10° CONGRESO INTERNACIONAL de la INDUSTRIA LÁCTEA

Funcionalidad de la caseína no micelar

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PennState

8/8/2024

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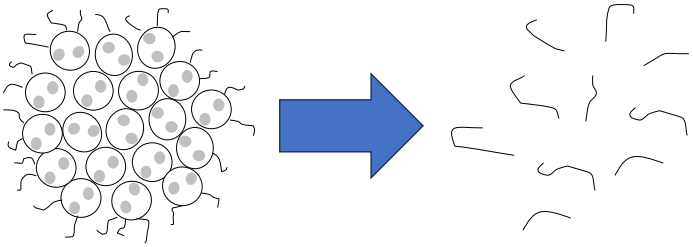
Contenido

- Contexto
- La micela de caseína
- Funcionalidad
  - Jets de alta presión
  - Ambientes iónicos
  - Solventes (etanol)
- Necesidades



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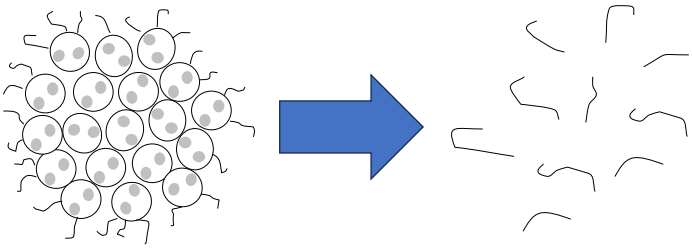

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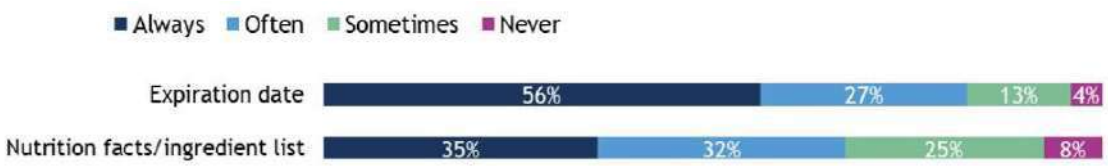
Contenido

- **Contexto**

How often do you actively look for the following information on a food/ beverage package (ie look for it on purpose)?



Base: 2000 internet users 18+
Source: Kantar Profiles/Mintel, May 2023

MINTEL

EUROMONITOR INTERNATIONAL

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Contexto

- Consumidores demandamos
  - etiquetado natural, sustentable, limpio
  - no estamos dispuestos a sacrificar calidad consistente
- Presión por sustituir ingredientes sintéticos
  - Aceites vegetales brominados
  - Rojo 40
  - Dióxido de titanio
  - Polysorbatos
- La diversificación de ingredientes funcionales naturales es difícil
  - 84% de la harina que se usa en productos elaborados es de trigo
  - 95% de la proteína vegetal es de soja o trigo

$U 384 / L

INGREDIENTS: CREAM, SKIM MILK, CANE SUGAR, EGG YOLKS, VANILLA EXTRACT.

$U 76 / L

INGREDIENTS: MILKFAT AND NONFAT MILK, SWEET CREAM BUTTERMILK, LIQUID SUGAR (SUGAR, WATER), CORN SYRUP, WHEY, HIGH FRUCTOSE CORN SYRUP, CONTAINS LESS THAN 2% OF MONO- AND DIGLYCERIDES, NATURAL FLAVORS, GUAR GUM, CALCIUM SULFATE, CAROB BEAN GUM, CARRAGEENAN, ANNATTO EXTRACT (COLOR).

MINTEL

EUROMONITOR INTERNATIONAL

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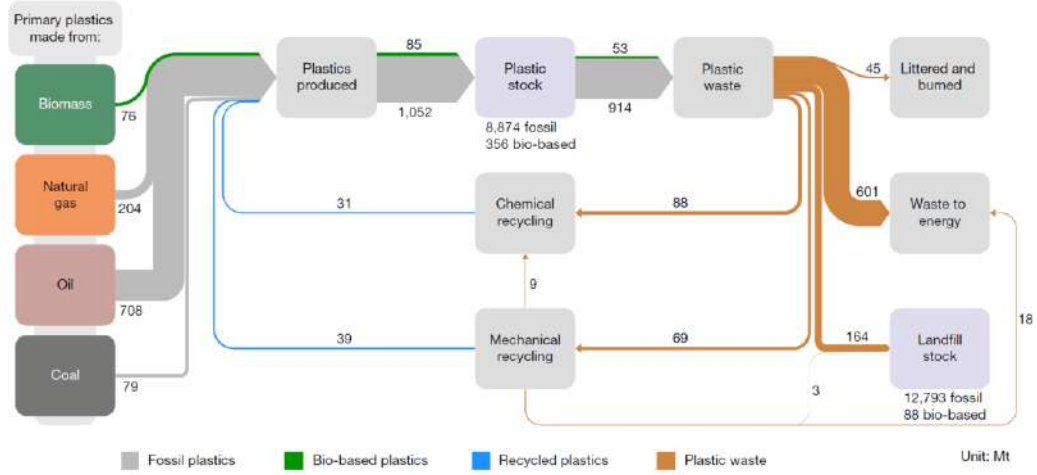
Contexto

PennState

Demanda por biomateriales

https://doi.org/10.1038/s41586-022-05422-5



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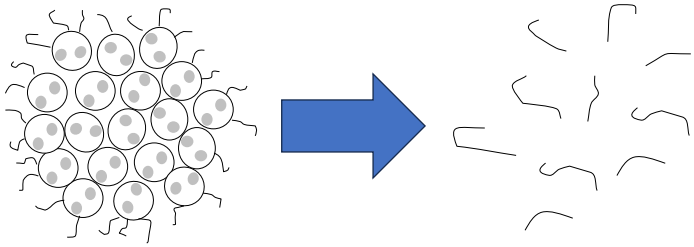

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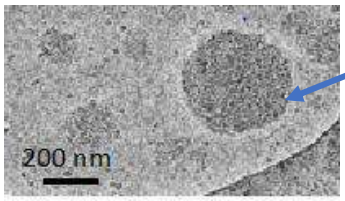
La micela de caseína

Component	Average (%)
Water	87.0
Fat	4.0
Protein	3.25
Casein	2.6
Whey Protein	0.6
Lactose	5.0
Ash	0.75

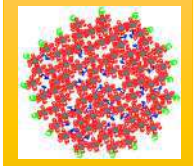


J Dairy Sci., 2022, (105):2119-2131

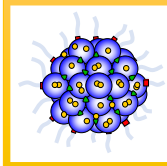
Casein micelles (CM)
10^{14} CM per mL
(100 billones)
- *ca.* 5,000 monomers per CM

Horne, D. 2006 colloid & interf sci, 11:148-152

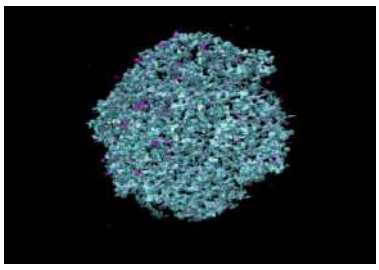
Holt, C. *et al.*, 1998. FEBS, 252(1):73-79



