Fundamentals of Fermented Dairy Foods

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Fundamentals of Fermented Dairy Foods

- Basic Fermented Milk Types, Attributes, & Standards
- Dairy Ingredients Options
- Manufacturing Steps
- Quality Challenges and Opportunities

Yogurts and Other Fermented Milks

Physical Form
- Spoonable
  - Set
  - Stirred
- Pourable/Drinking

Milk source, composition, dairy ingredients
- Cow, goat, sheep, yak, mare
  - Higher total solids
    - Fat content
    - Protein content

Processing
- Heat treatment
- Homogenization
- Strained/concentrated
- Other?
- Storage/Packaging

Flavors and Other Ingredients
- Cultures
- Fruit/Herbs
- Stabilizers
- CHO (Sweetener types)
- Health & Wellness Ingredients
- Other (Natural colors, etc.)

Consumer Tastes and Preferences

Texture differences
(thickness, creaminess, curdy v. smooth)

Differences in fermented flavors
(buttery, tartness/acidity)

Compositional differences
(fat, protein, CHO,)

Health benefits (gut, bone, muscle, cognition, immune function, etc.)

Flavors

Environment
(sustainability, organic, grass-fed)

Simple ingredients

Milk and Cream Products and Yogurt Products; Final Rule To Revoke the Standards for Lowfat Yogurt and Nonfat Yogurt and To Amend the Standard for Yogurt

A Rule by the Food and Drug Administration on 06/11/2021

. . .Final rule to revoke the standards of identity for lowfat yogurt and nonfat yogurt and amend the standard of identity for yogurt in numerous respects. This action modernizes the yogurt standard to allow for technological advances while preserving the basic nature and essential characteristics of yogurt and promotes honesty and fair dealing in the interest of consumers.

B. Summary of the Major Provisions of the Final Rule

. . . The final rule amends the standard of identity for yogurt by making certain technical changes, permitting reconstituted forms of basic dairy ingredients (cream, milk, partially skimmed milk, and skim milk used alone or in combination) and the use of any optional safe and suitable milk-derived ingredient under certain conditions. The final rule also establishes functional classes of safe and suitable ingredients including cultures, flavoring, color additives, stabilizers, emulsifiers, and preservatives, and replaces the list of nutritive sweeteners with the term “nutritive carbohydrate sweeteners. . .

US Standard of Identity for Yogurt (amended 1/17/2023)

. . .Revoke the standards of identity for lowfat yogurt and nonfat yogurt and amend the standard of identity for yogurt in numerous respects. This action modernizes the yogurt standard to allow for technological advances while preserving the basic nature and essential characteristics of yogurt and promotes honesty and fair dealing in the interest of consumers.

Sec. 131.200 Yogurt

(a) *Description.* Yogurt is the food produced by culturing one or more of the basic dairy ingredients . . . with a characterizing bacterial culture that contains the lactic acid-producing bacteria, *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus. . .*

(b) *Basic dairy ingredients.* Cream, milk, partially skimmed milk, skim milk, or the reconstituted versions of these ingredients may be used alone or in combination.

(c) *Optional dairy ingredients.* Other safe and suitable milk-derived ingredients may be used to increase the milk solids not fat content of the food above the minimum of 8.25 percent required in paragraph (a) of this section, provided that the ratio of protein to total nonfat solids of the food, and the protein efficiency ratio of all protein present must not be decreased as a result of adding such ingredients.

There is no Greek or High protein yogurt standard in U.S.

Yogurt is a Grade A Product

United States Department of Agriculture

Agricultural Marketing Service

Dairy Programs

USDA Specifications for Yogurt, Nonfat Yogurt and Lowfat Yogurt

5.0 Dairy ingredients.

5.1 All milk products used in the manufacture of yogurt, and the plant in which the yogurt is processed shall comply with all applicable requirements of the latest revision of the "Grade A Pasteurized Milk Ordinance," Food and Drug Administration, or regulations substantially equivalent thereto.

