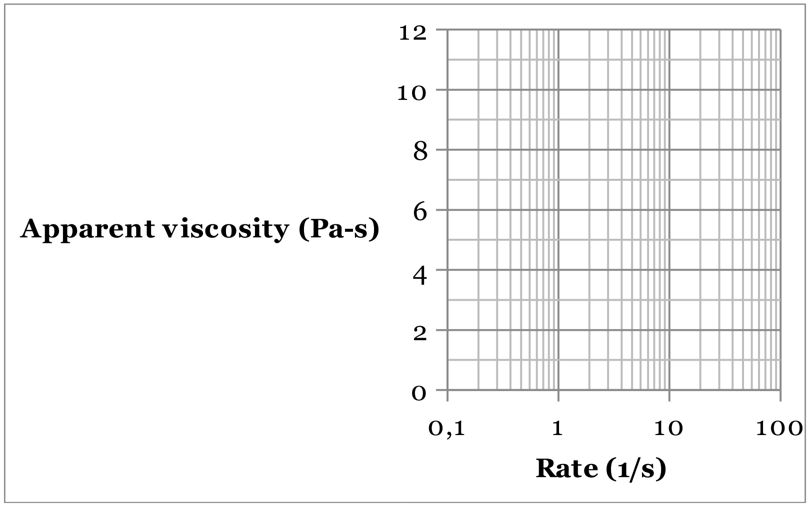
WPI-Tween20 (2:2)

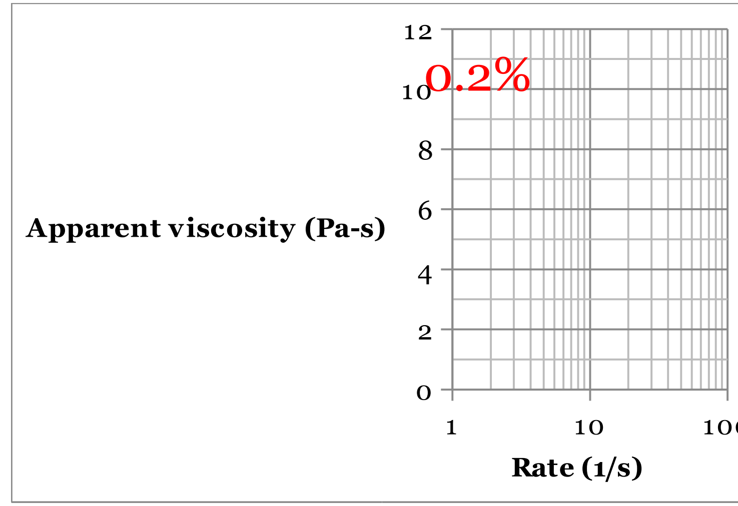
Influence of pectin concentration on creaming rate at 2:2 WPI-Tween20 ratio



- 0.6% pectin □ Stability trend not in agreement with MLS method
- Centrifugation: good correlation for viscosity increase and depletion flocculation
- Is there another phenomenon occuring?

Bulk rheology





0.4%

0.6%

Influence of pectin concentration on apparent viscosity of WPI-Tween20 ratios

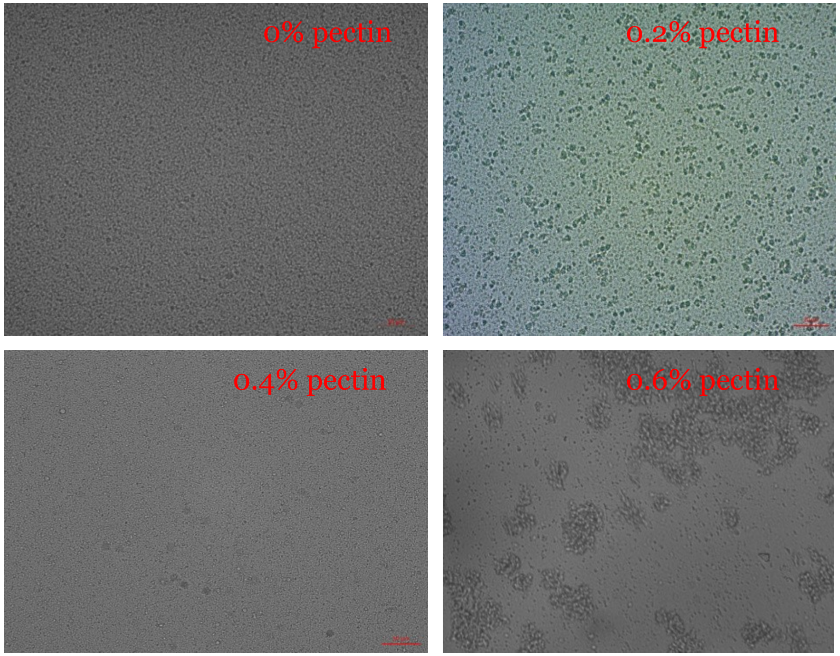
Bulk rheology

WPI-Tween20 (2:2)

Influence of pectin concentration on apparent viscosity of WPI-Tween 2:2 ratio

- Low pectin concentration□ high WP ratios, high low-shear viscosity
- 0.6%□newtonian for 1:0, 3:1 and 2:2, slight increase flocculation for high Tween ratios
- Liquid like- emulsions

Microstructure



(2:2) ratio

Conclusions

- Droplet size significantly decreased at high Tween concentrations (>2:2)
- Stability in the MLS-centrifugation ☐ results in accordance at 2:2 ratio
- Best combination for increased stability – reduced droplet size☐ 2:2 WPI-Tween, 0.4%

WPI displacement by Tween

(z-potential during storage, protein content at the aqueous phase)

Thank you! Questions?

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