UNIVERSITY OF BIRMINGHAM

It's all in the Mix...

The processing route to unique formulations

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EFFECT OF SUGARS ON MIXED BIOPOLYMER SYSTEMS

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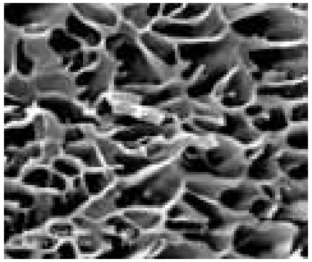
Background



- Mixed biopolymers are of direct industrial significance.
- Proteins, polysaccharides and sugars are major nutritive, texture and taste imparting components in dairy emulsions.
- Stability, taste and texture are responsible for successful marketing and increased food consumption.
- Structure of these foods is built by intermolecular interactions between the components.

Aim and Objectives

Explore the process of texture formation in sodium caseinate-galactomannan-sugar model systems.

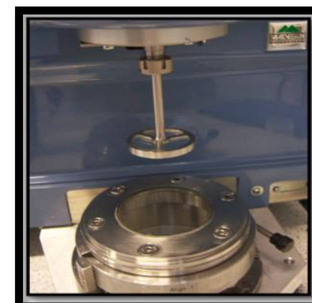
Part 1: Liquid-liquid phase separation ⇨ w/w emulsions

Part 2: Deformation of the emulsions in flow ⇨ microstructure at quiescent conditions and in flow

Part 3: Interfacial properties (effect of composition) ⇨ new texture

Experimental work

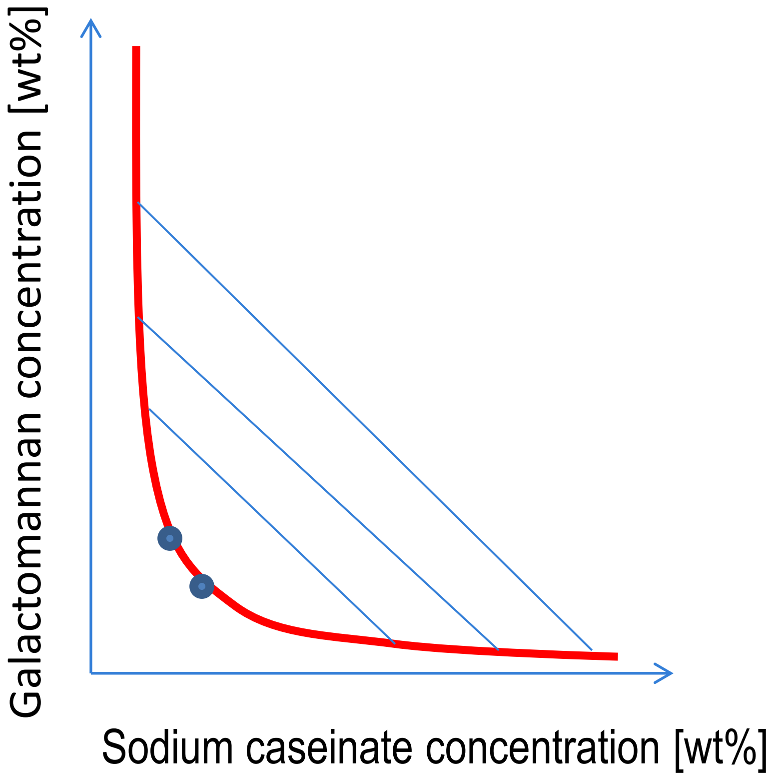
- Cosolubility of sodium caseinate-galactomannan-sugar systems studied by phase-volume ratio method



- The effect of composition on the microstructure at rest and under shear visualised by microscopy and optical rheology

