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New Processes for New Products

Impact of protein modification – designed functionalities as food ingredients

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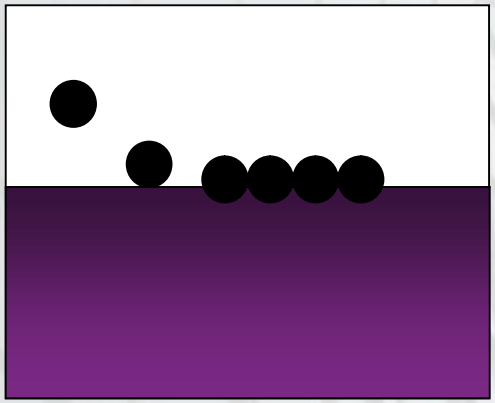
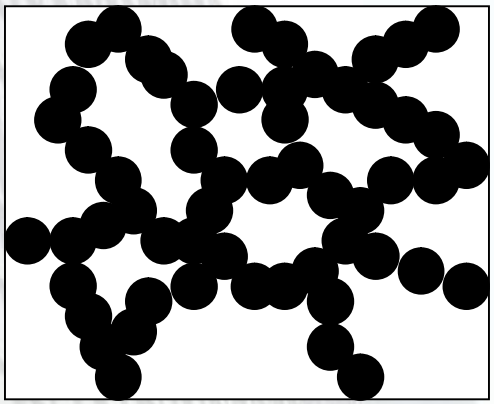
Molecular Function



Interfacial properties

***Foams and Emulsions**

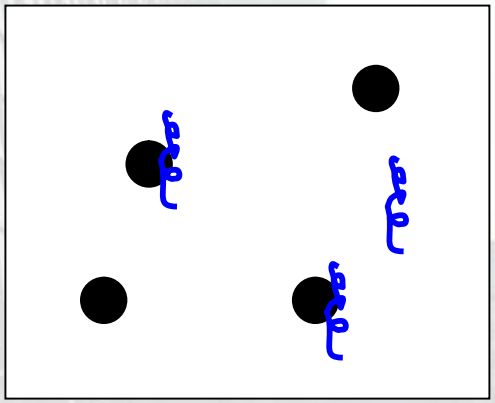


Network formation

***Gels and films**

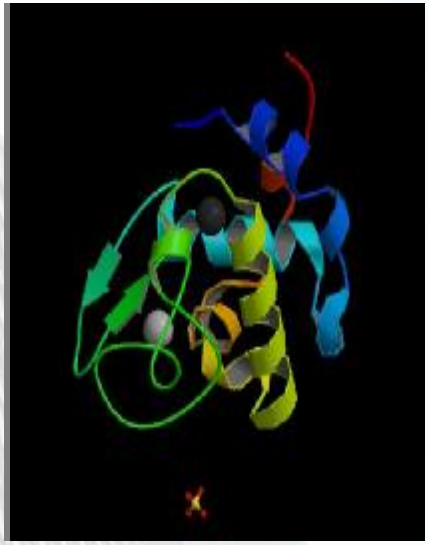
Soluble particles (heat stability)

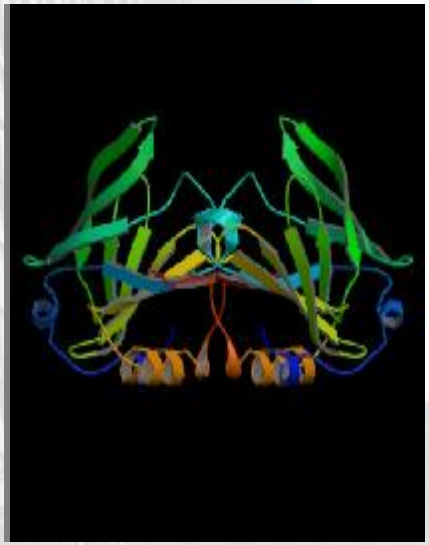
***Beverages**



Modifications

- Soluble aggregates
  - è Denaturation and aggregation
- Hydrolysis
- Deamidation
- Glycosylation
- Add other polymers





Angel Food Cake

- Form Foam (200 ml)
  - è 10% protein
  - è 12% Sugar
- Blend in:
  - è 33 g cake flour
  - è 75.8 g powdered sugar
- Bake

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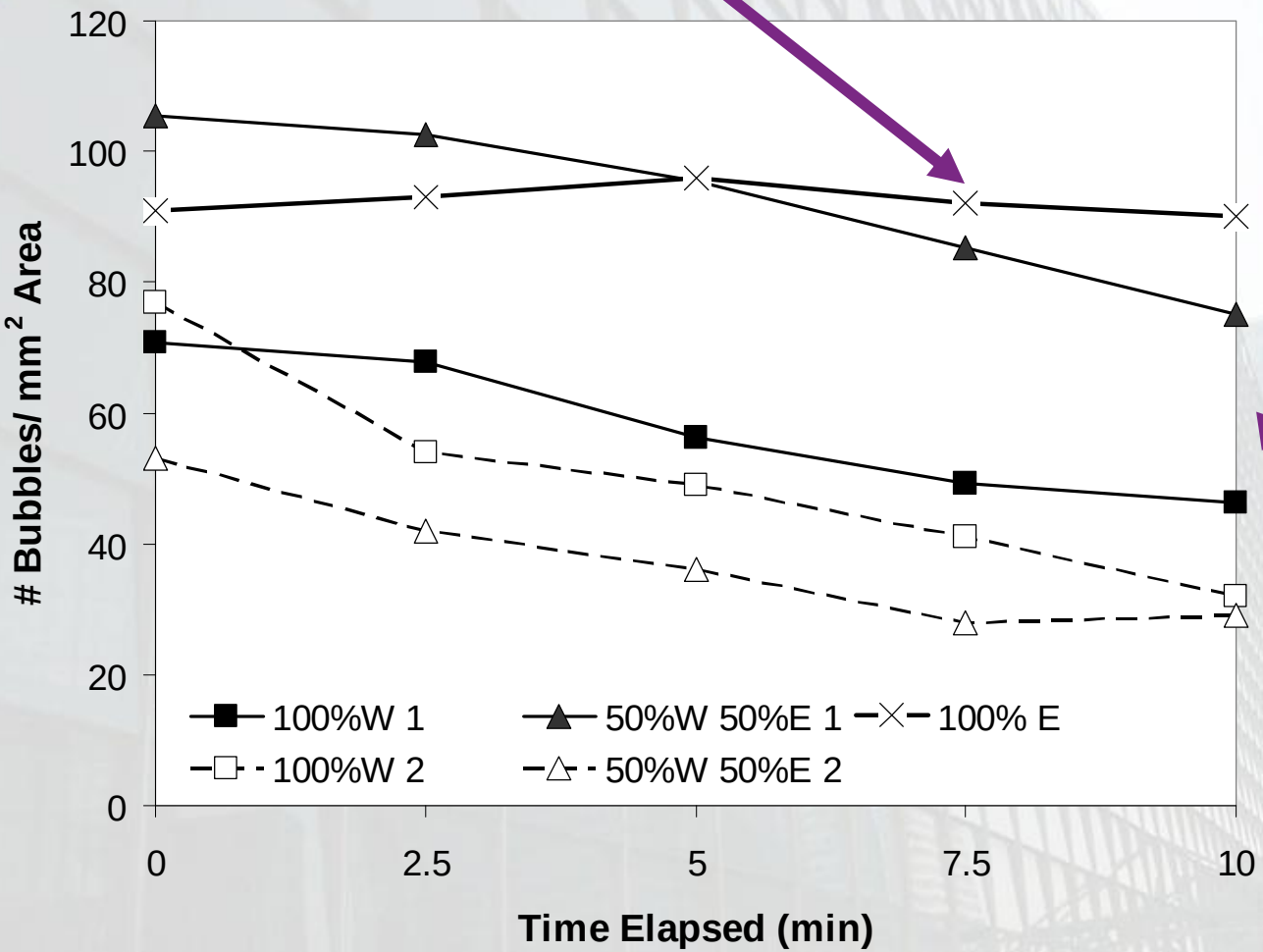
Stability of the wet foam