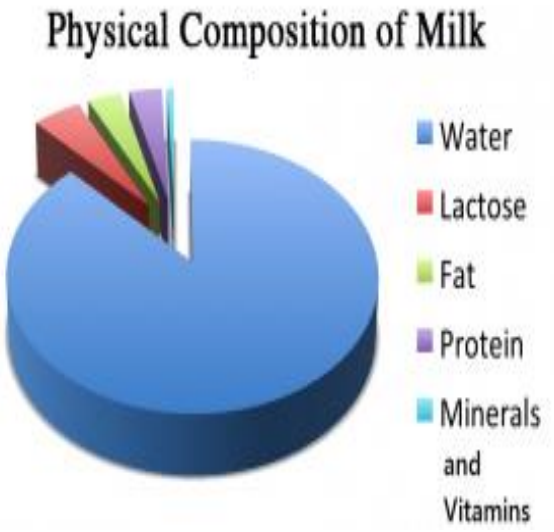
Benefits of Using Dairy Ingredients In Fermented Milk Products

- Improved texture by increasing viscosity and firmness.
- Reduction of syneresis (free liquid on top of product).
- Standardization of the protein and fat content helps maintain product consistency
- Convenience and readily available dry dairy ingredients.
- Use dairy ingredients for a cleaner, more consumer-friendly label.
- Improved flavor, as compared to using non-dairy ingredients.
- Enhanced nutritional composition due to the addition of protein, minerals and other bioactive components.
- Source of lactose for fermentation

"AVERAGE" Proximate Bovine Milk Composition

(Individual milk supplies vary in composition)

	Water	87.6%
	Lipid	3.7% (3.4 - 5.0%)
SNF	Protein	3.3% (3.1 - 3.9%)
SNF	Carbohydrate (Lactose)	4.7% (4.6 - 5.0%)
SNF	Ash(mineral)	0.7% (0.68 - 0.72%)
	Total Milk Solids	12.4% (11.8 - 14.7%)



% Solids Nonfat (SNF) = % TMS - %fat = 11.8– 3.4 = 8.4
= % TMS - %fat = 14.6 – 5.0 = 9.6

Dairy Ingredient Processing

- 5-12% total solids to ~96% total solids
- 10 – 200 time concentrated depending on the product

Milk Powders (NDM, SMP, WMP)

Milk Protein Concentrate (MPC, MPI)

Casein/ates

Dry

Standardize protein (SMP)

Remove Water/(Fat) (NDM)

Membrane, Dry

Remove Water, Fat, Lactose, Minerals

Precipitate, Dry

Remove Water, Fat, Lactose, Whey Protein, Minerals

Range of Possibilities

Cheese Making

Whey

Membrane, Dry

Remove Water Lactose, Minerals

Whey (Whey powder, WPC-34, WPC 80, WPI)

Membrane, Dry

Milk Derived Whey

Micellar casein

New Fractions

New Ingredients

NDC NATIONAL DAIRY COUNCIL

Potential Sources of Milk Solids for Fermented Milk Products

US DAIRY EXPORT COUNCIL (2017)

INGREDIENT	PROTEIN (%)	LACTOSE (%)	FAT (%)	ASH (%)	MOISTURE (%)
Whole Milk Powder	24.5–27.0	36.0–38.5	26.6–40.0	5.5–6.5	2.0–4.5
Skim Milk Powder	34.0–37.0	49.5–52.0	0.6–1.25	8.2–8.6	3.0–4.0
UF Skim Milk	10.0–12.0	2.5–3.5	0.0–0.5	0–2.5	80.0–85.0
Milk Protein Concentrate 42	40.0–43.0	45.0–47.0	0.5–1.5	7.0–8.0	3.5–5.0
Milk Protein Concentrate 80	79.0–83.0	4.0–6.0	1.0–2.0	7.0–8.0	3.5–5.0
Micellar Casein Concentrate 85	85.0–87.0	1.0–3.0	1.0–3.0	4.0–6.0	4.0–6.0
Milk Protein Isolate	87.0–89.0	1.0–2.0	1.0–2.0	3.5–6.0	3.5–5.0
Sweet Whey Powder	11.0–14.5	63.0–75.0	1.0–1.5	8.2–8.8	3.5–5.0
Whey Protein Concentrate 34	34.0–36.0	48.0–52.0	3.0–4.5	6.5–8.0	3.0–4.5
Whey Protein Concentrate 80	80.0–82.0	4.0–8.0	4.0–8.0	3.0–4.0	3.5–4.5
Whey Protein Isolate	90.0–92.0	0.5–1.0	0.5–1.0	2.0–3.0	3.5–5.0

Ultrafiltered Milk (Liquid)

Ratio of casein to whey protein same as in milk but higher ratio of protein to lactose (low lactose or low carb products)

Milk Product	Moisture	Fat	Protein	Lactose	Ash
UF milk	70-75%	11-14%	10-12%	<5%	<2.5%
UF skim milk	80-85%	<0.5%	10-12%	<5%	<2.5%
UF skim milk, with diafiltration	80-82%	<0.5%	16-17%	<1%	<1.5%

Excluded as basic ingredient for yogurt in recent FDA ruling but may still use with a Temporary Marketing Permit.