- The interfacial properties of the systems calculated by drop retraction method

Part 1: Phase behaviour



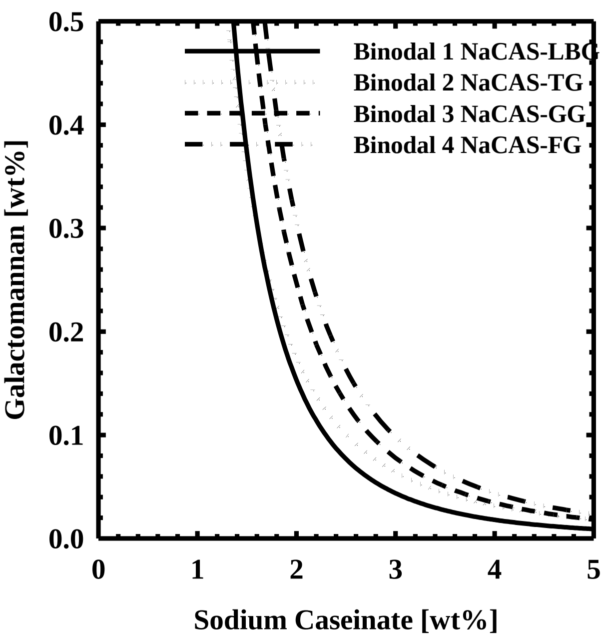
- binodal
- tie lines
- characteristic points

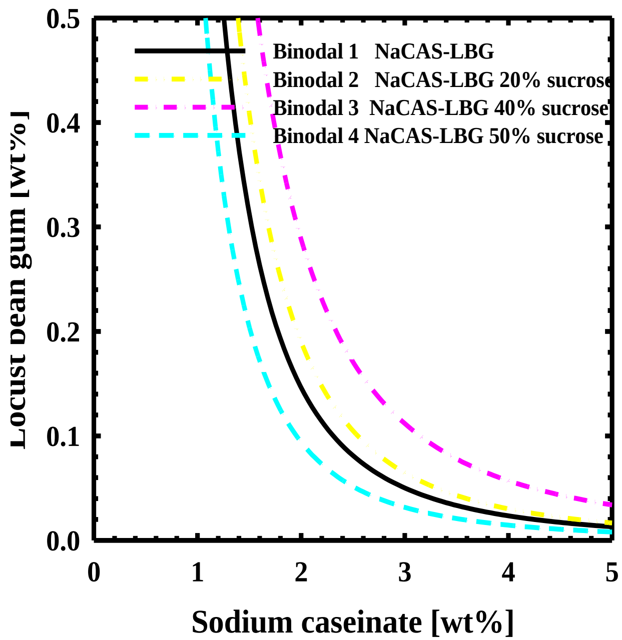
-galactomannan type
-sugar concentration
-sugar type

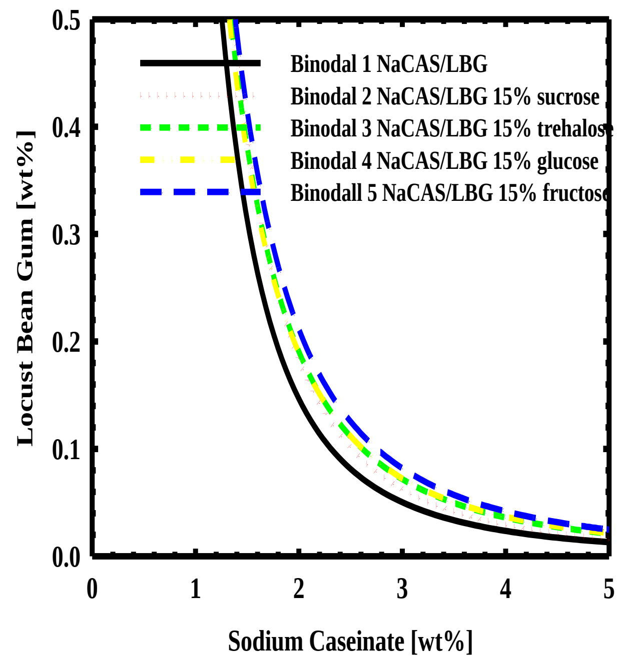
❑ 2D composition-composition isothermal phase diagram

Part 1: Phase behaviour

- Effect of galactomannan type
- Effect of sugar concentration
- Effect of sugar type





