Processors' Guide & Formulations

Milk-Based Beverages

Market and Trends
Standards and Regulations
Operations Principles
Processing
Trouble Shooting
Starter formulations

Prepared for the Pacific Coast Coalition by the California Dairy Innovation Center, October 2024.

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Market Trends

COMPETITIVE LANDSCAPE: FOR THE LATEST INFORMATION, PLEASE CONTACT CDIC.NET

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Labeling, Regulatory, Packaging

STANDARD OF IDENTITY

Outlines requirements for specific standardized milk and cream:

CFR Title 21

- CFR - Code of Federal Regulations Title 21 – FDA accessdata.fda (.gov)https://www.accessdata.fda.gov › cfcfr › cfrsearch
- *Description.*
  - Milk defined as the lacteal secretion, practically free from colostrum, obtained by the complete milking of one or more healthy cows.
  - For Beverages: Milk must be pasteurized or ultrapasteurized and contain:
    - not less than 8 1/4 percent milk solids non fat
    - not less than 3 1/4 percent milkfat

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Dairy Ingredient Functionality

DAIRY CHOICES

Fluid Whole Milk	Fluid Lactose Free Milk	Fluid UF Milk
Cream	Fluid UF Lactose Free Milk	Milk Powders

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Dairy Ingredient Functionality

FUNCTIONAL DIFFERENCES

	WHOLE MILK	LACTOSE FREE MILK	UF MILK	MILK POWDERS	CREAM
Pros	• Richest in flavor • High nutritional value • Low cost • Availability	• Appropriate for lactose sensitive consumers • Similar nutritionals to whole milk • Easy digestibility	• Higher protein content • Creamy texture • Lactose reduced • Potential cost savings	• Extended shelf life • Convenient and portable • Cost effective • Versatile • Consistent	• Rich and creamy • Enhanced flavor • Increased fats, vitamin A and D
Cons	• Not suitable for lactose intolerant individuals • Can separate into cream and skim • Typically purchased by truckload	• Higher cost than milk • Sweeter than milk • Will involve additional processing steps	• Loss of nutrients • Flavor not as strong • Consumers not as aware of this process	• Nutritional loss • Texture and taste lacking compared to fresh milk • Potential for lumping	• High calorie content • Texture can be greasy or heavy

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Scale Up and Commercialization

MILK SPECIFIC PROCESSING OPERATIONS

- Heat Treatment [see next slide]
  - Conventional pasteurization
  - UHT
  - Sterilization
- Separation
  - Centrifugal Separation – to separate cream from skim milk
  - Microfiltration – passing milk through a membrane filter with very small pores to remove bacteria
- Homogenization
  - Forcing milk through tiny spaces under pressure to help reduce particle size

Fortification
Adding vitamins, minerals, to enhance nutritional value

Fermentation
Milk fermented with bacteria

Concentration
Evaporated Milk – removing milk through evaporation
Condensed Milk – sugar added to sweeten evaporated milk
Powdered milk – dried to remove water

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Scale Up and Commercialization

MILK SPECIFIC PROCESSING OPERATIONS

- HTST (High Temperature Short Time)
  - 72 ˚C (161 ˚F) for 15 seconds
  - Packaging: HPDE, Glass Bottle, Metal
  - Produce large volumes, increase energy efficiency, minimize contamination
  - Can help retain color and flavor but has caramelized notes
  - Used for: fresh milk, cream and other dairy products that are refrigerated
- LTLT (Low temperature Long Time)/Vat Pasteurization
  - 63 ˚C (145 ˚F) for 30 min
  - Packaging: HDPE, Glass Bottle, Metal
  - Preserves nutrients, better flavor, lasts longer refrigerator
  - A batch (not continuous) process
  - Used in smaller scale dairy operations
- Ultra Pasteurized
  - 138 ˚C (280 ˚F) for 2 seconds
  - Packaging: Cartons, HDPE
  - Depending on pack may be for aseptic or ESL products
  - Kills virtually all spoilage organisms allowing milk to be stored at room temperature if aseptically packaged
  - Used for: shelf stable milk, ESL milk