Balancing Functionality of Caseins and Whey Proteins

- *Heat Treatment*
- *Protein Concentration*
- *Fat Level & Homogenization*

Whey Proteins

Viscosity,
Water Holding Capacity

Whey Protein Isolate
Whey Protein Concentrate
Whey Protein Phospholipid Concentrate

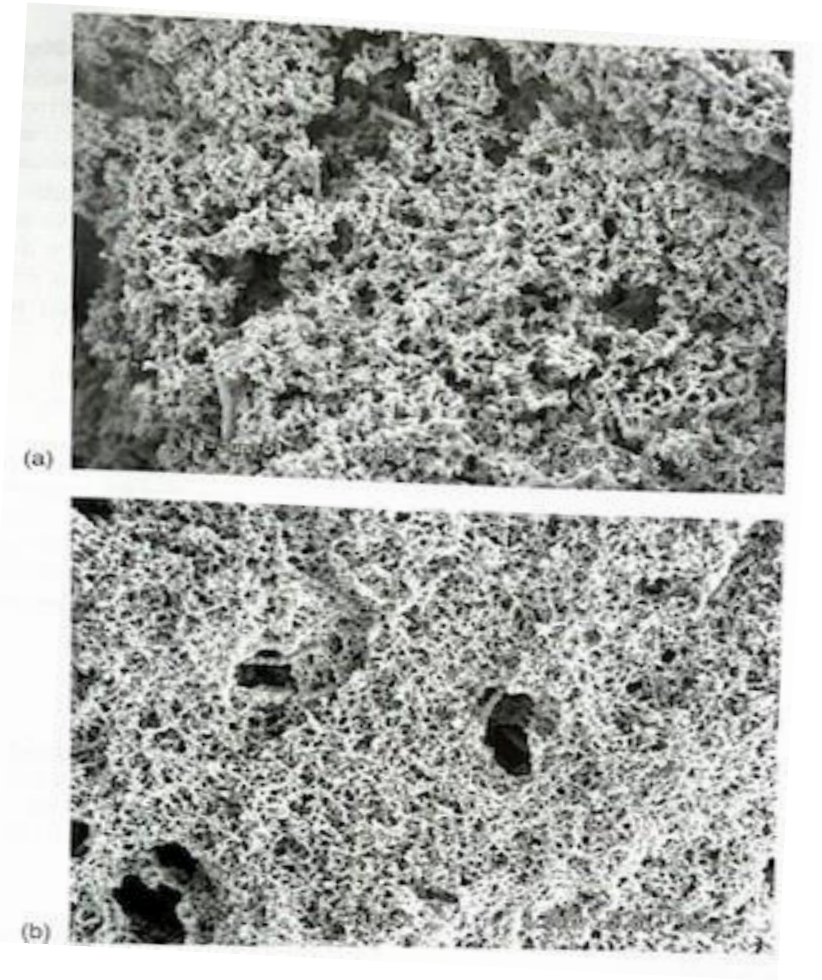
Milk Powders
Condensed Skim
Milk Protein Concentrate
Milk Protein Isolate
UF Milk Retentate (liquid MPC)
Buttermilk Powder

Caseins

Firmness

Caseinates
Micellar Caseins

Microstructure of solids added yogurts (Remeuf, 2003)