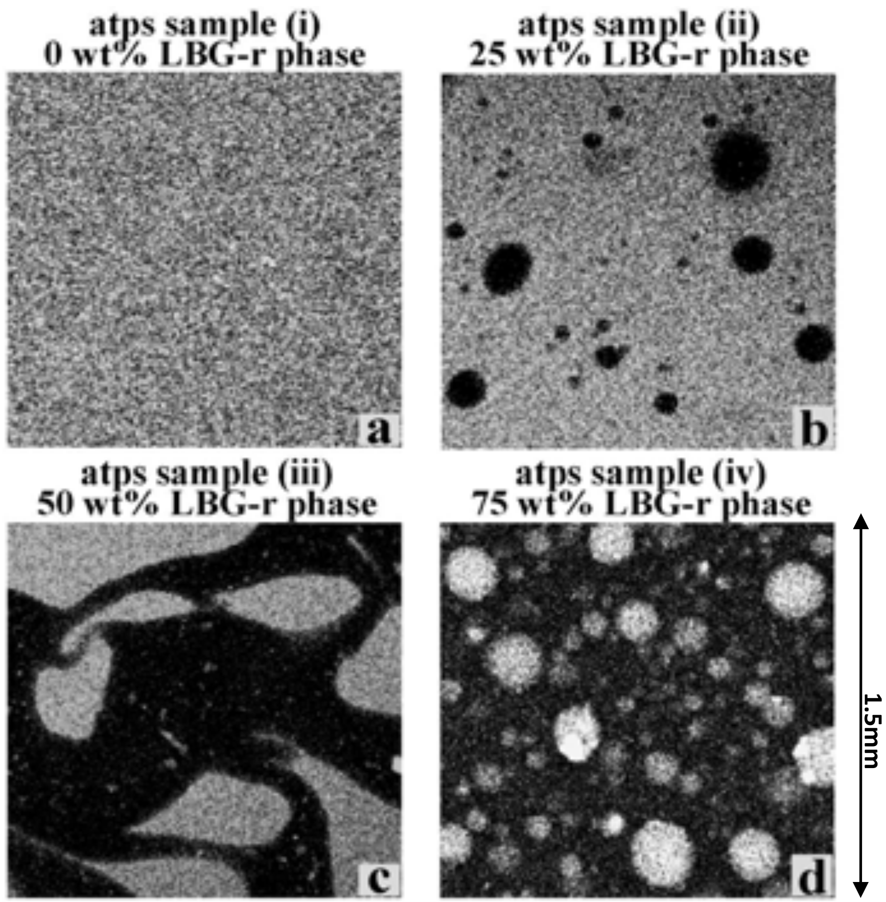


Conclusions (Part 1)

- Highly branched galactomannans improve the cosolubility of the biopolymers.
- Sugar content below the critical concentration improves the cosolubility.
- Increasing sugar concentration reduces the cosolubility.
- At 15% of sugar, fructose and trehalose improve the cosolubility most significantly.