Dalgleish, D. 2011. Soft Matter, 7: 2265-2272



Walstra, P. 1999. Int. Dairy J. 9(3-6):189-193



J Dairy Sci., 2011, 94 :5770–5775

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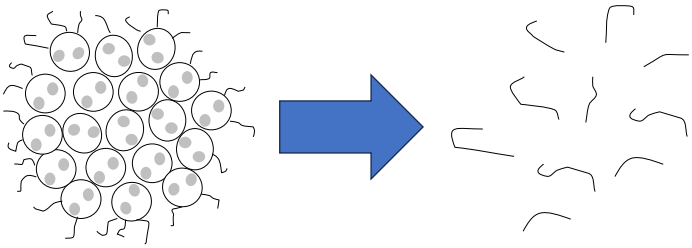

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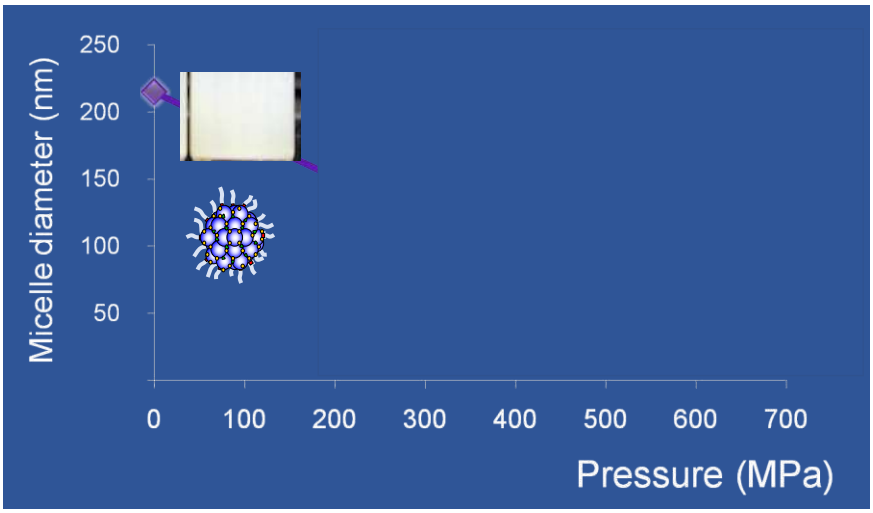
Alta presión hidrostática y caseína



Casein micelles dissociate under high pressure

J. Dairy Res. 2007, 74(4):452-458

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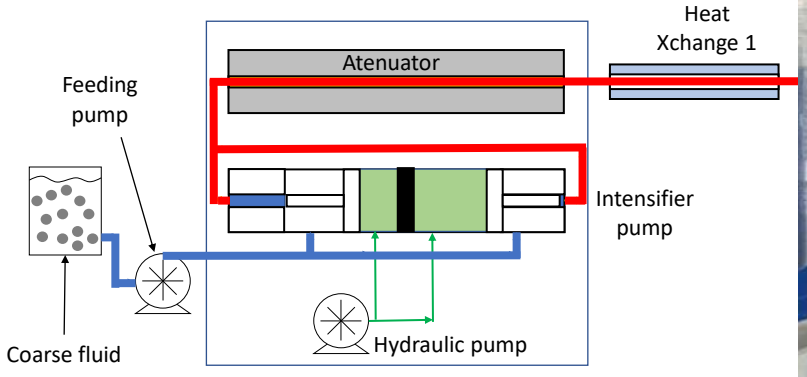
Jets de alta presión



Pressure up to **600 MPa**

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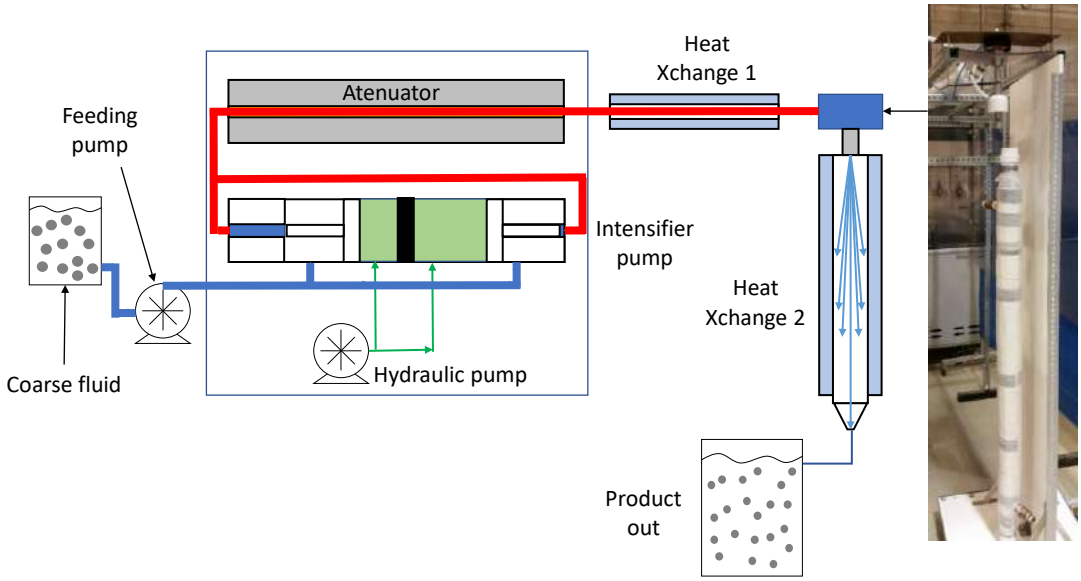
Jets de alta presión



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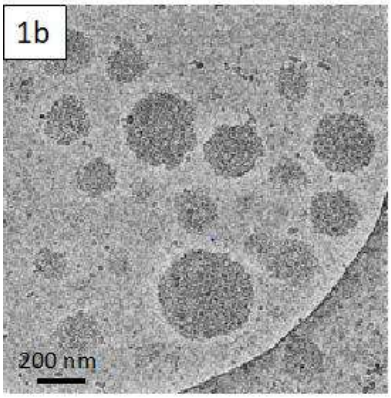
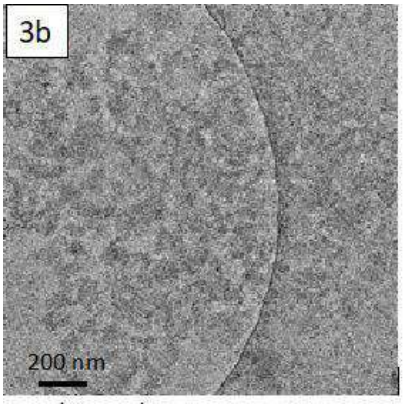
Micela de caseína y jets de alta presión

Up to 250 MPa



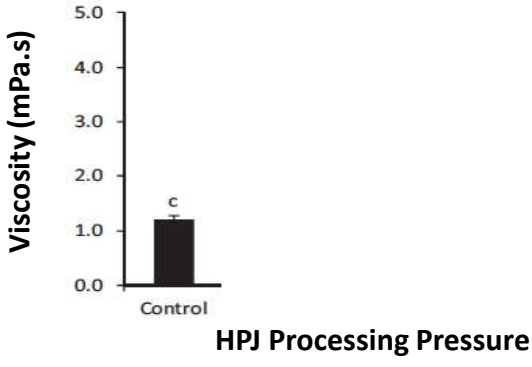
400 / 500 MPa



Funcionalidad?