Egg white bubbles remains stable

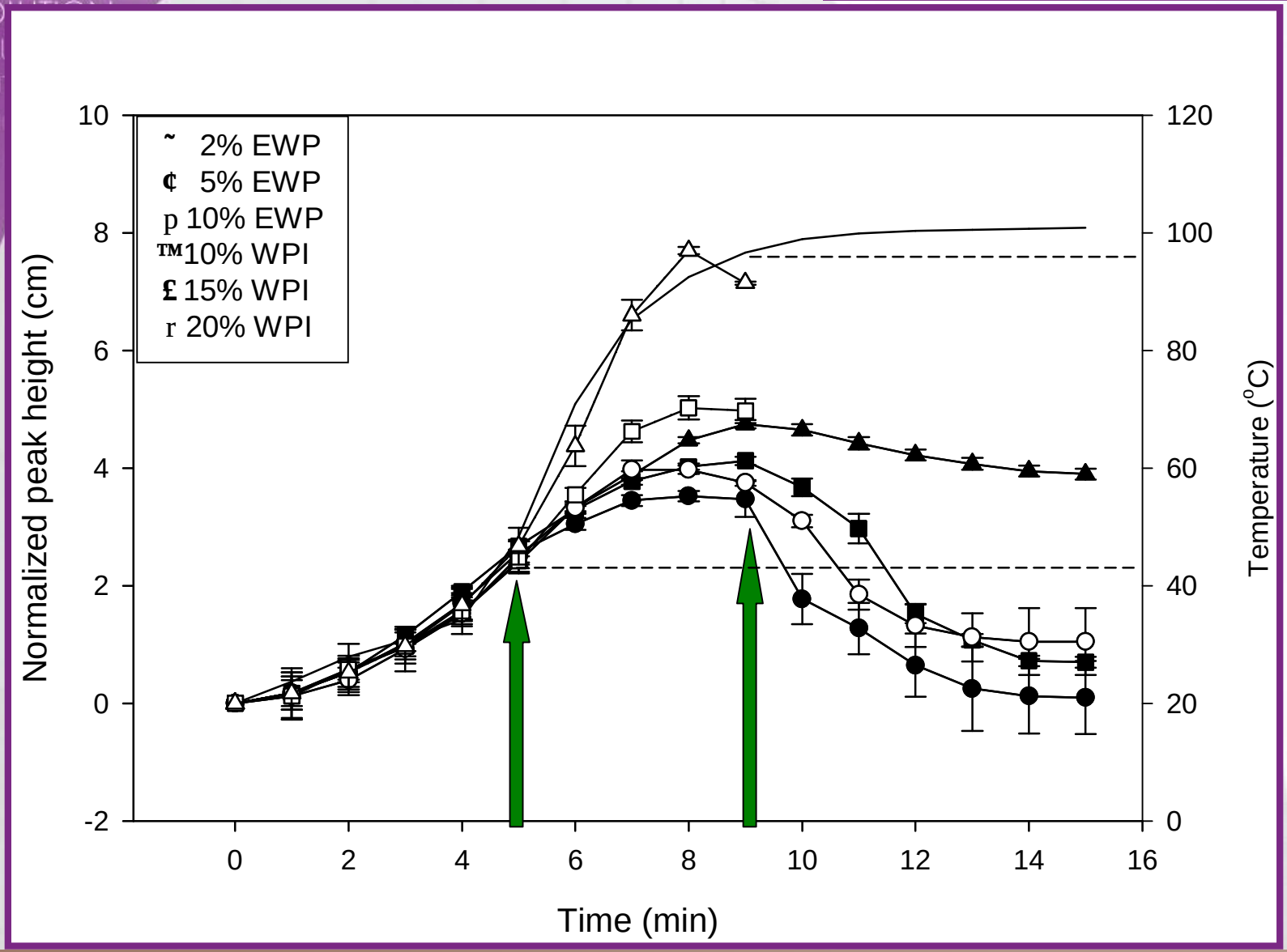
Whey protein isolate bubbles destabilize



E.A. Foegeding, unpublished data.

Expansion of cakes during cooking

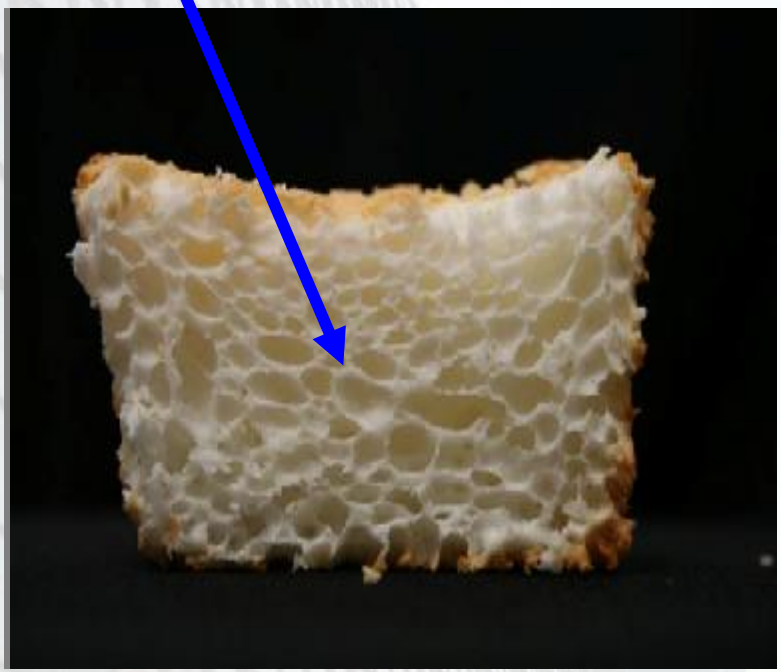
(Pernell et al., 2002, J. Food Sci., 67, 2945)



Problem in cake structure

Loss of bubble stability during baking

100% Egg White



75% Egg White & 25% WPI

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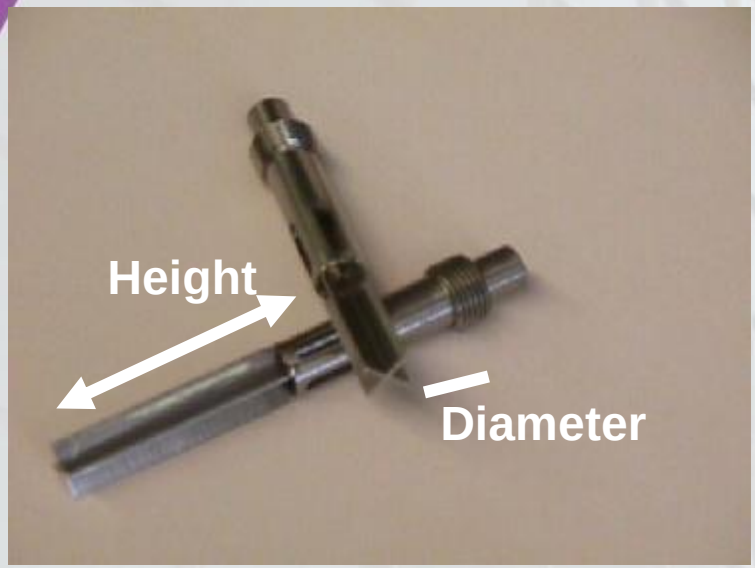
Properties of Foams

- FORMATION
  - Foamability – Effectiveness of gas encapsulation (Wilde and Clark, 1996)