Part 2: Effect of volume fraction on microstructure

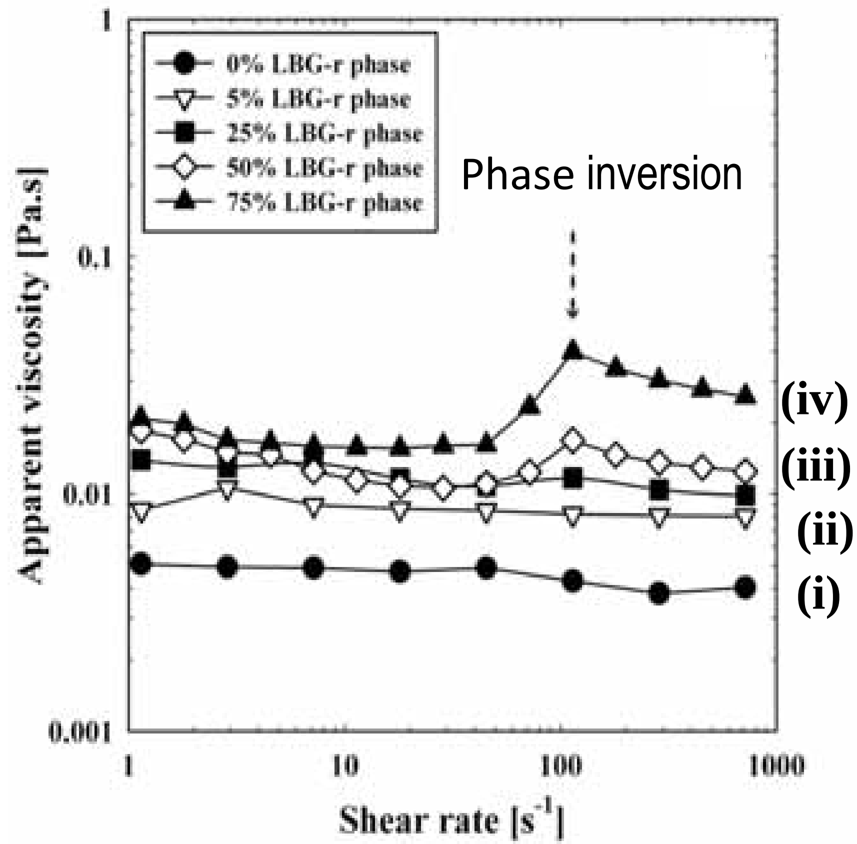
- At quiescent conditions



Polysaccharide-rich phase

Protein-rich phase

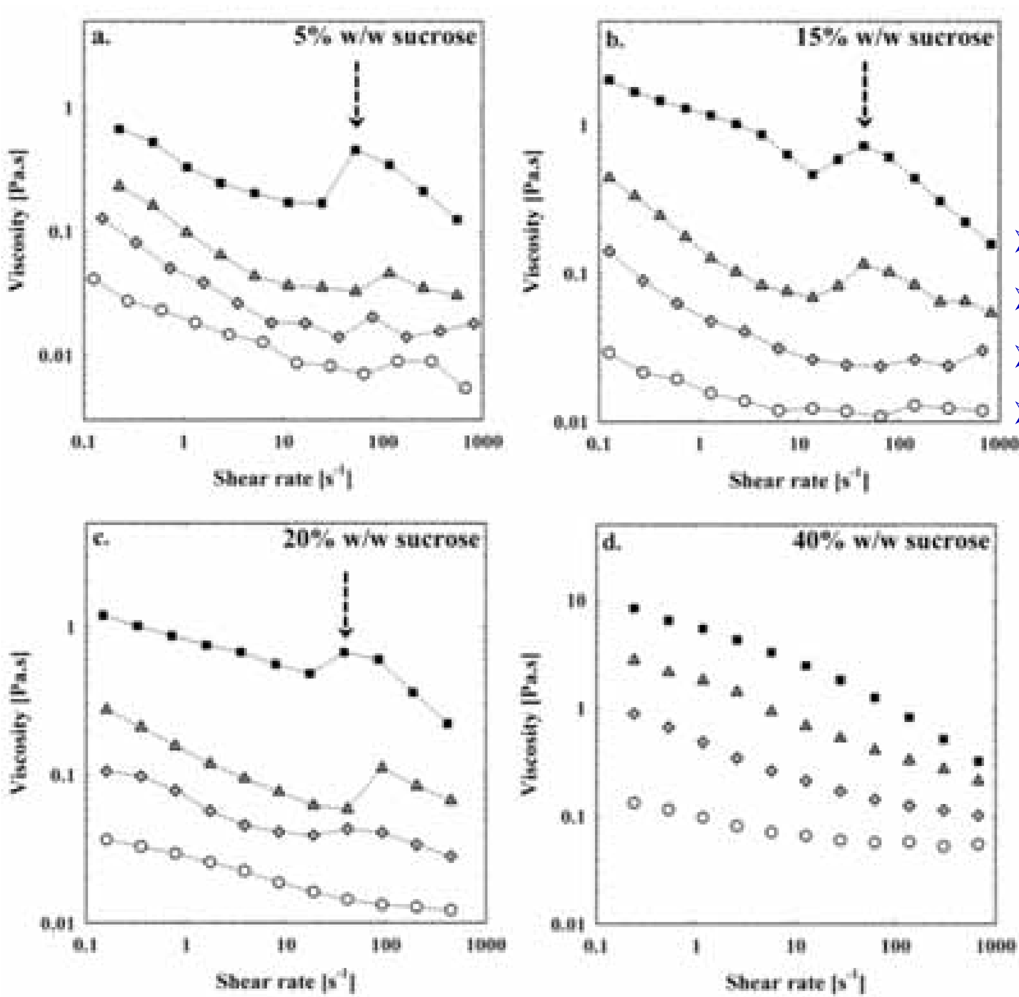
- Under shear



NaCAS-LBG (no sugar)