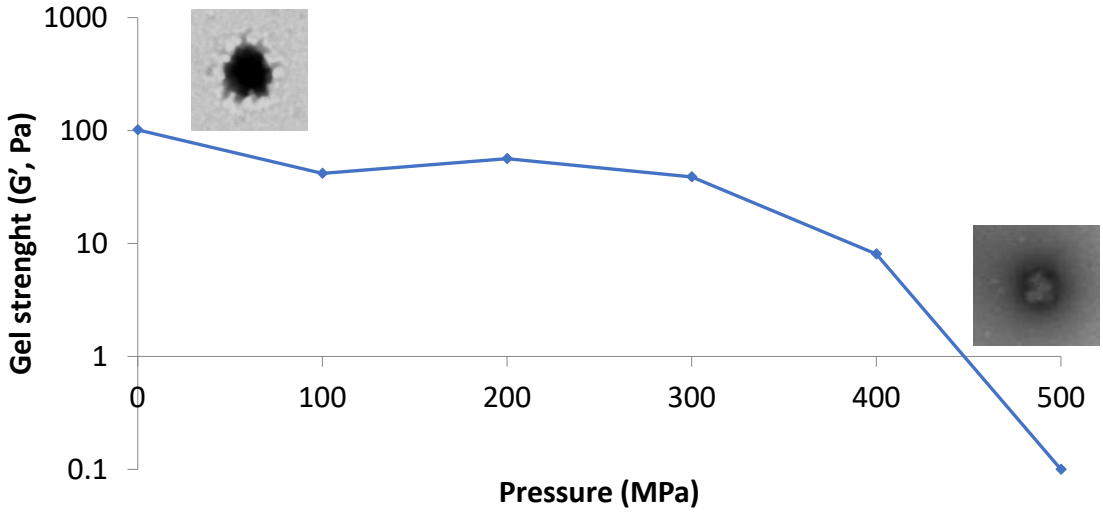
Journal of Dairy Science 2022(105):2119-2131

Viscosidad de leche descremada



International Dairy Journal 87 (2018) 60-66

Respuesta al cuajo



International Dairy Journal 2016, 55: 52-58

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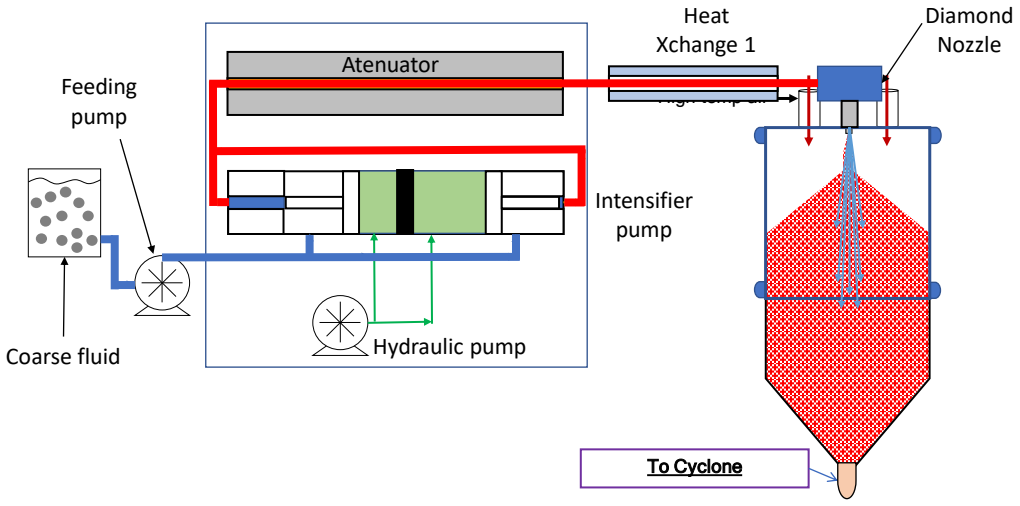
Secado spray en jets de alta presión



Journal of Food Engineering 292 (2021) 110249

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Secado spray en jets de alta presión

Journal of Food Engineering 292 (2021) 110249

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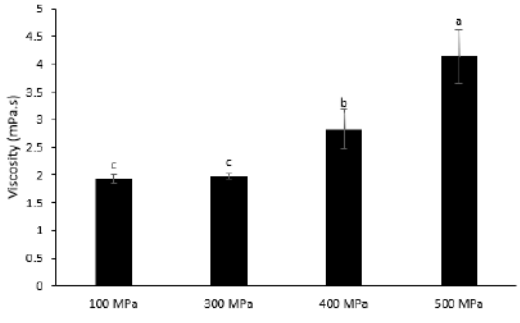
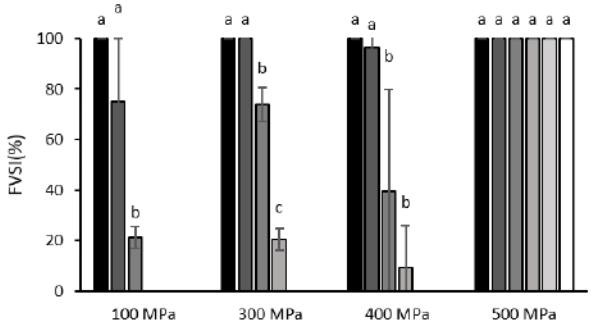
Secado spray en jets de alta presión



Viscosity of reconstituted high pressure jet spray dried powders processed at 100 to 500 MPa and reconstituted to 9% TS.



Foam Volume Stability Index (FVSI) of reconstituted HPJD powders. Legend: 0.5 h (■); 1 h (■); 2 h (■); 4 h (■); 6 h (□); 8 h (□) after foam preparation.

Journal of Food Engineering 292(2021):110249

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Control HPJ

0 hours

US010390543B2

(12) **United States Patent**
Harte et al.

(10) **Patent No.: US 10,390,543 B2**
(45) **Date of Patent: Aug. 27, 2019**

(54) **FOAMING AND EMULSIFYING PROPERTIES OF HIGH PRESSURE JET PROCESSING PASTEURIZED MILK**

(58) **Field of Classification Search**
CPC A23C 9/1524; A23C 2210/10; A23C 2210/30
USPC 426/580