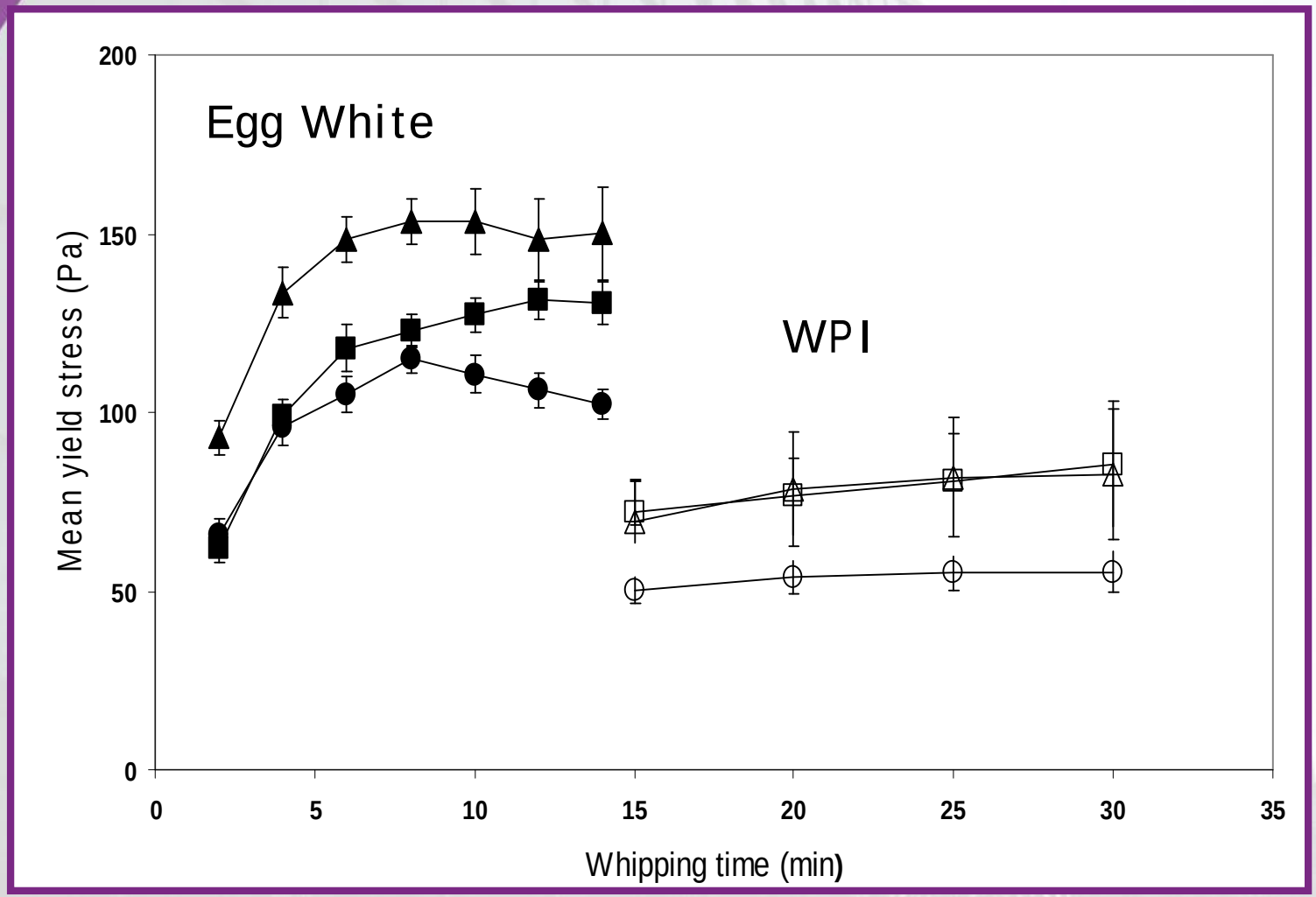
- PHYSICAL PROPERTIES
  - Air phase volume (overrun) and bubble size
  - Rheological – Shear moduli and yield stress
- STABILITY
  - Drainage
  - Coalescence
  - Disproportionation

Yield Stress (s_o) - Vane Technique



Yield Stress (σ_0) ∝ (bubble size, air phase volume, interfacial tension and/or rheology)

Egg White vs. Whey Protein Isolate
(Pernell et al., 2000, Journal of Food Science, 65, 110)



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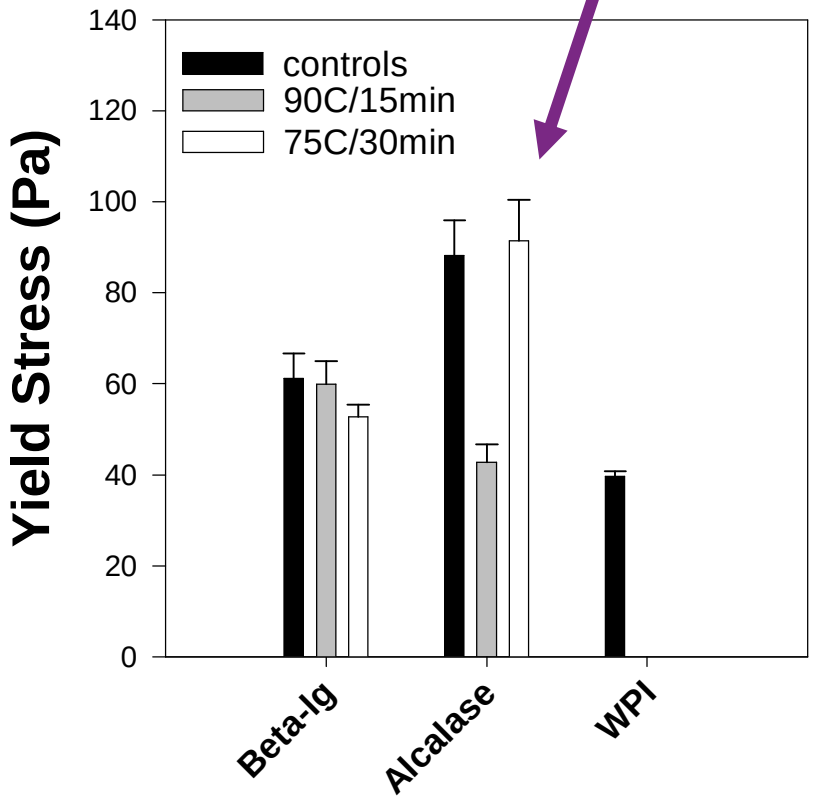
Hydrolysis to improve foaming

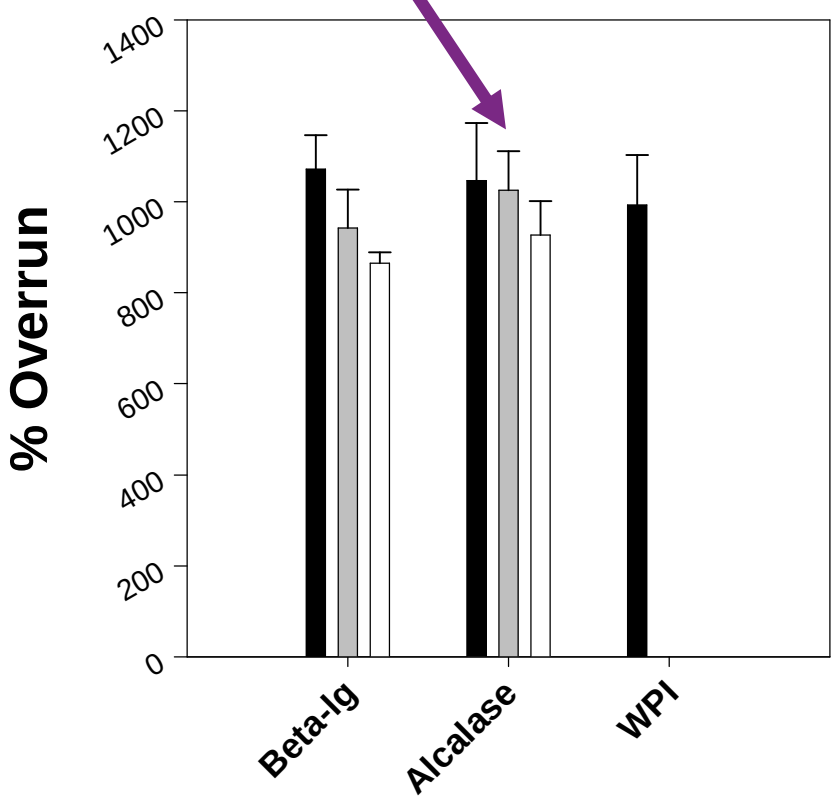
Davis et al., 2005, J. Colloid and Interface Science, 288, 412