Part 2: Effect of volume fraction on microstructure

- Effect of sugar concentration on the evolution of the microstructure in flow



- (iv) 75%,
- (iii) 50%,
- (ii) 25%,
- (i) 0% of the LBG-r.

NaCAS-LBG (with sugar)

Conclusions (Part 2)

<u>Under quiescent conditions:</u>

- Phase sense depends on the volume fractions of the equilibrium phases.

- Phase inversion occurs at about equal volumes.

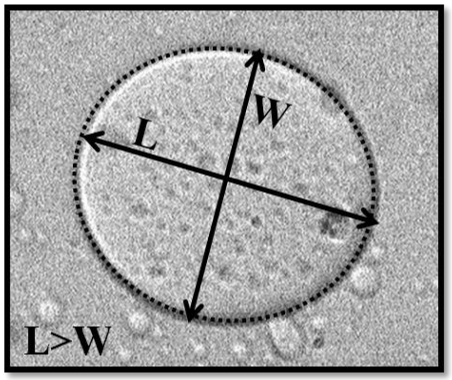
<u>Under shear:</u>

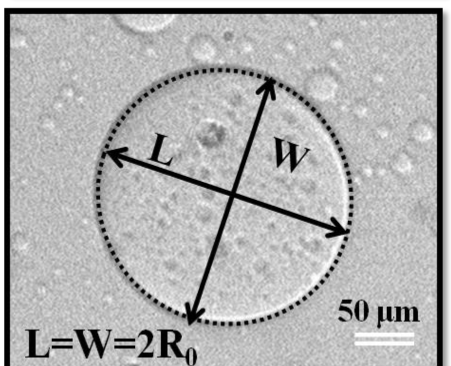
- For low sugar, microstructure depends on the volume fraction and applied shear.

- For high sugar, microstructure depends on the volume fraction only.

Part 3: Interfacial properties

Drop retraction method





1. Droplets are deformed under shear and when this is removed their retraction is recorded.
2. Deformation parameter **D** vs. time.