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Leche chocolatada

Control **with** k-carrageenan

Day 0 → Day 14

Control **NO** k-carrageenan

20

21

Leche chocolatada

Control **con** k-carrageenan

Day 0 → Day 14

Control **125 MPa**

22

Leche chocolatada

Control **con** k-carrageenan

Day 0 → Day 14

Control **250 MPa**

23

Leche chocolatada

Control **con** k-carrageenan

Day 0 → Day 14

Control **375 MPa**

24

Leche chocolatada

Control **con** k-carrageenan

Day 0 → Day 14

Control **500 MPa**

25

Leche chocolatada

Control **con** k-carrageenan

Day 0 → Day 14

Control **500 MPa + Casein**

US Provisional patent application 62/522,521

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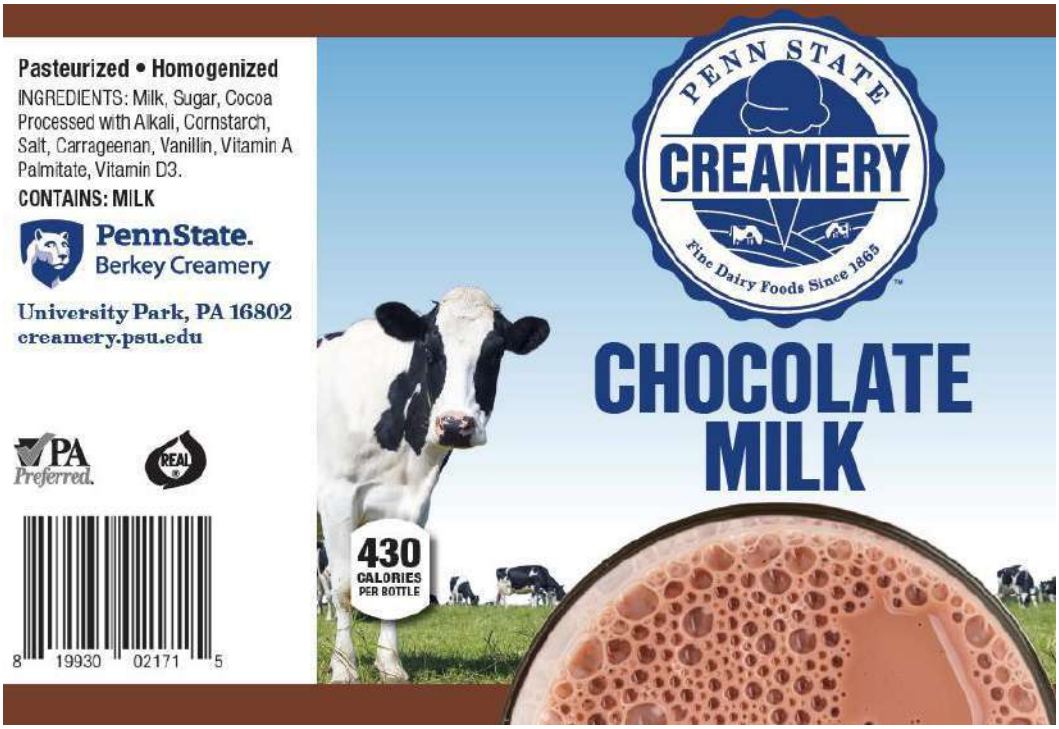

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(12) **United States Patent**
Harte et al.

(10) **Patent No.: US 11,363,825 B2**
(45) **Date of Patent: Jun. 21, 2022**

(54) **STABILIZATION OF CARRAGEENAN FREE CHOCOLATE MILK**

USPC 426/580, 584, 519
See application file for complete search history.

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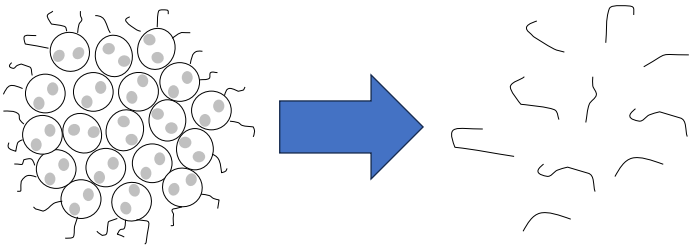

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Ultra filtered milk, water, organic cane juice, natural flavors, vegetable glycerin, **potassium phosphate**, cellulose gum, sunflower lecithin, **sodium phosphate**, cellulose gel, **sodium citrate**, **potassium chloride**, **salt**, gellan gum, stevia (reb A), and monk fruit

~ 8.4 % w/v protein content

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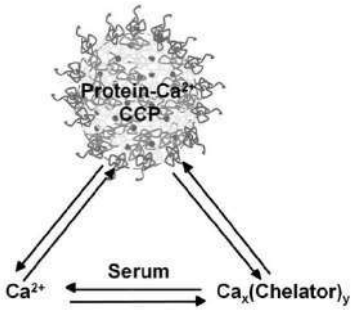
Sales y la micela de caseína

- **Calcium and phosphate chelation**
  - Negatively charged amino acid side-chains on casein micelles become less bound to calcium
- **Buffering capacity**
- **Direct interaction with proteins**
  - Observed changes in the isoelectric point of proteins
  - Salt protein-specificity?



- These changes lead to **partial micellar dissociation**

(de Kort, 2012)

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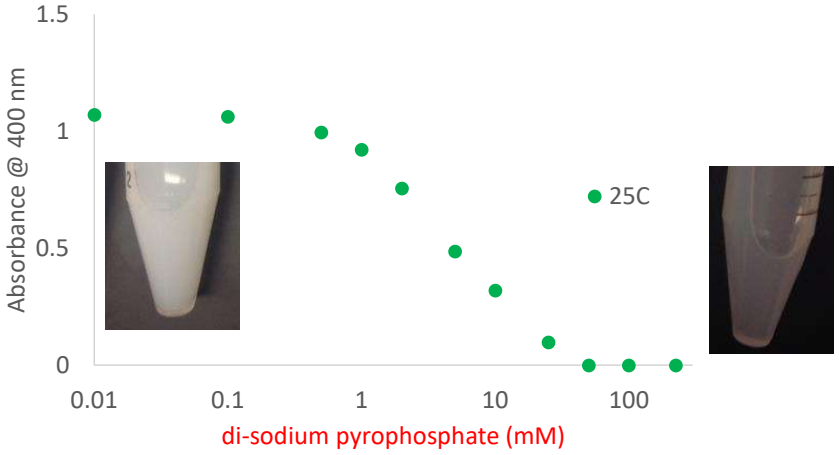
Concentración crítica (C*; mM)



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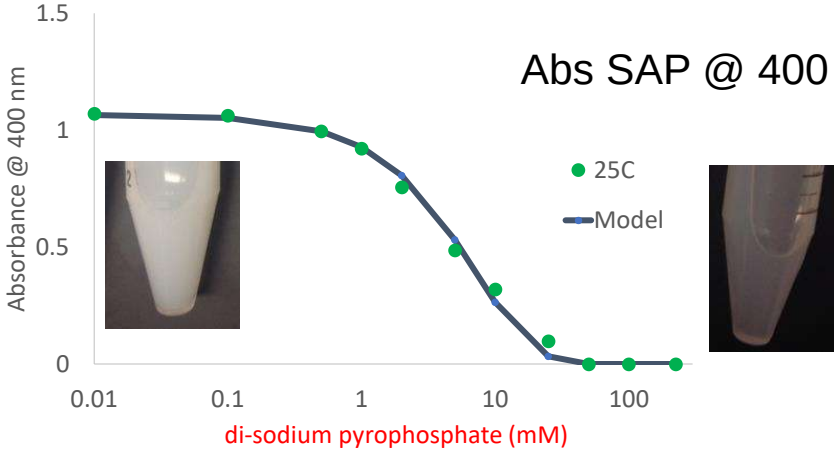
Concentración crítica (C*; mM)



$$\text{Abs SAP @ 400 nm} = A_0 \cdot e^{-\frac{C_{salt}}{C^*}}$$

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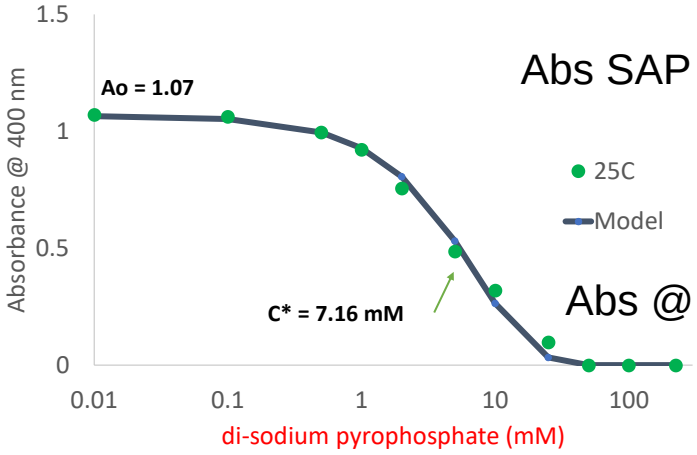
Concentración crítica (C*; mM)