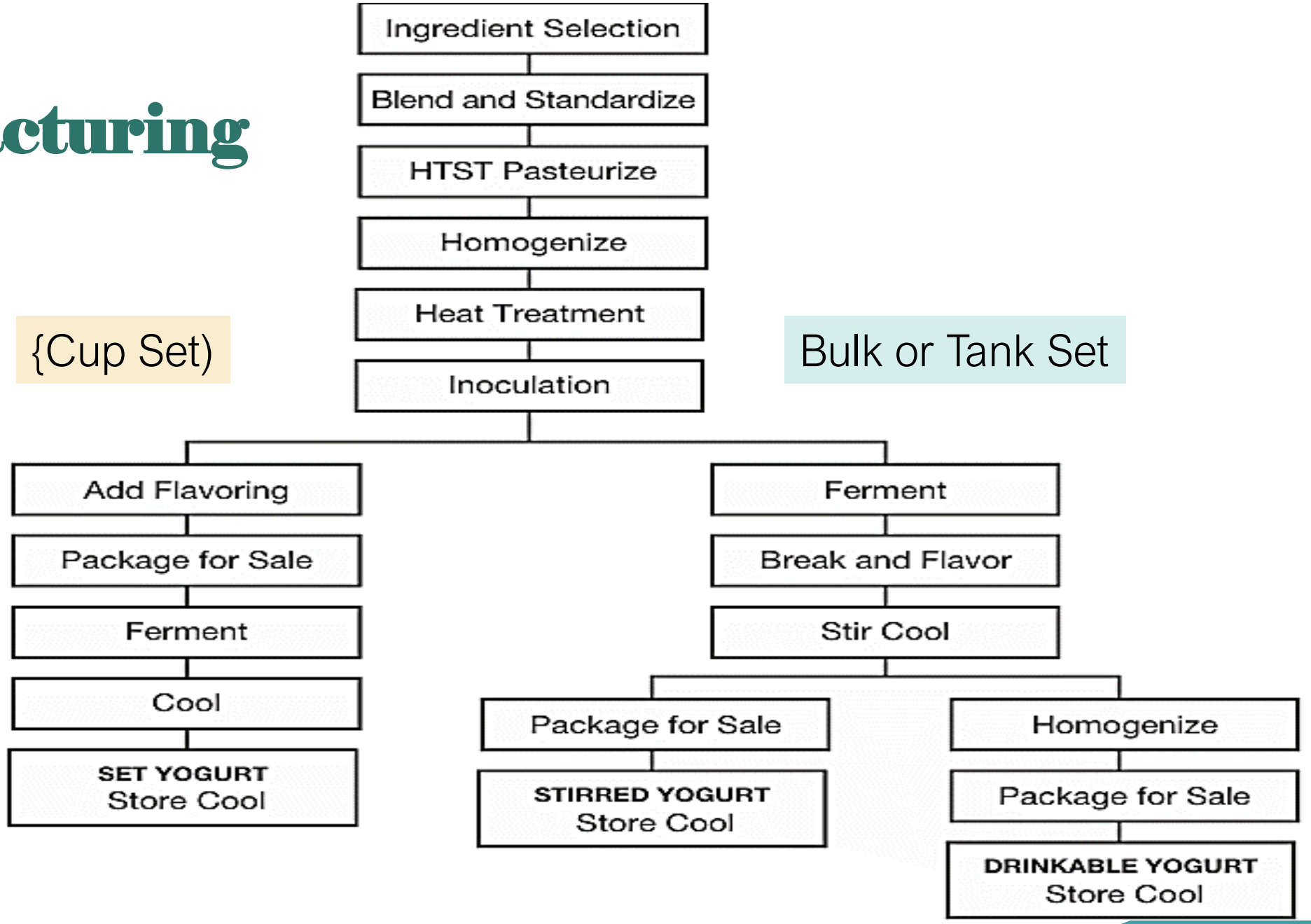
Milk Powder

Fine dense network, with small pore size (firmness, higher viscosity, less serum separation)