Extensive hydrolysis with Alcalase

Improved yield stress

and did not decrease overrun





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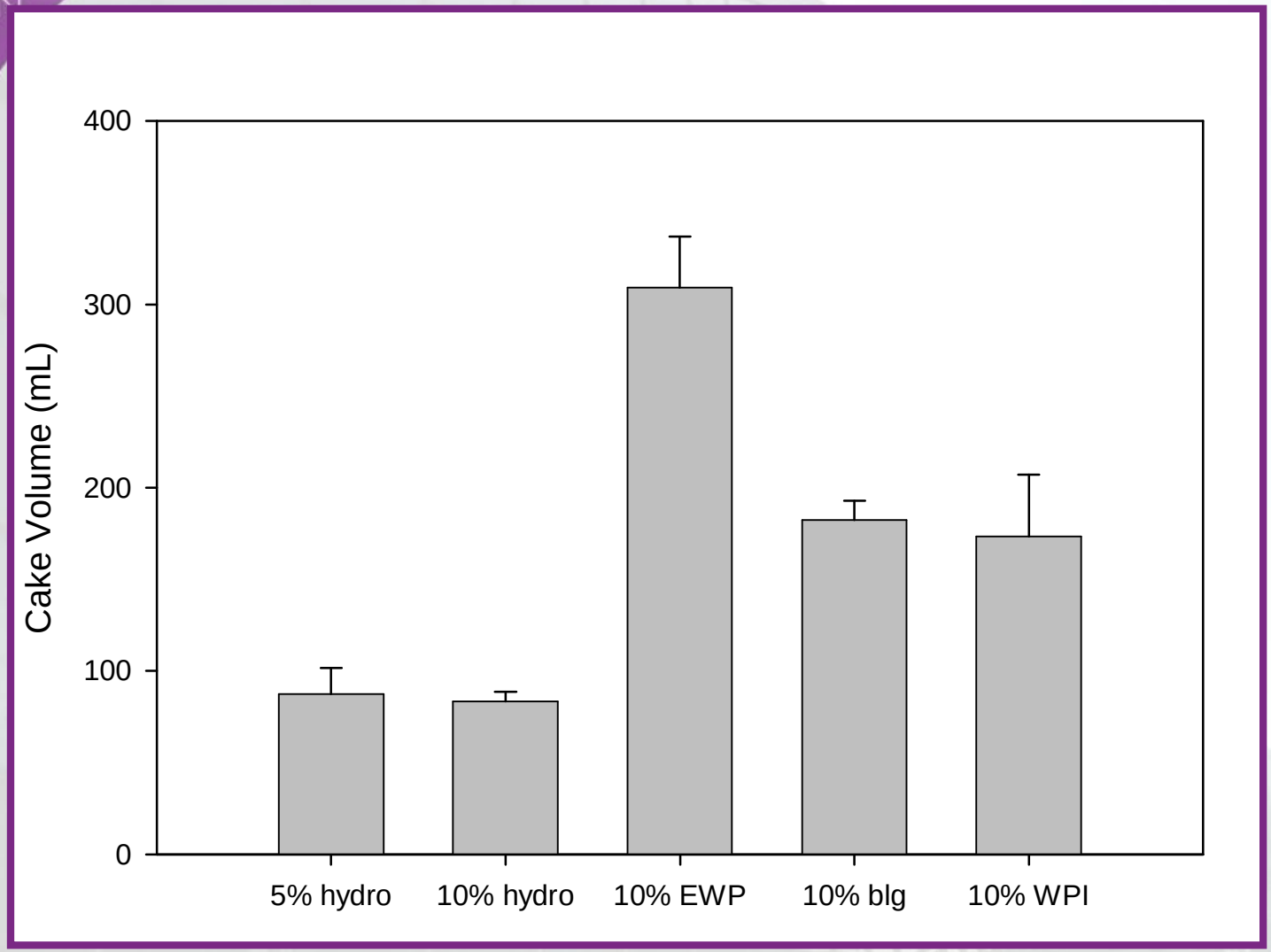
Does it work in a cake?



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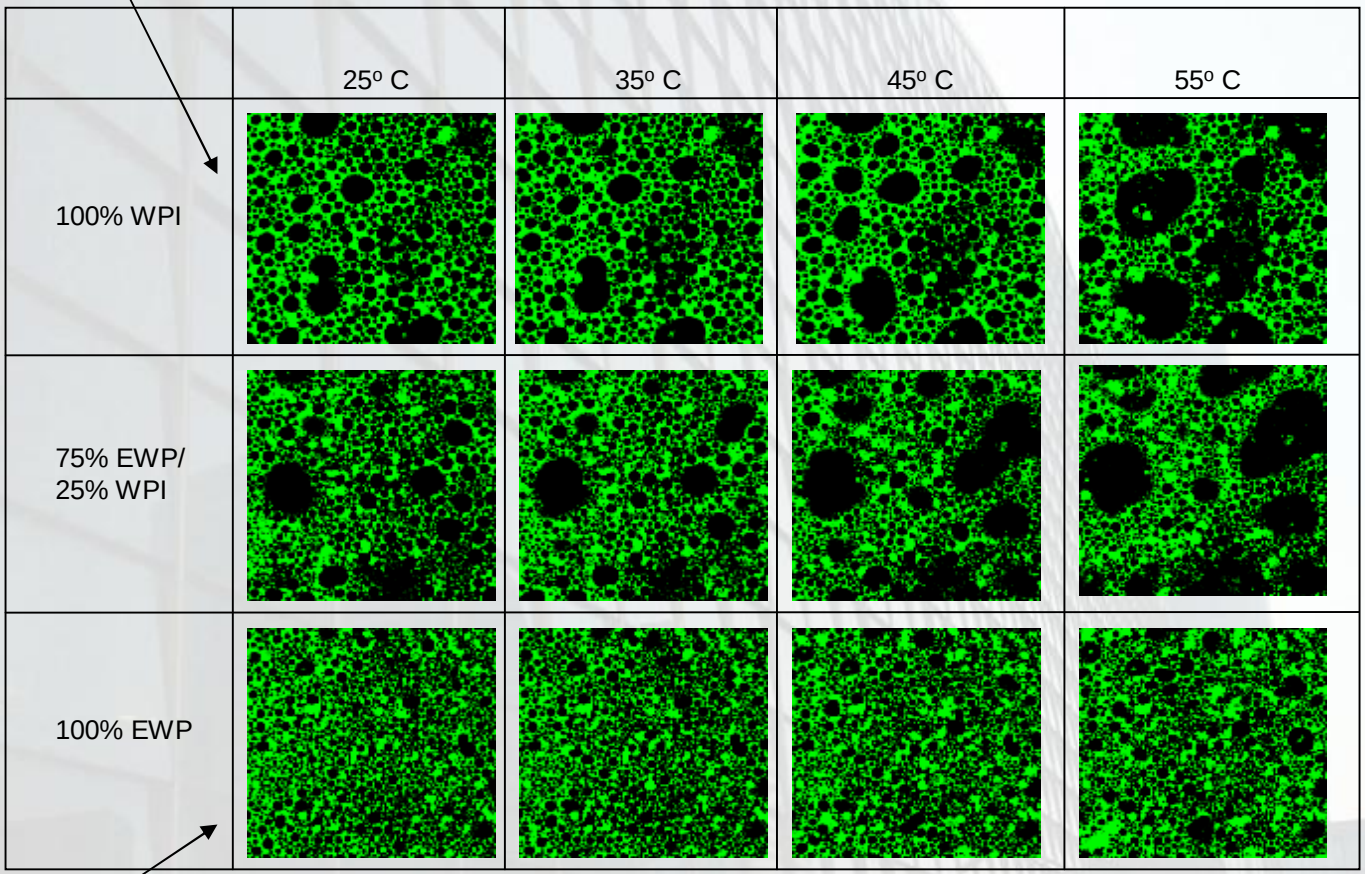
What happened during baking?

WPI batters destabilize during the entire process



Egg white batters remain stable during the entire process

Lesson: Functionality is the entire process!

Improved wet Foam functionality

But did not improve Thermal stability

Protein/sugar foam

Blend in wheat starch and protein (flour)

Heat to expand air cells, set the protein/starch network and remove moisture

Angel Food Cake

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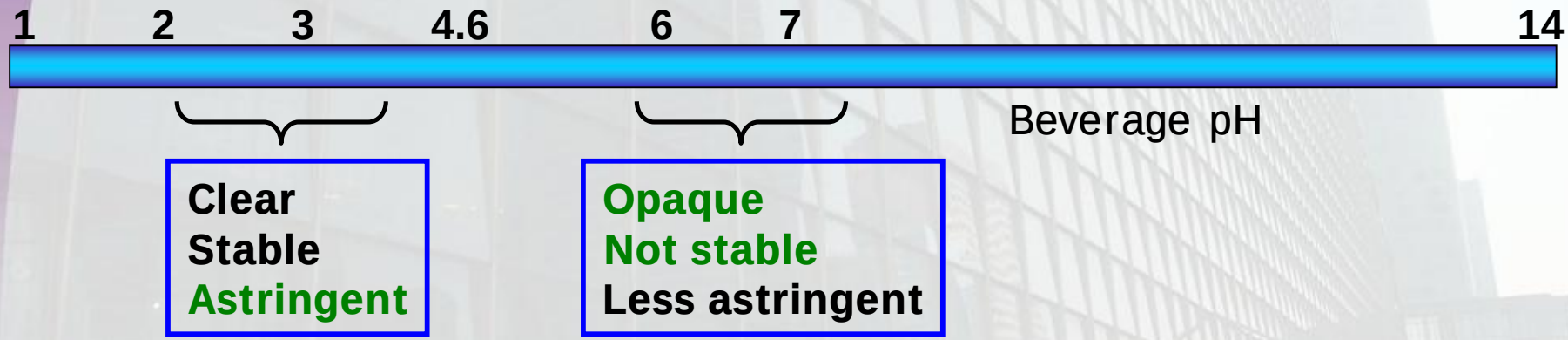
Whey proteins in Beverages