$$\boxed{D = \frac{L-W}{L+W}}$$

3. Characteristic time **τ**.
4. Viscosity ratio **λ**.

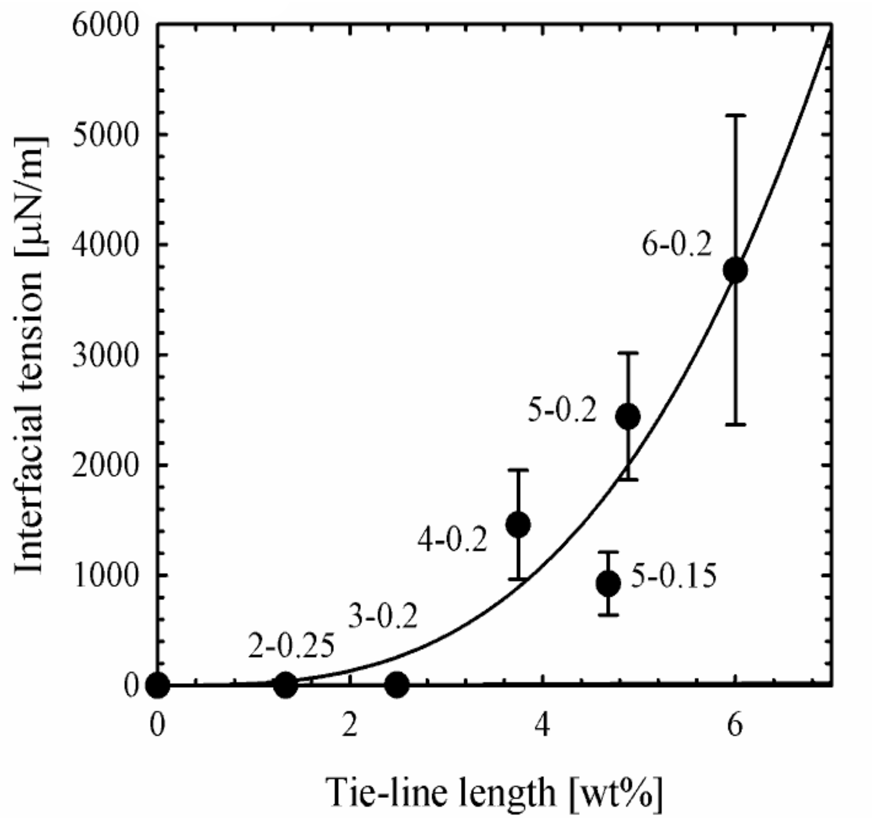
$$\boxed{\lambda = {\eta_d}/{\eta_c}}$$

5. Interfacial tension **σ**

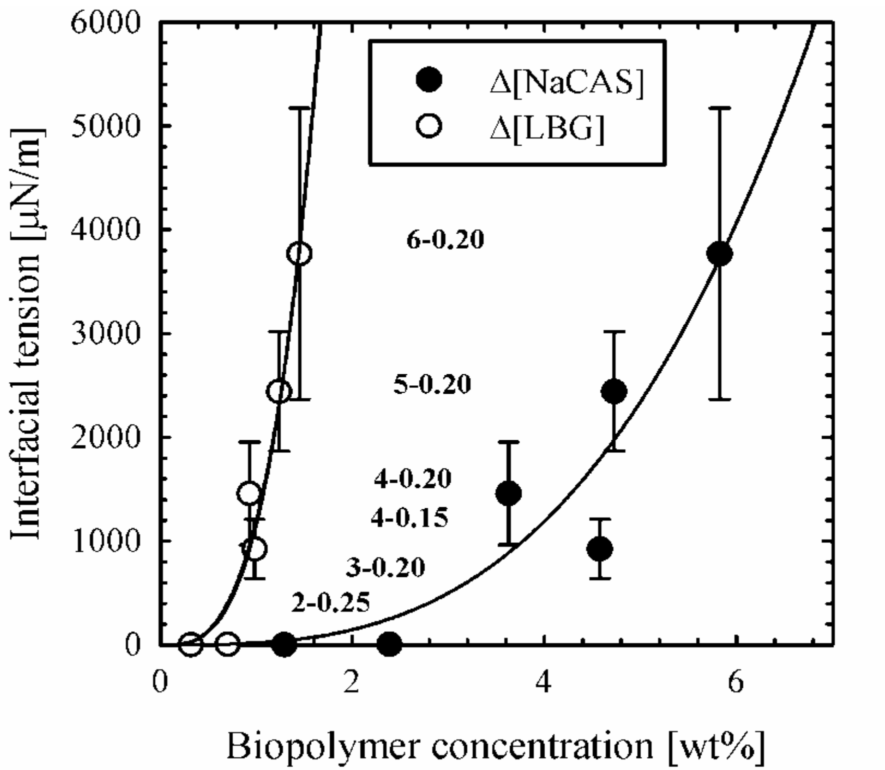
$$\boxed{\sigma = f(\eta_c, \lambda, R_0, \tau)}$$

Part 3: Interfacial properties

- Effect of total biopolymer concentration



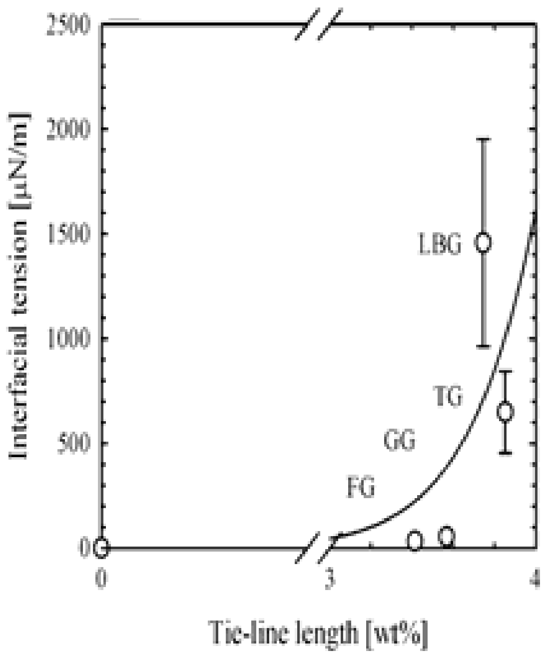
- Effect of individual biopolymer concentration