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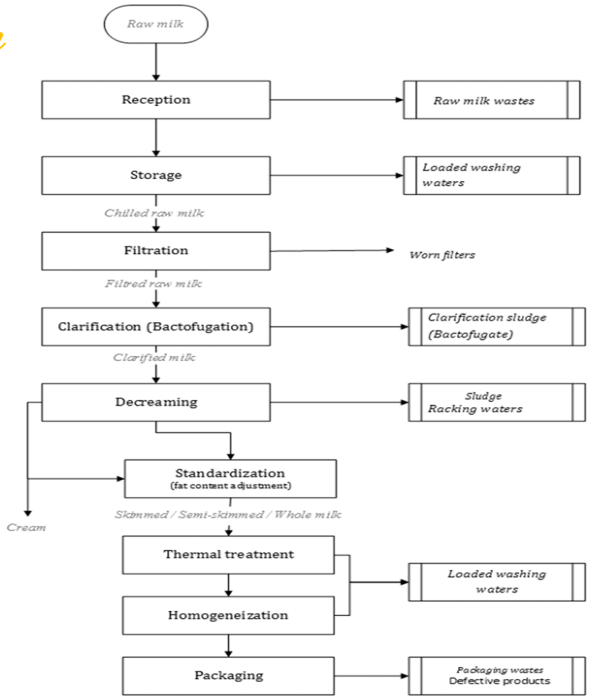
Scale Up and Commercialization

GENERAL PROCESSING



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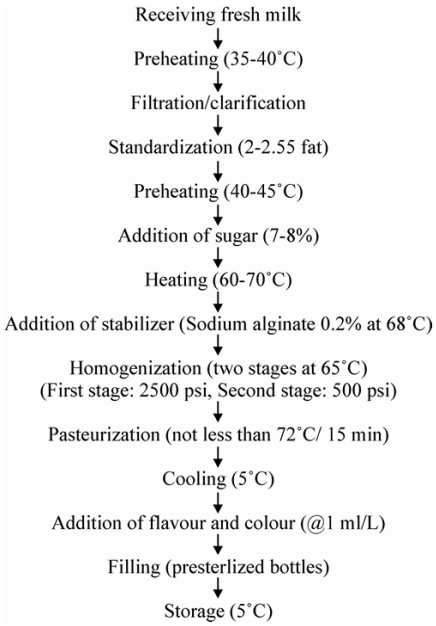
Scale Up and Commercialization

GENERAL PROCESSING OF FLAVORED MILK



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Scale Up and Commercialization

NEXT STEPS

1. Perform a pilot trial at a CMO (Contract Manufacturer or lab facility)
2. Perform a consumer testing study
3. Start shelf-life study
4. Determine your cost of goods (COGS) t determine financials and overall cost per unit and margins
5. Secure vendors and suppliers and obtain lead times for supply. This will enable you to develop a timeline to commercialization.
6. Determine your distribution options and where you want to launch (regional vs. national)

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Troubleshooting

PROTEIN CONSIDERATIONS AND WATCHOUTS

- Protein Stability
  - Casein very heat stable but can gel during extending processing if pH drops, adding polyphosphates could help
  - Whey proteins not heat stable (must create the right environment, i.e formula) but has greater solubility
    - Aggregate in the presence of excess ionic calcium – can be problematic in calcium fortified products
  - Ensure you are considering pH for each protein to prevent aggregation

- Off Flavors and Textures
  - Can occur through protein aggregation or gelation. Ingredient choice can minimize off flavors.

- Separation
  - Can lead to sedimentation where protein lies at bottom of container

- Gelation (influenced by temperature and pH)
  - Proteins can interact and form a gel network → increasing viscosity of product
  - Use of MPC high exposure to heat can lead to gelation, make sure you watch the temperature and monitor the products even weeks after processing.

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Troubleshooting

SEPARATION OF FAT

- Main Issue:
  - Fat can separate if not properly processed

- Solution:
  - Homogenization
    - Breaks down fat globules into smaller sizes, helps to prevent fat from separating and floating
  - Adding Emulsifiers
    - Adding lecithin or carrageenan can help to create stability as they will help bind water and fat
  - Adding Thickeners
    - Using gums can increase viscosity and prevent sedimentation

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Troubleshooting

FLAVOR INSTABILITY

- Main Issue:
  - Over time flavors can interact with other ingredients or dissipate leading to off-flavors or no flavors. Reactions such as: oxidation, hydrolysis, and Maillard Reaction can occur over time
- Solution:
  - Proper Storage conditions can help prevent flavors from degrading
  - Formula Change
  - Flavor Masking
    - Adding flavor agents can help to mask undesirable flavors