Stability
*No visible phase separation

Flavor
*No off-flavors
*Low astringency

Clarity
*Clear like soft drinks

Nutrition & Health
*No changes in biological properties



General Approach

- Inhibit denaturation or alter aggregation
  - Addition of charged polysaccharides (dextran sulfate)
  - Addition of β- or α_s-casein to act as “molecular chaperones”

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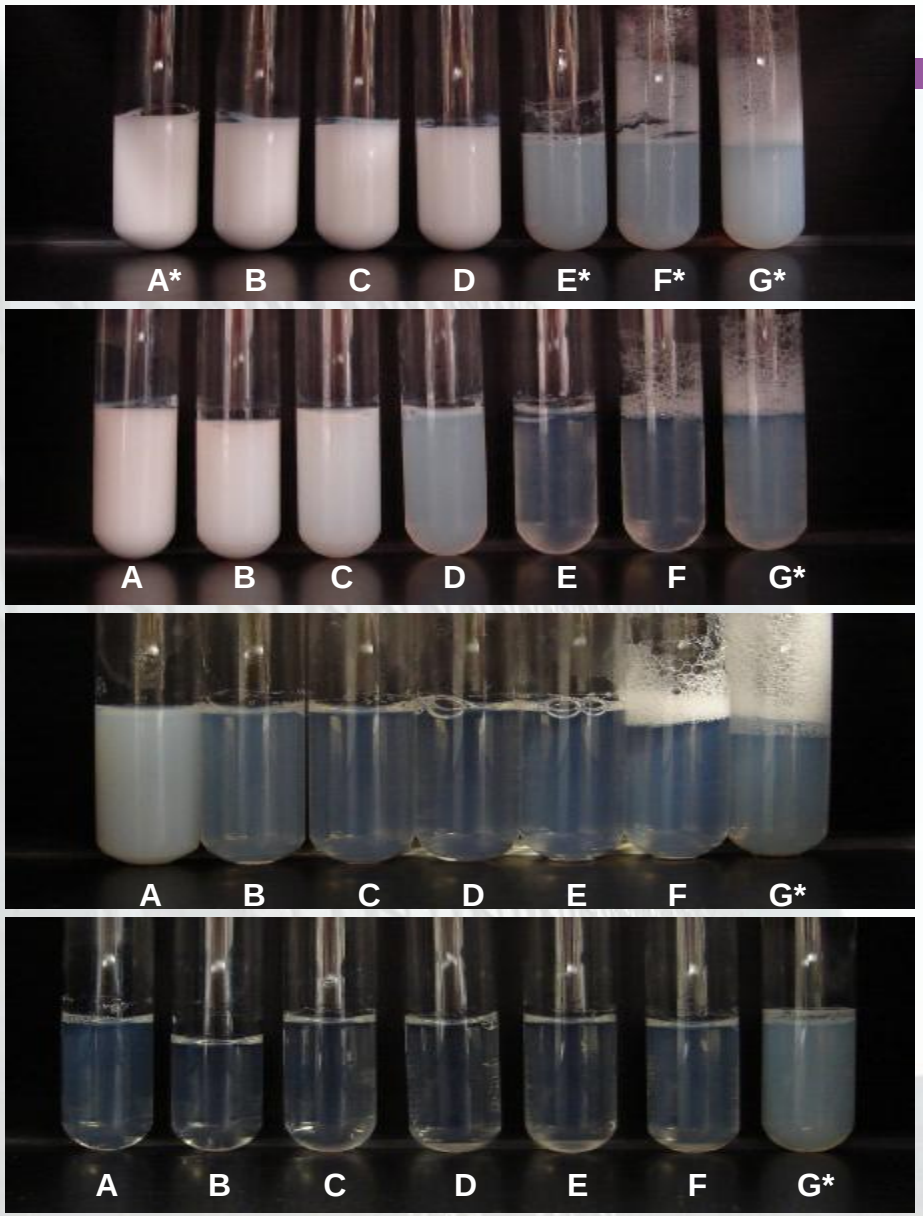
Dextran Sulfate (DS)

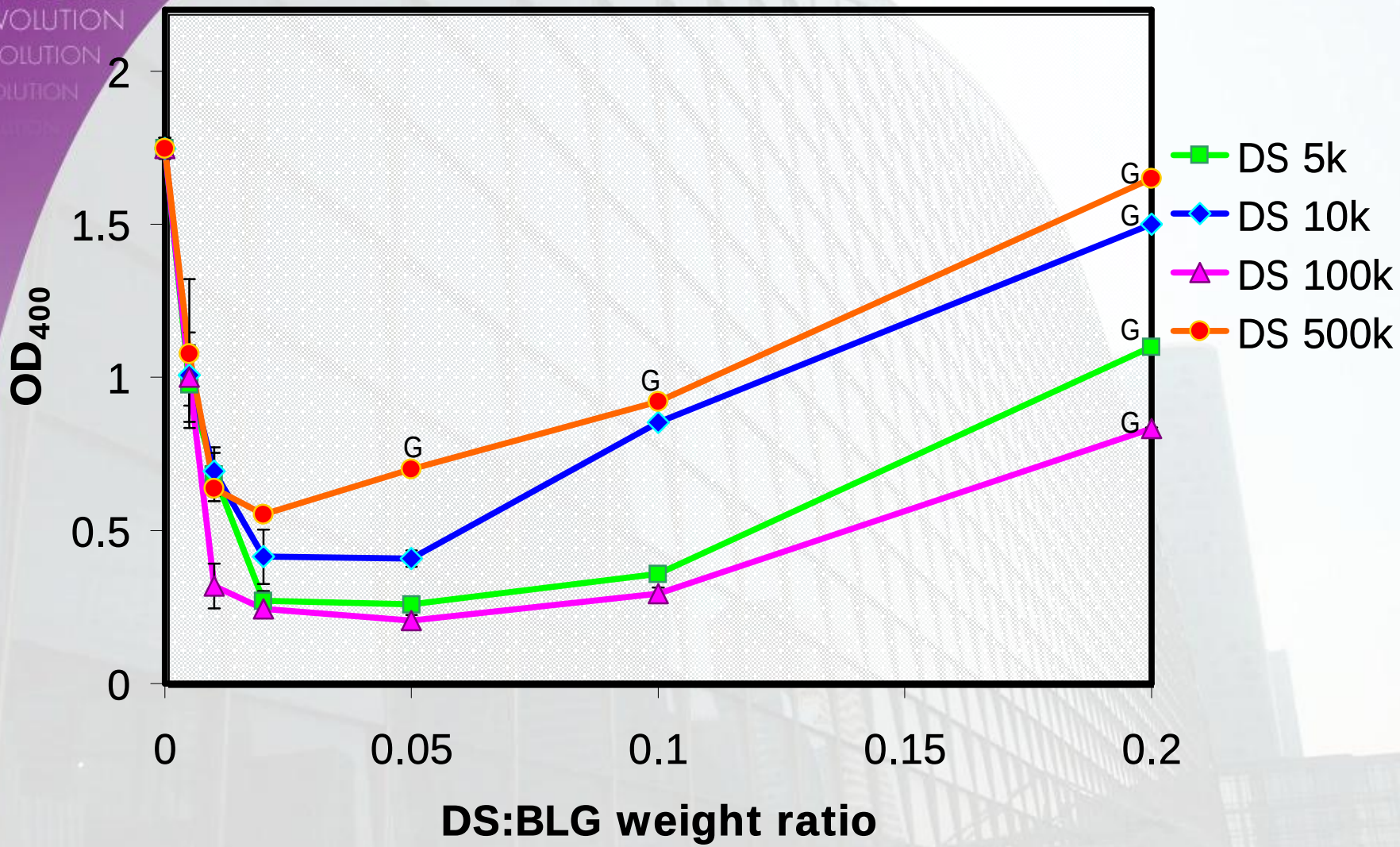
- 6% β-Lactoglobulin
- Heated at 85°C for 15 min
- * = Gel