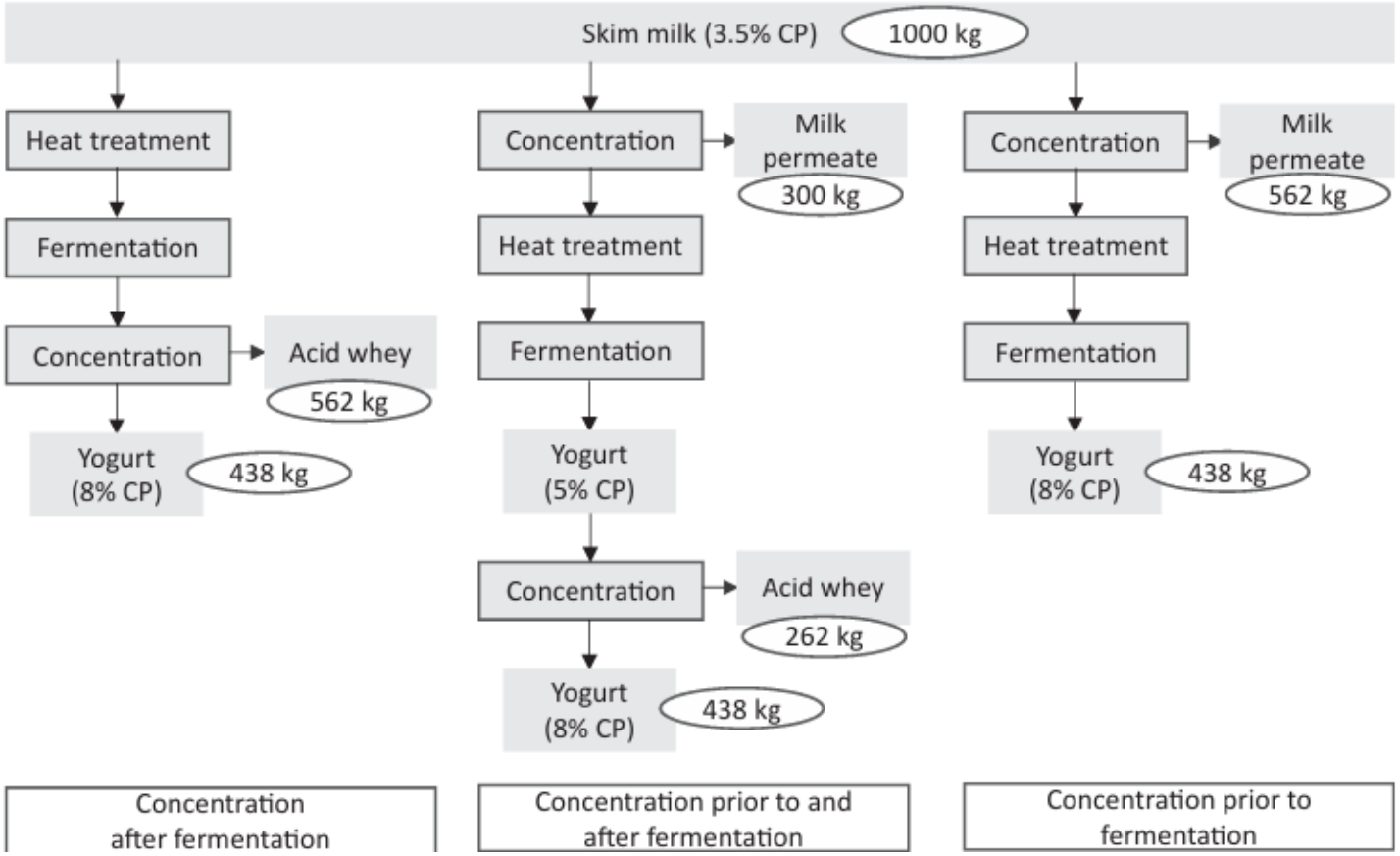
Whey Protein Concentrate

Fine dense network with small pore size (firmness, higher viscosity, less serum separation)

Yogurt Manufacturing Steps



Higher Protein Fermented Milks



Nozzle separator

Pre-Ultrafiltration, nozzle separator

Pre-Ultrafiltration

Jorgensen, et. al., International Dairy Journal(2019) 42-59

CODEX ALIMENTARIUS

INTERNATIONAL FOOD STANDARDS

Food and Agriculture Organization of the United Nations

World Health Organization

E-mail: codex@fao.org - www.codexalimentarius.org

CODEX STANDARD FOR FERMENTED MILKS CODEX STAN 243-2003

- Yogurt must contain minimum of 2.7% protein . . .
- No “Greek yogurt standard, but concentrated fermented milks must contain minimum of 5.6% protein

Individual Country Standards and Requirements

https://www.prismnews.com/topics/protein/fda-weighs-new-yogurt-standards-amid-greek-yogurt

Poor Dairy Ingredient Reconstitution

- Finished product composition
  - Product loss/yield
  - Product functionality
    - Performance
      - emulsification, heat stability, viscosity, aeration, etc.
    - Sensory quality (taste, appearance, texture)
      - Grainy, chalky, poor body
    - Product stability – whey-off
- Process efficiency
  - heat exchanger fouling, cleaning costs)
  - excessive foaming

Heat Treatment

Improves viscosity, water holding (minimize serum separation),

Legal Pasteurization:

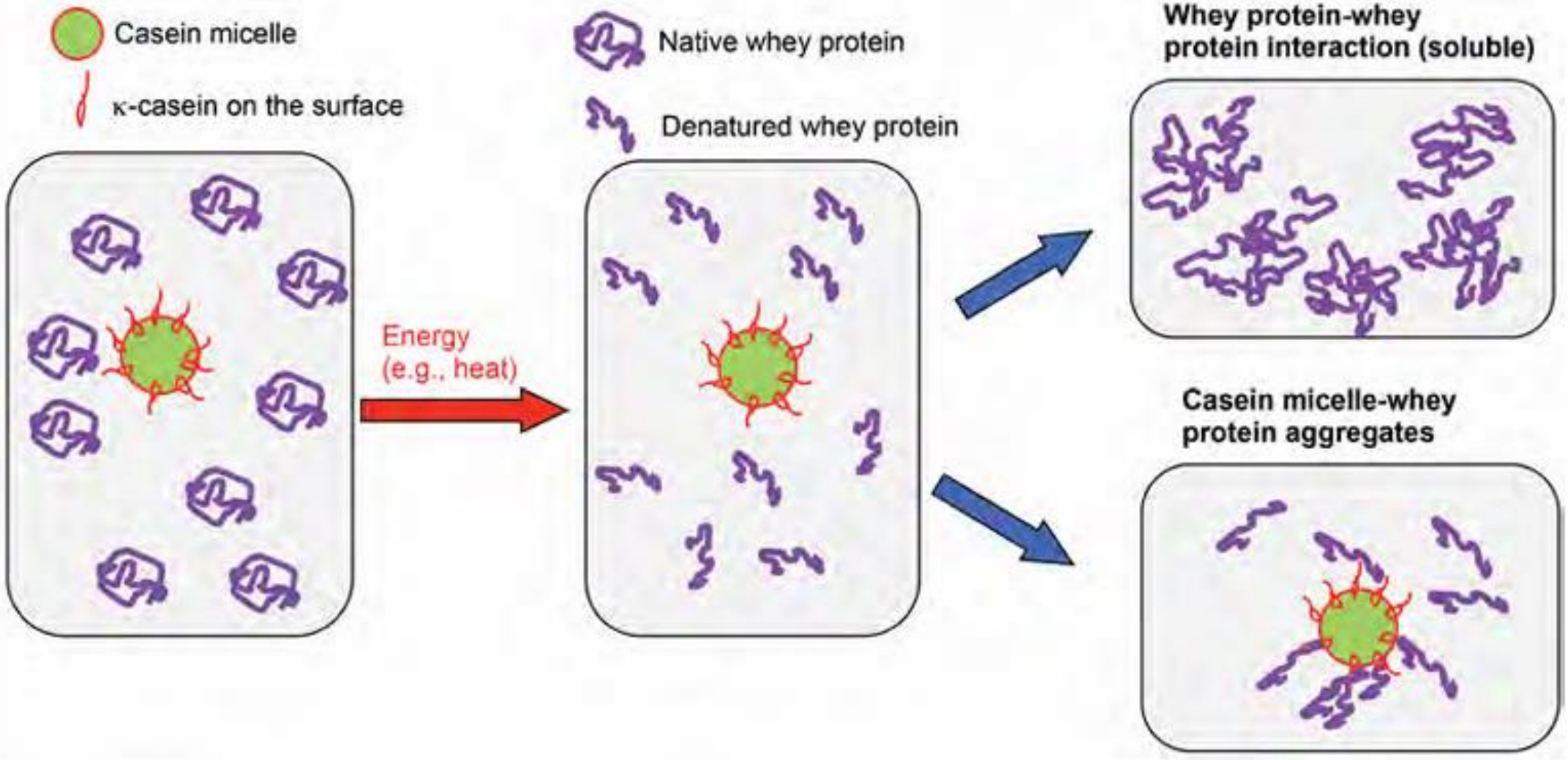
Temperature	Holding Time	Process
145 F	30 minutes	Vat (LTLT)
161F	15 seconds	HTST

Heat treatment (use of extended holding tube for HTST)

Temperature (C)	Holding Period (min.)	Denaturation of Whey Protein (%)
85	20-30	85-90 *(Optimum)*
90.	15	85-90
95	8-10	90-95

Chandan, et. al. (2006)

Heat induced Interaction of Denatured Whey Proteins with Casein



Effect of Different Heat Treatments of Milk on Serum Separation and Viscosity Values of Ayran (Turkish Yogurt)

	Storage Period					
	Day 1		Day 7		Day 14	
Ayran Samples[a]	Serum Separation (mL/100 mL)	Viscosity (cP)	Serum Separation (mL/100 mL)	Viscosity (cP)	Serum Separation (mL/100 mL)	Viscosity (cP)
A	5.5	66	21.5	58	29.5	65
B	1.9	135	7.6	133	11.8	109
C	0.8	136	5.1	136	8.1	120

Source: Tamuçay-Özünlü, B., Ayran kalitesinde etkili bazı parametreler üzerine araştırmalar, PhD thesis, Ankara University, 2005.