$$\text{Abs SAP @ 400 nm} = A_0 \cdot e^{-\frac{C_{salt}}{C^*}}$$

$$\text{Abs @ 400 nm} = 1.07 \cdot e^{-\frac{C_{salt}}{7.16}}$$

r = 0.997

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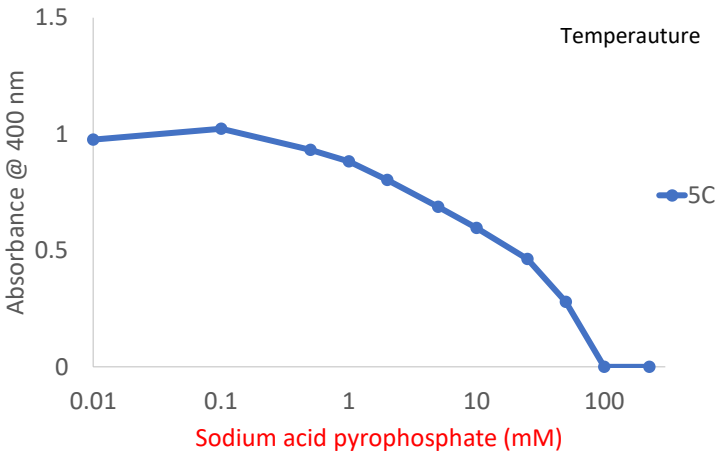
Efecto de la temperatura en C*



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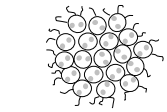
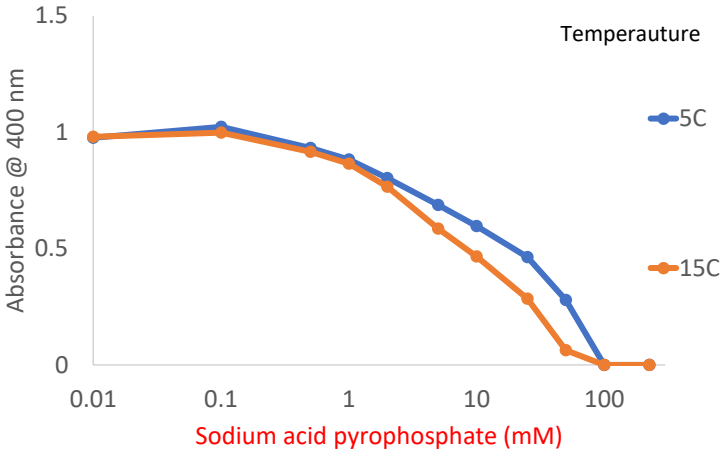
Efecto de la temperatura en C*





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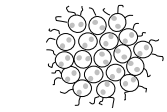
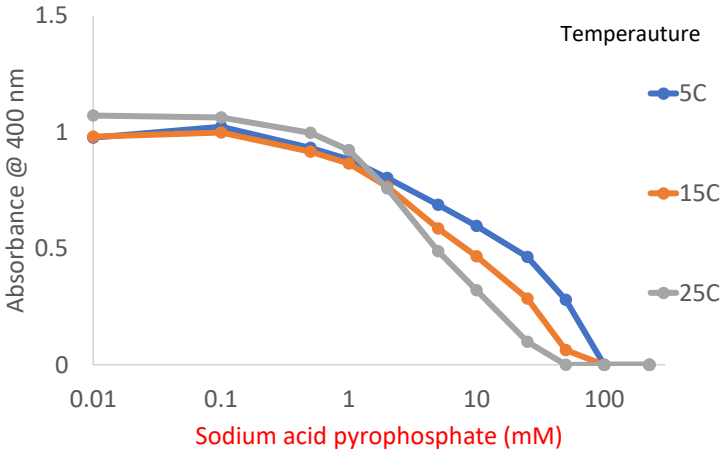
Efecto de la temperatura en C*





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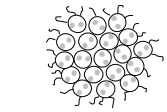

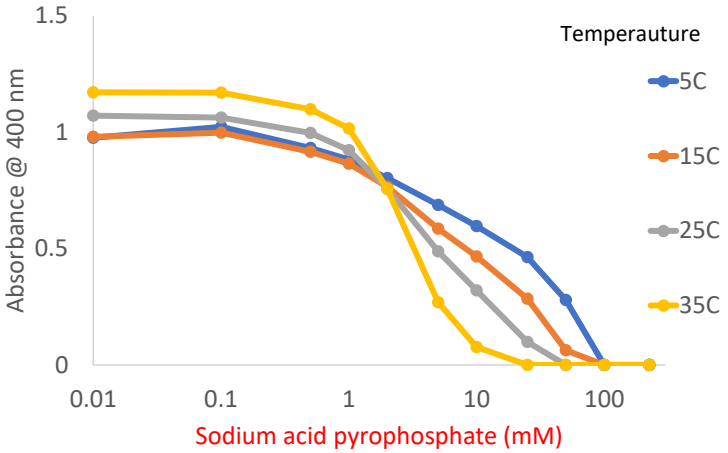

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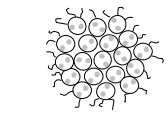

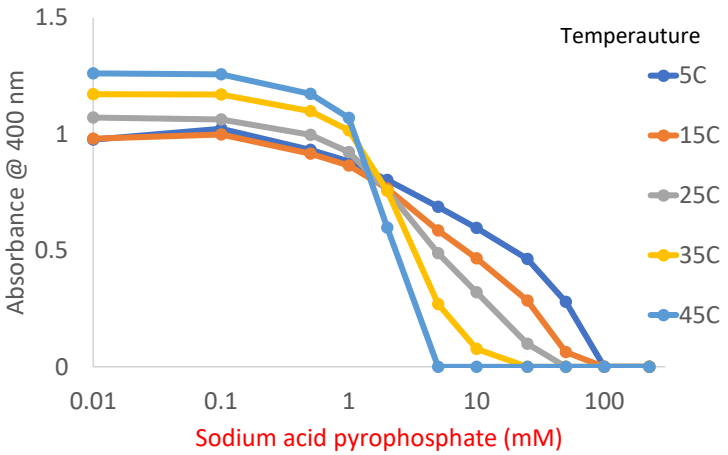

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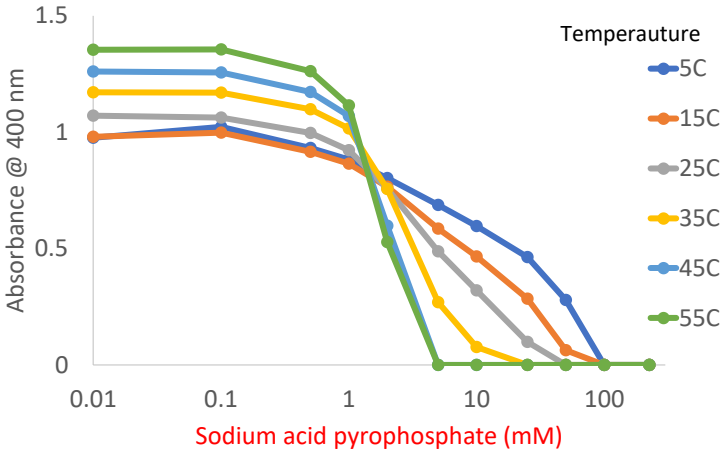
Efecto de la temperatura en C*