A **à** G = increasing DS concentration



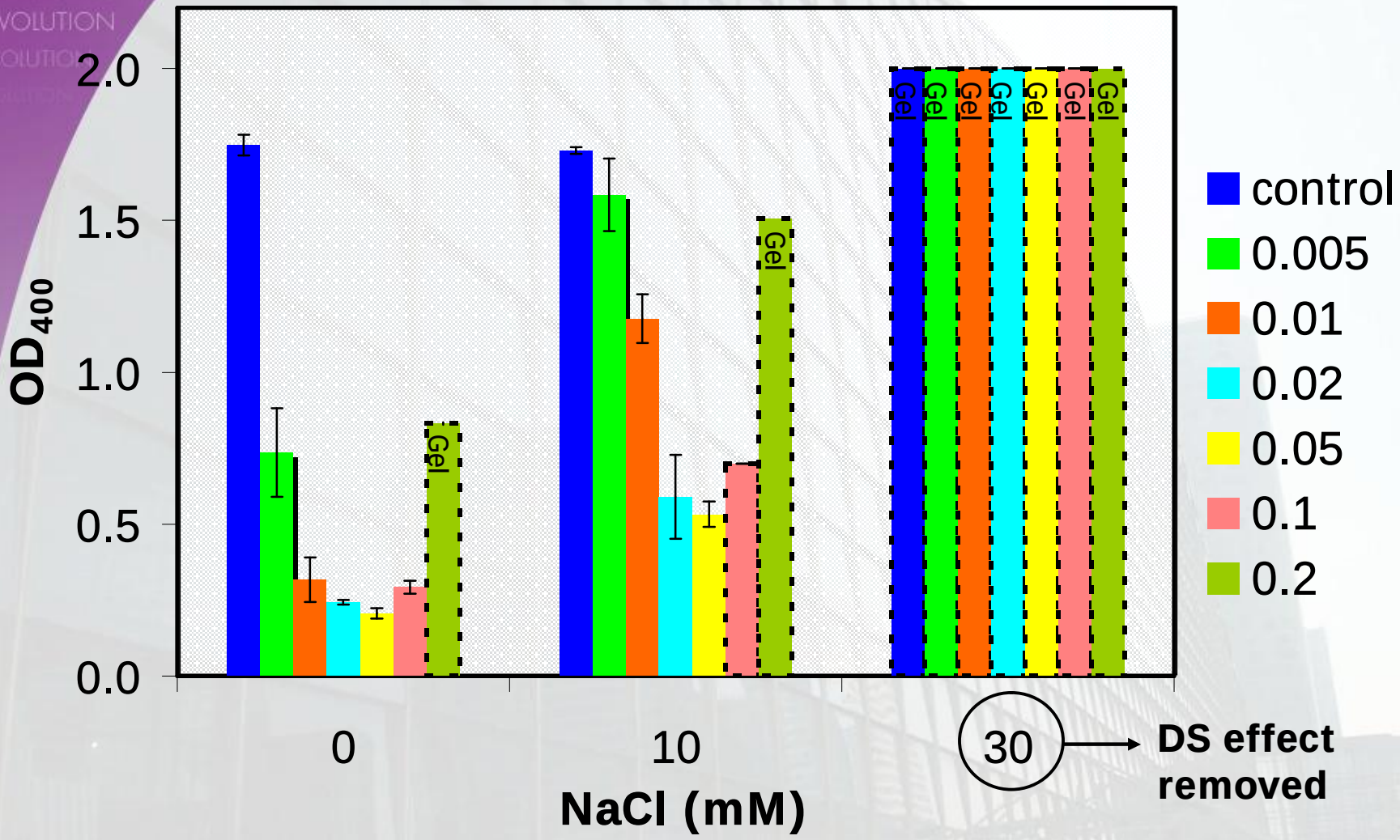
Vardhanabhuti, B. and Foegeding, *Unpublished data*

Effect of dextran sulfate M_w at pH 6.0



Vardhanabhuti, B. and Foegeding, *Unpublished data*

Effect of NaCl



Vardhanabhuti, B. and Foegeding, *Unpublished data*

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Caseins as Molecular Chaperones: Previous investigations

Study	pH	Temp. (°C)	Time (min)	Whey components (%)	Caseins (%)	Total protein (%)
*1	7.0	70	5	a-lac (0.2) b-lac (0.2)	a_s-casein (0.6)	1.0
*2	7.1	70	480	b-lac (0.5)	a_s-casein (0.5)	1.0
*3	6.0	85	10	Whey protein isolate (0.5)	a_{s1}/b-casein (0.5)	1.0

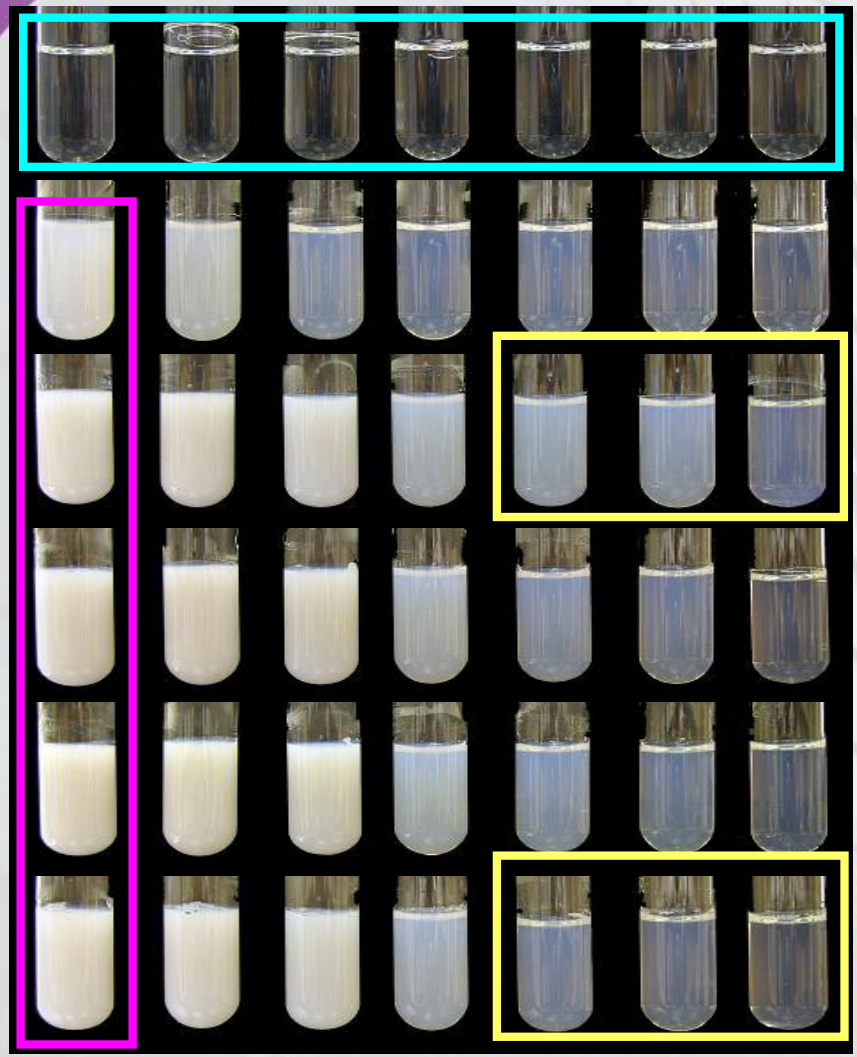
TOO LOW!

**1 Bhattacharyya and Das, J. Biol. Chem. (1999), vol. 274, p. 15505*

**2 Morgan et al., J. Agric. and Food Chem. (2005), vol. 53, p. 2670*

**3 O'Kennedy and Mounsey, J. Agric. and Food Chem. (2006), vol. 54, p. 5639*

b-Lactoglobulin & b-casein (BCN)