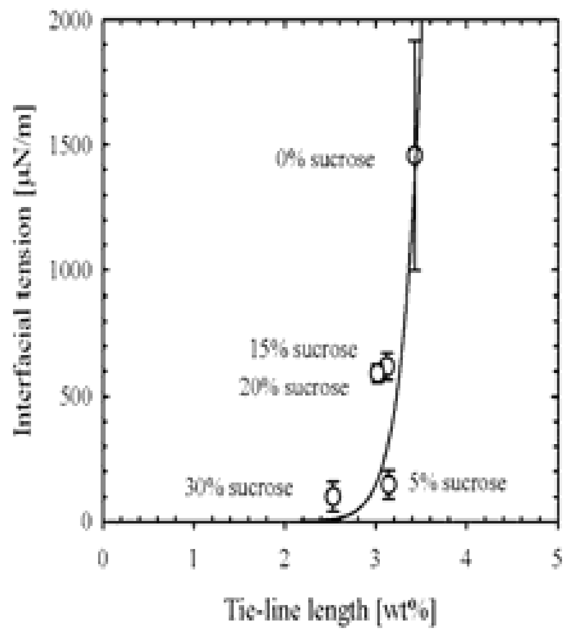
NaCAS-LBG (no sugar)

Part 3: Interfacial properties

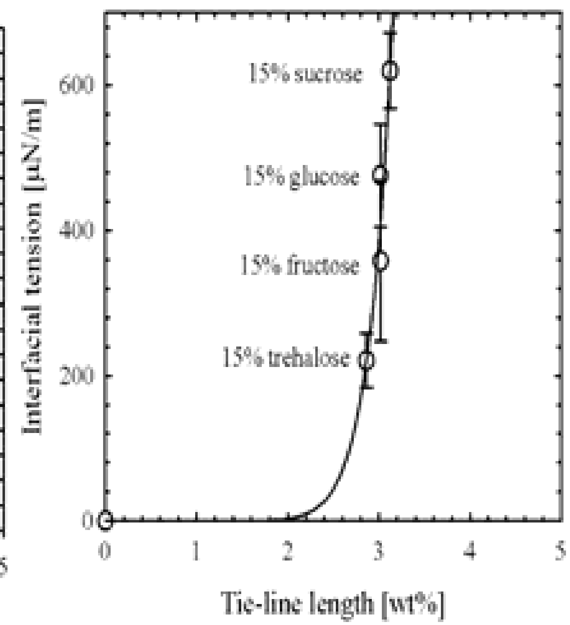
- Effect of galactomannan type



- Effect of sugar concentration



- Effect of sugar type



The above points represent systems of 4% NaCAS-0.2% GM/LBG.

Conclusions (Part 3)

- Power law relationship exists between the interfacial tension and the measured parameters.

- The interfacial tension in a system of a constant biopolymer concentration depends on the type of galactomannan, sugar concentration/type.

Summary of findings

- Sugars below critical concentration improve mixing behaviour of the biopolymers and reduce interfacial tension compared with the systems without sugar.

- A strong link between the microstructure and rheology of the systems is observed.

- Shear-induced phase-inversion observed in the low sugar environment is absent in the high sugar environment.

Related literature

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Schorsch C., Clark A.H., Jones M.G., and Norton I.T. (1999). Colloids and Surfaces B: Biointerfaces, 12, 317-329.

Semenova, M.G., Antipova, A.S. and Belyakova, L.E. (2002), Current Opinion in Colloid and Interface Science 7, 428-444.

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Thank you very much for your attention.

Do you have any questions?