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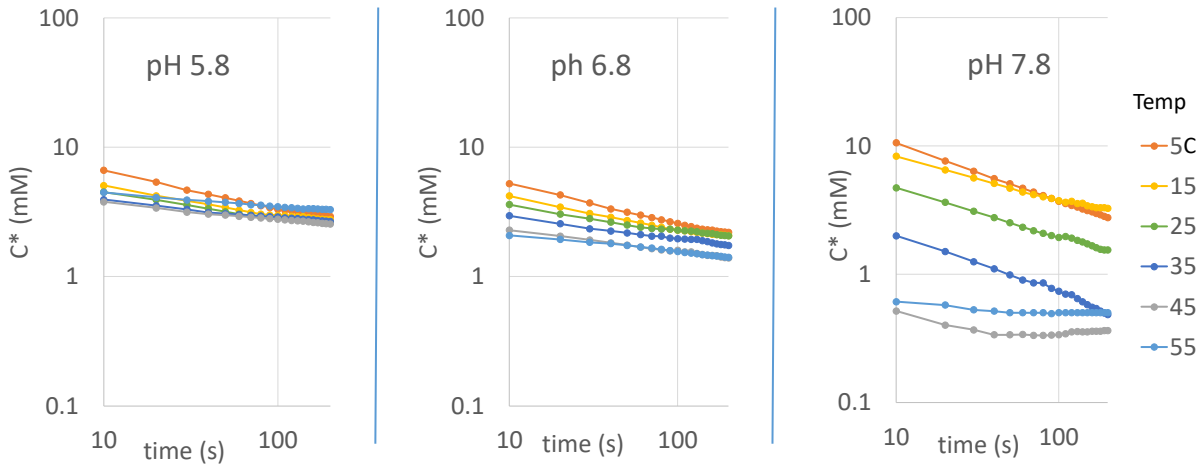
Efecto de pH sobre C* - Sodium Citrate



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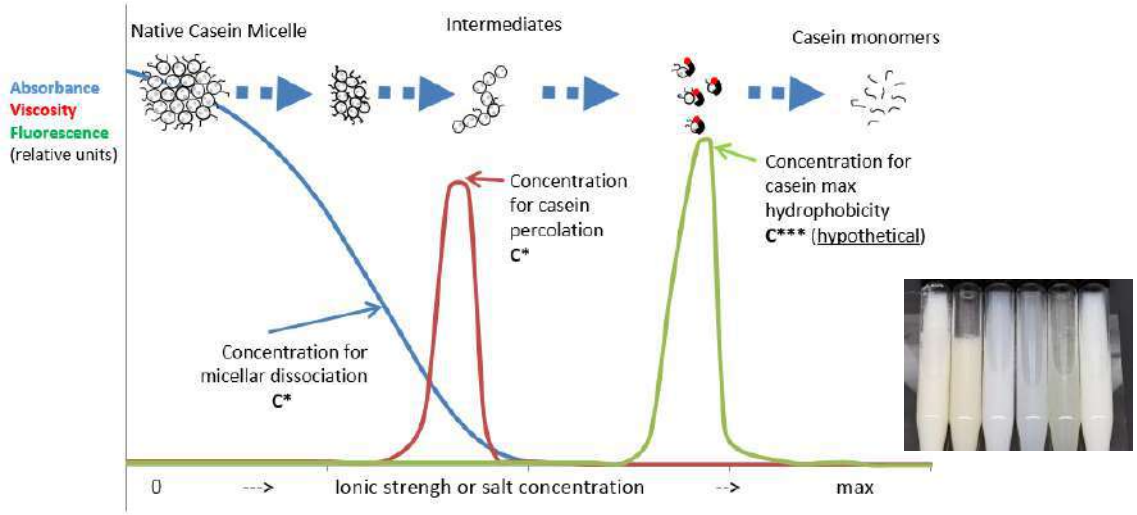
Cuántos intermediarios?



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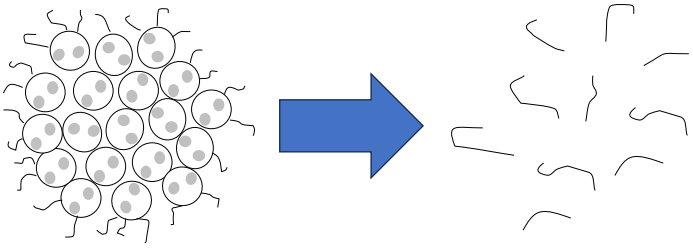

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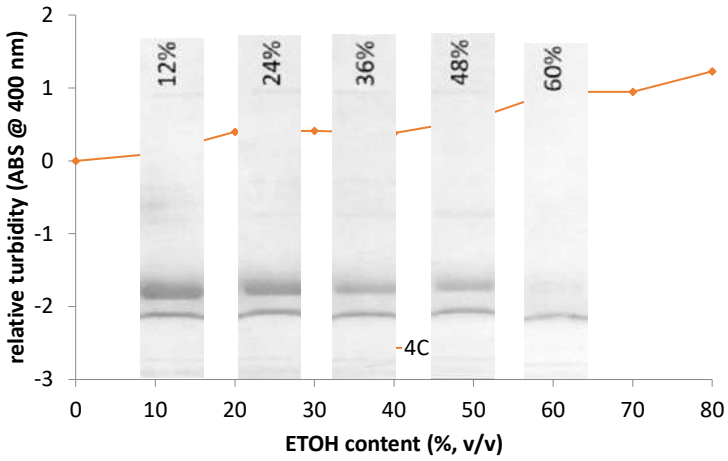
Etanol en leche descremada



Lewis et al., JDS accepted

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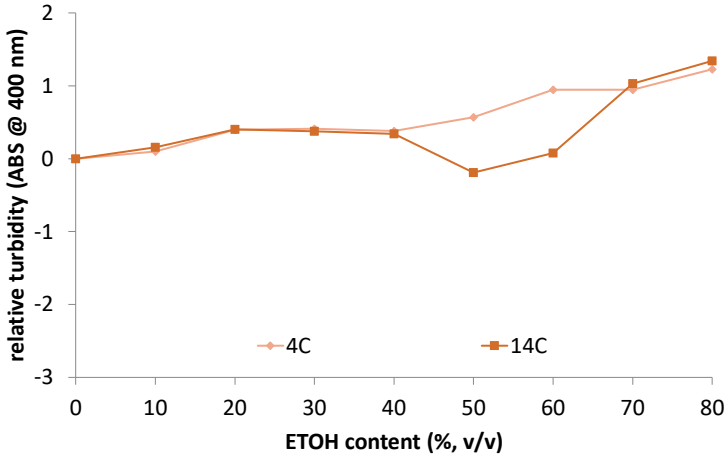
Etanol en leche descremada



Lewis et al., JDS accepted

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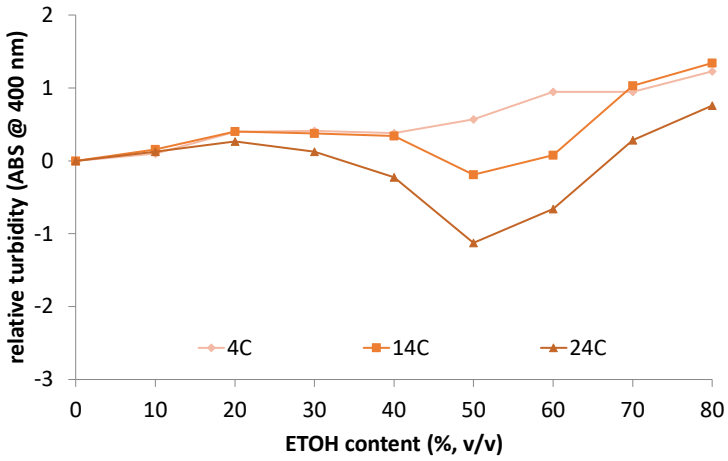
Etanol en leche descremada