TEXTURE ISSUES

- Main Issue:
  - Undesirable texture.
  - Gelation can also occur due to protein interactions
- Solution:
  - Viscosity – control the thickening agents added or type of thickener
  - Particle Size Reduction
    - Homogenization reduces the size of particles and can make the texture a lot smoother
  - Temperature Control
    - Proper temperature throughout the manufacturing process helps to maintain the product's viscosity. Temperature fluctuation or abuse can affect the stability of your product

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Troubleshooting

MICROBIAL CONTAMINATION

- Main Issue:
  - Contamination with microbials (bacteria, yeast, mold) → creates spoilage or foodborne illness
- Solution:
  - Implement proper sanitation using CIP (Cleaning in place) methods
  - Pasteurization
    - It is important to heat the milk to the proper temperatures to kill microorganisms that can be harmful to humans
  - Aseptic Processing
    - Processing at sterile environments will help to control risk
  - Storage
    - Refrigeration of products that are not shelf stable or aseptically processed

SHELF LIFE CHALLENGES

- Main Issue:
  - Short shelf life issues, how can you extend the shelf life?
- Solution:
  - Preservatives
    - Adding potassium sorbate or sodium benzoate
  - Packaging Changes
    - Packaging material that helps to maintain a proper barrier from oxygen or light
  - Processing Optimization
    - Optimizing parameters of processing, adding homogenization, checking processing conditions, mix times, etc.
    - Thermal Process Change.

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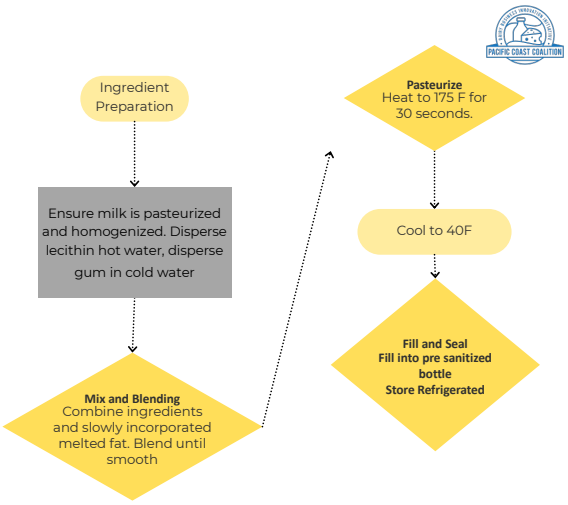
Starter Formulas

LOW FAT FLAVORED MILK

	g/100 g	Use
Skim milk	93.6	Base Product
Sugar	5.0	Sweetener
Natural Flavor	0.1	Flavor
Guar Gum	0.1	Thicken and Stabilize
Lecithin	0.2	Emulsifier
Cream	1	Added body and texture



pH 6.5-6.8
Blending Temperature 100-120F
Heating Temperature 167-175F

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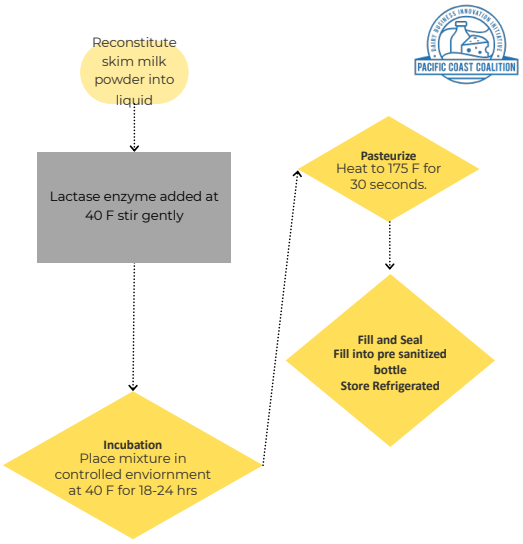
Starter Formulas