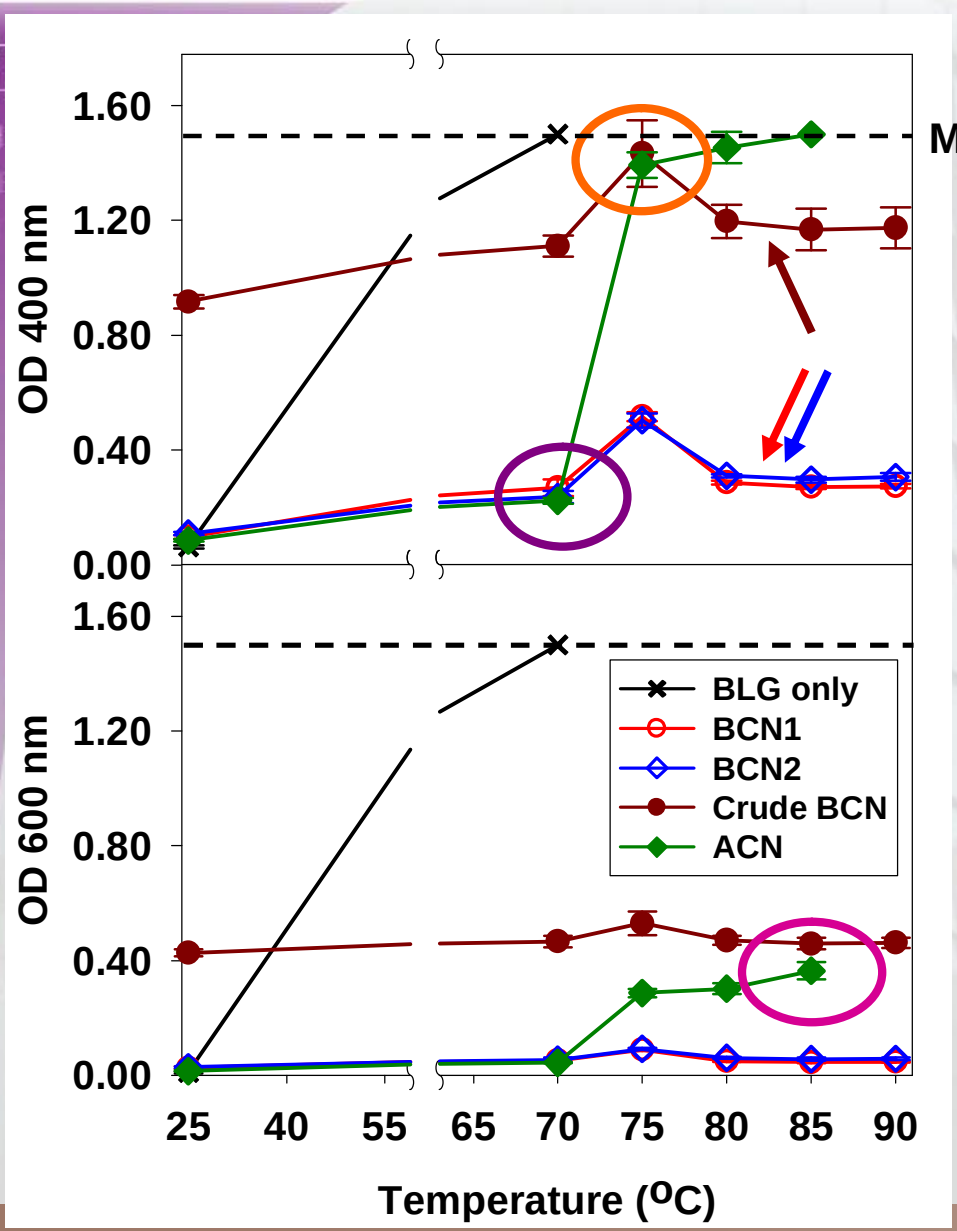


- Unheated solutions (25°C) were clear
- BCN decreased the turbidity of heated solutions, especially 2% BCN (total protein 8%)
- Heating at 90°C produced clearer solutions than at 75°C

Constant 6% (w/v) BLG

Yong et al, unpublished data

Effect of different caseins



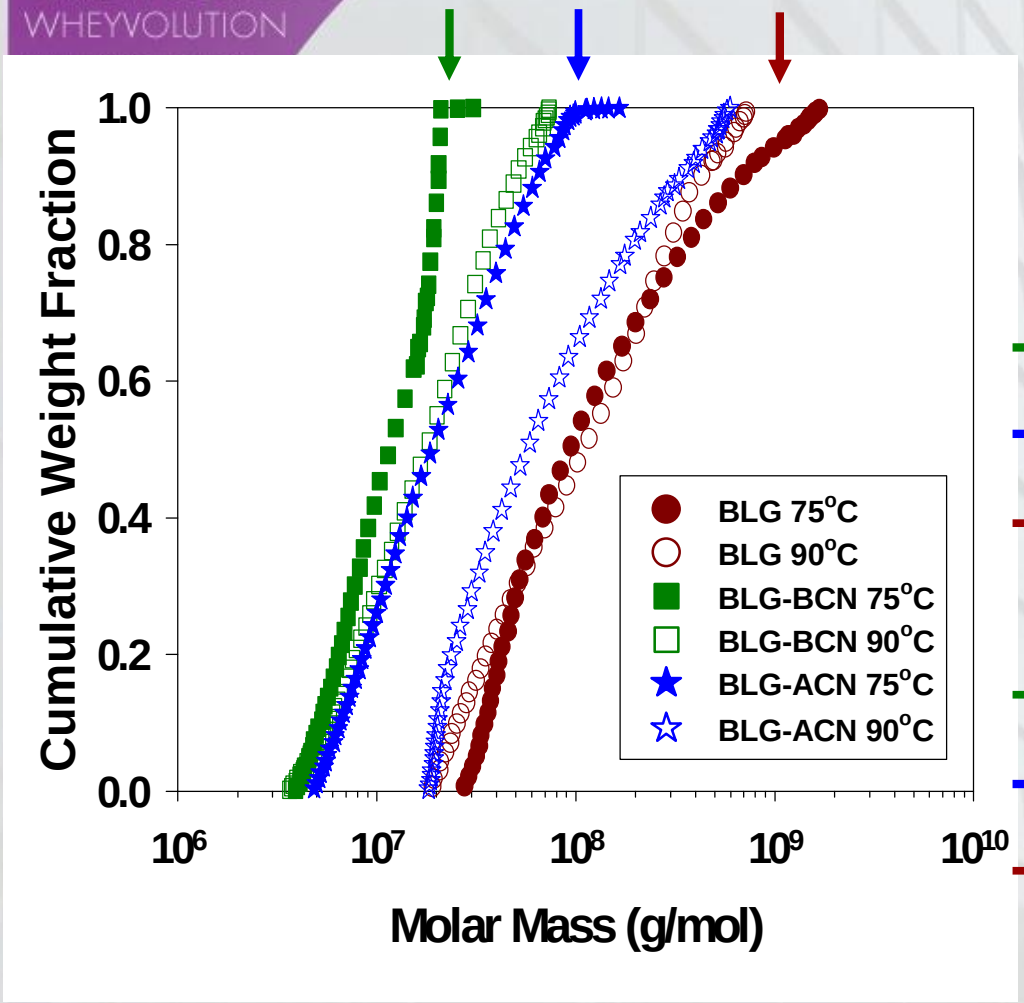
Maximum linear region

- **Two lots of BCN** produced identical turbidity profiles
- **A crude BCN** showed a systematic shift up
- a_s**-Casein** inhibited turbidity development at **70°C** matched with other studies
- However, turbidity increased drastically at **75°C** (lost chaperone ability) and formed gel at **90°C**

Constant 6% (w/v) BLG

Yong et al, unpublished data

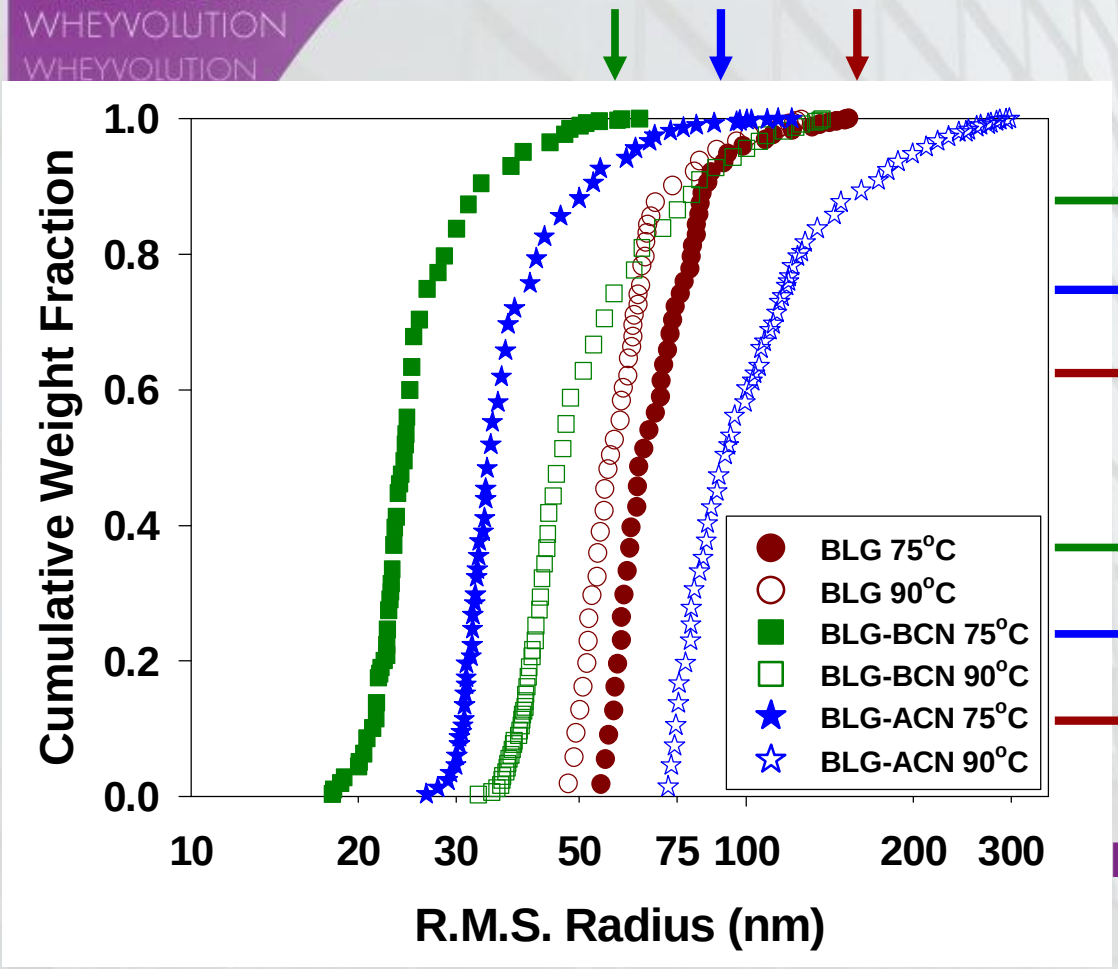
Molar Mass (SEC-MALS)