Lewis et al., JDS accepted

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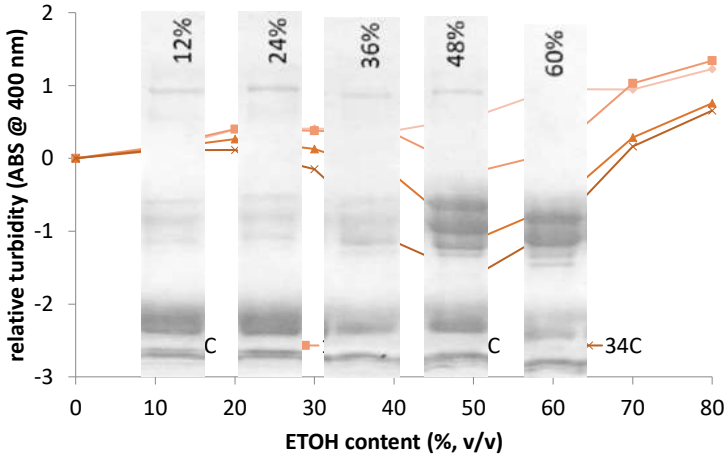
Etanol en leche descremada



Lewis et al., JDS accepted

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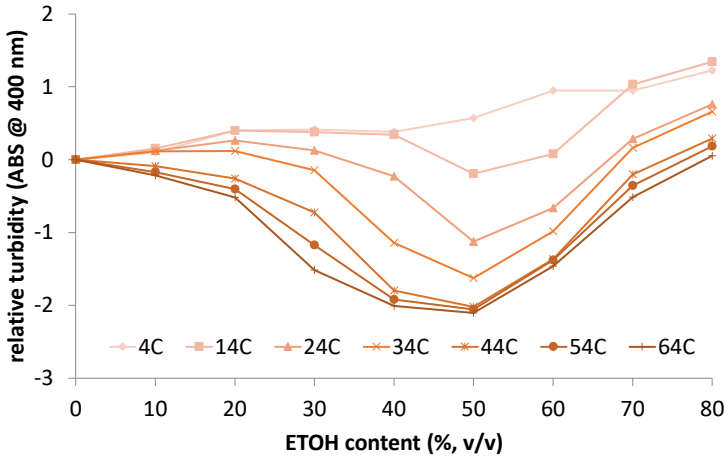
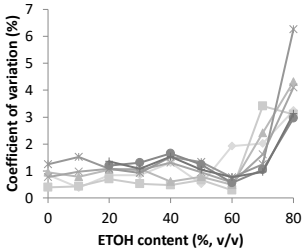
Etanol en leche descremada





Lewis et al., JDS accepted

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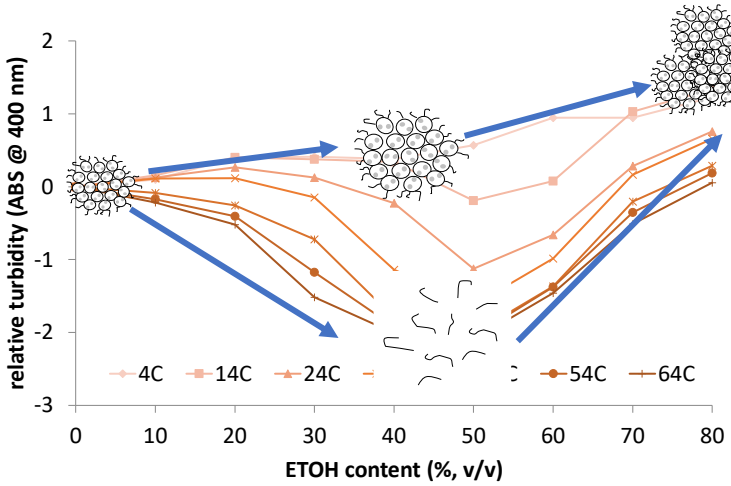
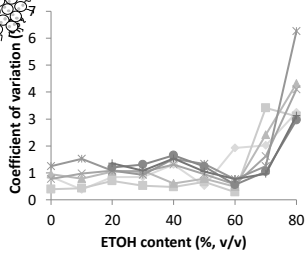
Etanol en leche descremada





Lewis et al., JDS accepted

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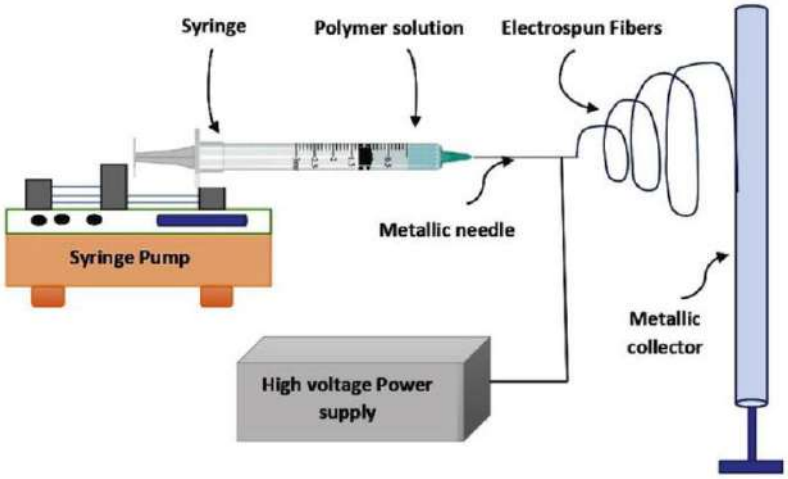
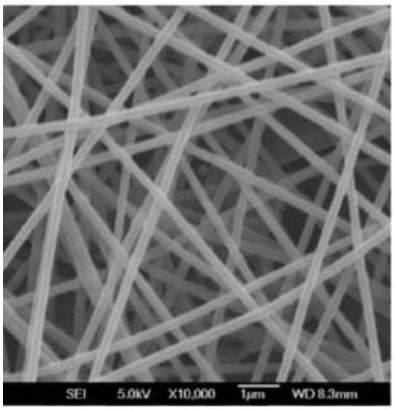
Electrospinning de caseína





https://doi.org/10.4209/aaqr.2019.07.0343

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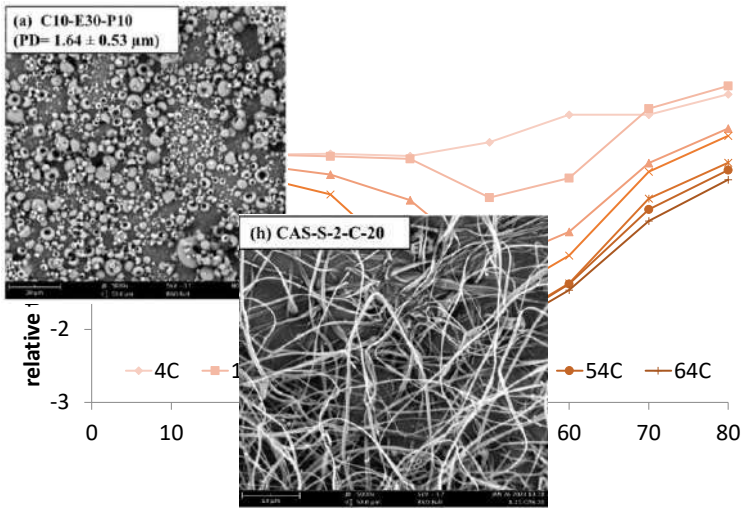
Etanol y Electrospinning de caseína