[a] A, 75°C for 5 min; B, 85°C for 5 min; C, 95°C for 5 min.

Processing innovation opportunities/challenges . . .

Milkfat

Higher pressure homogenization, microfluidization

- Increases casein at surface of fat globules to improve structure

Higher fat containing yogurts

Protein

Higher protein without excessive viscosity

Creating/selecting smaller casein micelles for fermented milks (HPP, MF)

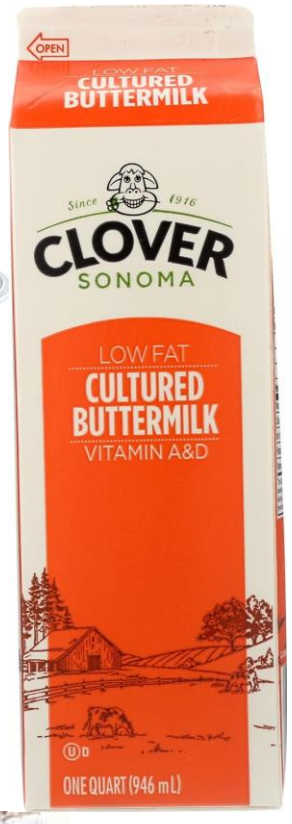
Processing Innovation Opportunities . . .

Fermented Milks Around the World

Chandan, 2002; Tamime and Robinson; 1999

Product Name	Country/Region	Product Name	Country/Region
Acidophilus Milk	United States, Russia	Karunga	Western Asia
Ayran/eyran/jugurt	Turkey	Leben/laban/laban rayeb	Lebanon,Syria,Jordan
Busa	Turkistan	Mazun,matzoon/matsun	Armenia
Chal	Turmenistan	Mezzoradu	Sicily
Cieddu	Italy	Pitkapiima	Finland
Cultured buttermilk	United States	Roba/rob	Iraq
Dahi/dudheedahee	India subcontinent	Shosim/sho/thara	Nepal
Donskaya/varenetes	Russia	Shrikhand	India
Dough/abdoogh/mast	Afghanistan, Iran	Skyr	Iceland
Ergo	Ethiopia	Tarag	Mongolia
Filmjolk/fillbunke/	Scandanavia	Tarho/taho	Hungary
Gioddu	Sardinia	Viili	Finland
Gruzovina	Yugoslavia	Yakult	Japan
Iogurte	Brazil,Portugal	Yiaourti	Greece
Katyk	Transcaucasia	Ymer	Denmark
Kefir, Koumiss/Kumys	Russia,Central Asia	Zabady/zabade	Egypt/Sudan
Kissel maleka/naja/yaourt	Balkans		

International Fermented Milk Products



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Yogurt: Technology and Biochemistry[1]

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Journal of Texture Studies

REVIEW OPEN ACCESS

A Review of Processing Techniques and Rheological Properties of Yogurts

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Review

Processing of high-protein yoghurt – A review

Camilla Elise Jørgensen [a, b], Roger K. Abrahamsen [b], Elling-Olav Rukke [b], Tom Kristian Hoffmann [a], Anne-Grethe Johansen [a, b], Siv B. Skeie [b, *]

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Review

Traditional fermented milk products of Eastern Mediterranean countries: A cultural heritage to preserve

Reine Abi Khalil [a, b, 1], Sophie Yvon [b, c, 1], Christel Couderc [b], Gwenaelle Jard [b], Rabih El Rammouz [d], Pierre Abi Nakhoul [a], Hélène Eutamène [b, c], Marie-José Ayoub [a, 1], Hélène Tormo [b, *, 1]

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Traditional and modern Nordic fermented milk products: A review

Judith A. Narvhus*, Roger K. Abrahamsen

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Traditional dairy fermented products in Central Asia

Gaukhar Konuspayeva [a, b, c, *], Almagul Baubekova [a], Shynar Akhmetsadykova [a, b, d], Bernard Faye [c]

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Thank you for your attention!

QUESTIONS????