- **Molar mass distribution at 25°C**
  - **Mean $3.0X10^4$**
- **Molar mass distribution at 75°C**
  - **BLG-BCN : $4.5x10^6$–$2.1x10^7$**
  - **BLG-ACN : $5.6x10^6$–$8.2x10^7$**
  - **BLG only : $3.2x10^7$–$1.1x10^9$**
- **Molar mass distribution at 90°C**
  - **BLG-BCN : $4.6x10^6$–$6.3x10^7$**
  - **BLG-ACN : $1.9x10^7$–$4.7x10^8$**
  - **BLG only : $2.2x10^7$–$5.7x10^8$**

Yong et al, unpublished data

Root Mean Square Radius



~ Radius distribution at 75°C

- BLG-BCN : 20−40
- BLG-ACN : 30−63
- BLG only : 55−98

~ Radius distribution at 90°C

- BLG-BCN : 37−100
- BLG-ACN : 74−210
- BLG only : 48−88

~ Radius of BLG at 75°C slightly higher than 90°C

Yong et al, unpublished data

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Conclusion

- β-Casein and as-casein showed chaperone effects by altering aggregation of β-lactoglobulin at pH 6 (8% w/v total protein)
- β-Casein was shown to be an effective approach to alter aggregation of β-lactoglobulin over a range of temperatures (70-90^{o}C)
- α_s-casein lost its chaperone ability at temperatures ≥ 75^{o}C

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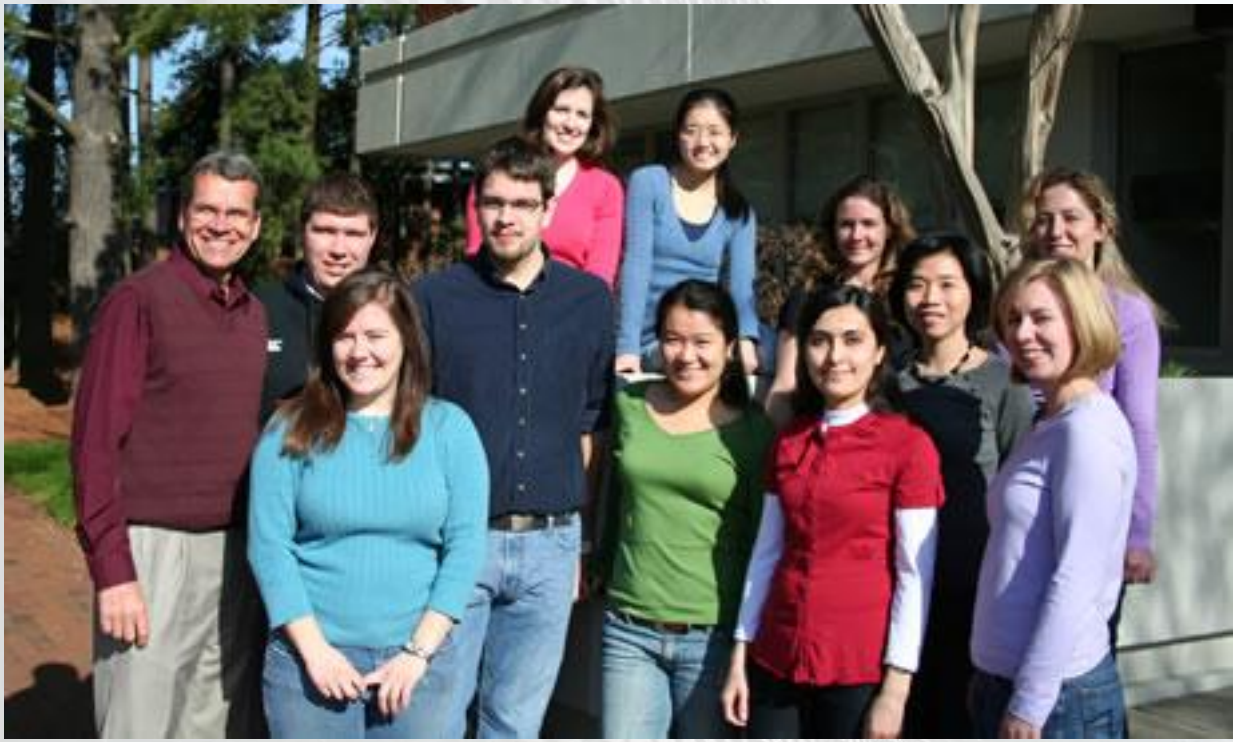
Thanks to:

*Dairy Management Inc. and the Southeast Dairy Foods Research Center for funding

*DAVISCO Foods International for donating the proteins



Protein Synthesis Units

SDFRC
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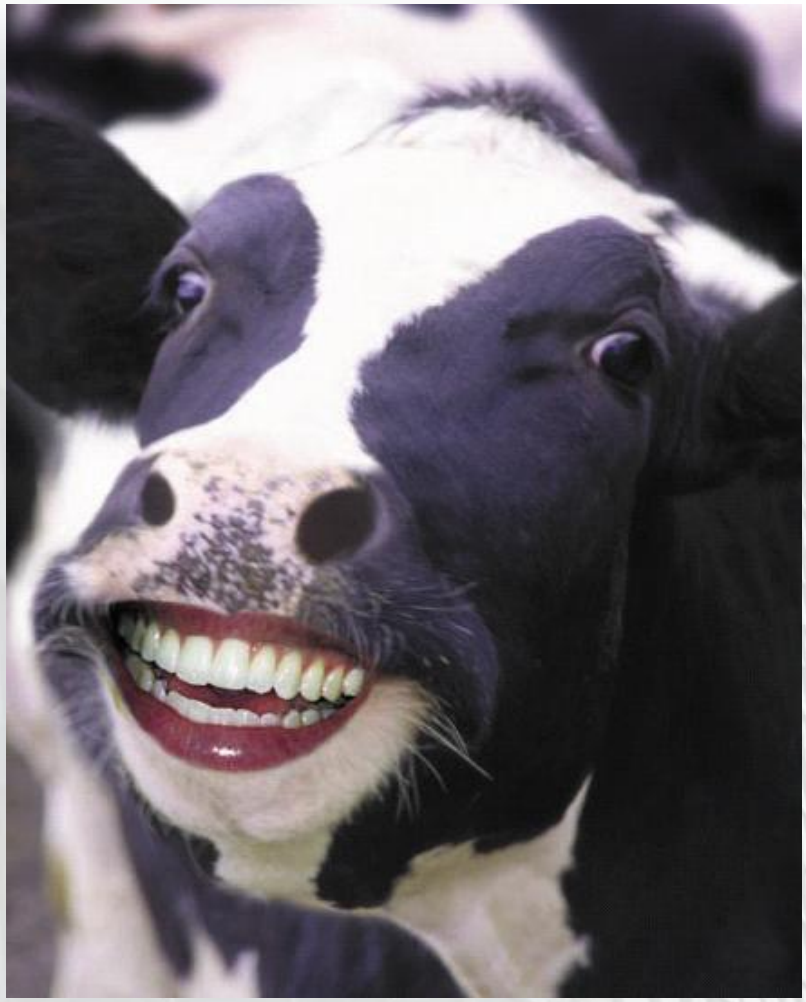
Questions?



From: www.whereamiwearing.com/rogue/food/

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