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Modulación de las fibras

- **Es posible funcionalizar las fibras?**
  - K-carrageenan (k-carr)
  - Transglutaminase (TG)
  - Hydroxypropyl methyl cellulose (HPMC)

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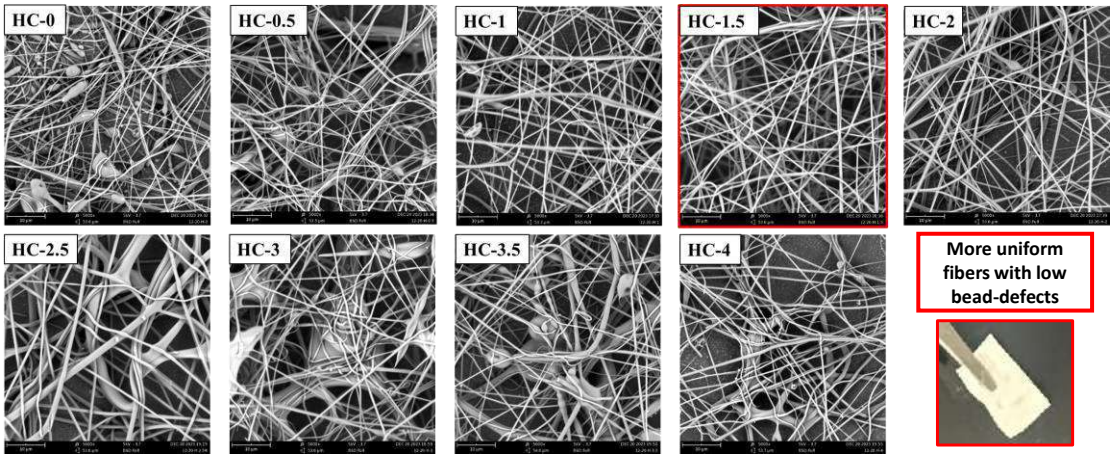
Modulación de las fibras- HPMC



Not published

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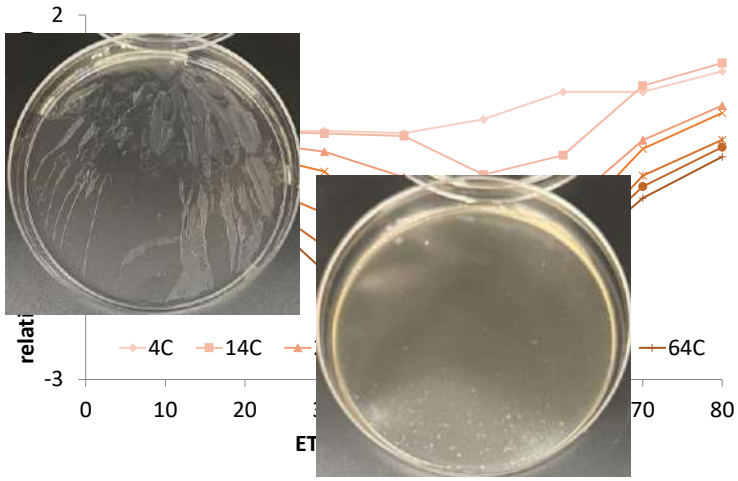
Casein films



Not published

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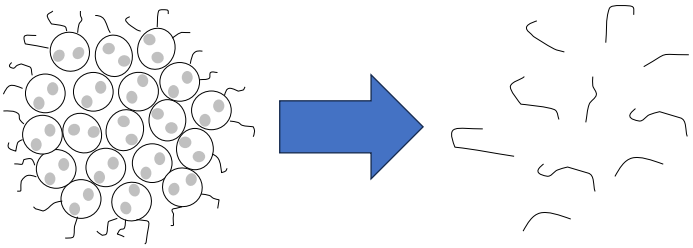
Contenido

- Contexto
- La micela de caseína
- Funcionalidad
  - Jets de alta presión
  - Ambientes iónicos
  - Solventes (etanol)
- **Necesidades**



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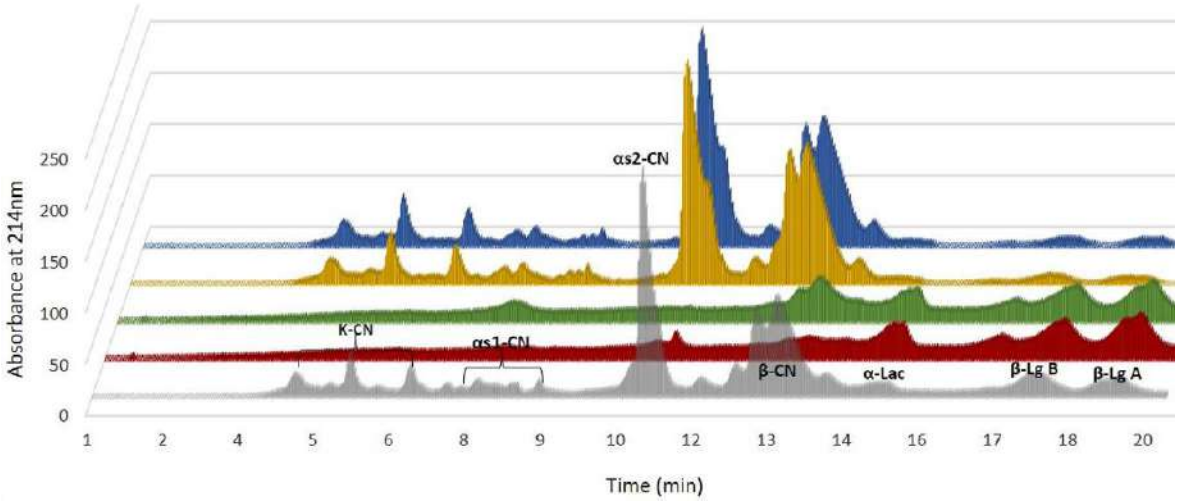
Mejores métodos para medir cada caseína



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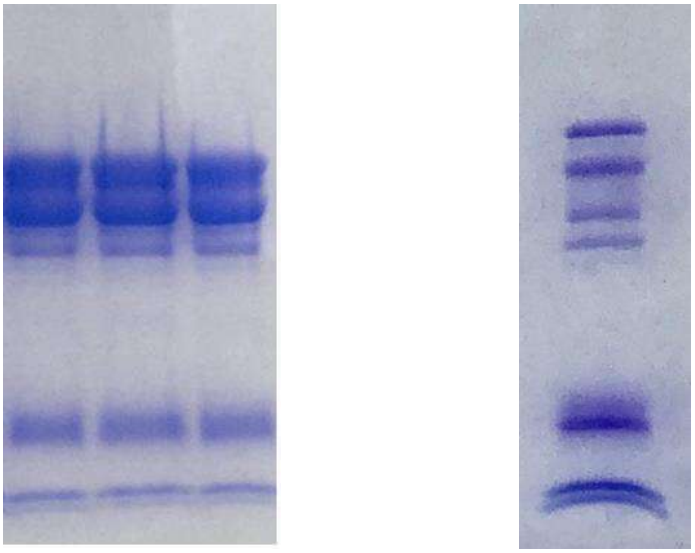
Mejores métodos para medir cada caseína



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8/8/2024

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