LACTOSE-FREE, LOW FAT MILK

	Lactose-Free, Low Fat Milk	Use
Skim Milk Powder	8%	Added as a base for formula
Water	90.9%	To hydrate the powder
Cream	1%	Added for body
Lactase Enzyme	0.1%	Helps to digest lactose in product



pH 7.0
Blending Temperature 95-100F

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Market Expectations

MARKET SIZE [2023-2030]

- Average Consumption of milk per person=30.3kg
- Common Themes:
  - Nutritional Delivery
    - High Protein
      Low Sugar
    - Lactose Free
- ORGANIC AND NATURAL
  - 2027 - CAGR 6%
- LACTOSE-FREE
  - Market Size by 2032 to be 21.59 billion
  - Expected 6.17% CAGR
  - Rising lactose intolerance boosts market growth
    - Affecting 30-75% of population
- GLOBAL
  - 2023-2030 – growing with a CAGR 4.4% projected to reach Usd 6.6 million

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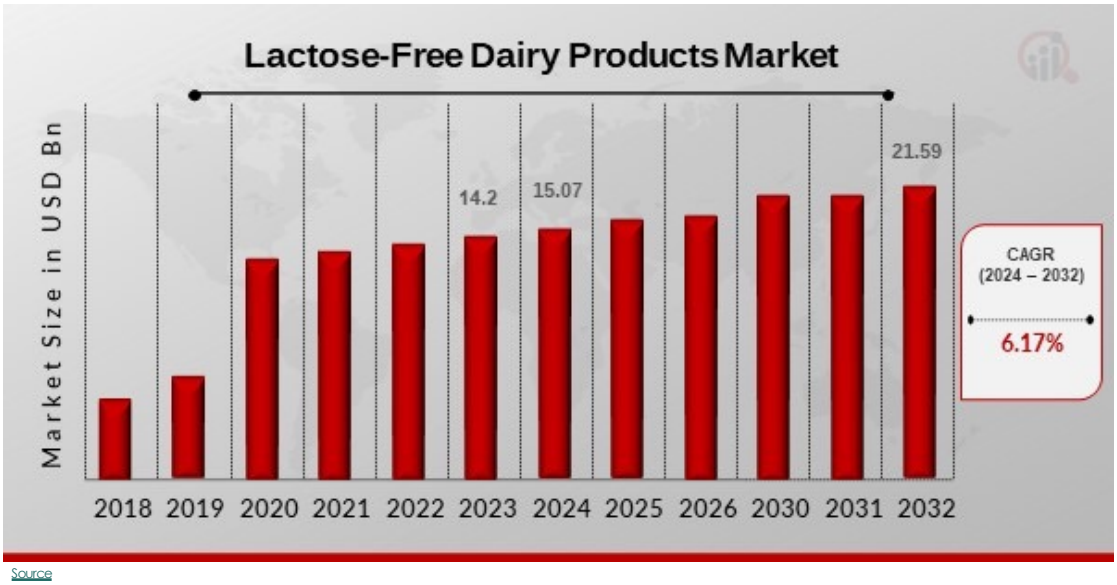
Market Expectations

LACTOSE FREE MILKS



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Market Expectations

CONSUMER SEGMENTATION

Types of Milk-Based Beverages

- Type of Milk Source
  - Cattle, goat, sheep, camel
- Type of Milk
  - Fat Level
- Method of Production
  - Thermal vs, non thermal
- Heat Desiccated
  - Evaporated and condensed milk
- Technology enhanced
  - pasteurized, sterilized, uht, ultra filtered
- Fortified
- Flavored [Kids especially]

Milk delivery

- UHT, canned, and ESL milks on market
- Milk enhanced beverages becoming more available with addition of functional ingredients

Wants

- Limited amounts of fat and cholesterol
- Concerns of health issues associated with dairy driving consumers to plant based
- See benefits of dairy for calcium, vitamins, minerals, and quality protein

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For more information please consult www.dairypcc.net

The PCC-DBII is part of a national initiative to help the dairy industry address ongoing supply chain and food system challenges by offering resources for: Business plan development, Marketing and branding, and Increasing access to innovative production and processing techniques to support the development of value-added products.

This initiative currently operates in six states — Arizona, California, Nevada, New Mexico, Oregon, and Washington — and is supported by collaborative partners and grant funding which will make more than $11.4 million available to regional dairy businesses for innovation-related investments.

Additional information for California processors and entrepreneurs available at www.cdic.net

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