

Introduction to Pasteurization

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Key concepts, purpose, methods, and applications

1. What Is Pasteurization?

Aspect	Description
Definition	A heat treatment process that reduces the number of viable microorganisms in food and beverages to a level that is safe for consumption and extends shelf life.
Origin	Developed by Louis Pasteur (1860s) while studying wine spoilage; later adapted for milk, juices, eggs, and other products.
Goal	Eliminate pathogenic bacteria (e.g., <i>Salmonella</i> , <i>Listeria</i> , <i>E. coli</i>) and reduce spoilage organisms while preserving nutritional and sensory qualities.

2. Why Pasteurization Matters

- Public Health** – Prevents foodborne illnesses; essential for vulnerable groups (children, elderly, immunocompromised).
- Shelf Life Extension** – Slows microbial growth, allowing distribution over longer distances and time.
- Economic Benefit** – Reduces product loss, waste, and recall costs.
- Regulatory Compliance** – Many countries mandate pasteurization for dairy, juice, and certain ready-to-eat foods.

3. Core Scientific Principles

Principle	Explanation
Thermal Inactivation Kinetics	Microbial death follows first-order kinetics: $\log \text{reduction} = (\text{time} \times \text{temperature factor})$. Higher temperatures achieve faster kill rates.
D-Value	Time (minutes) at a given temperature needed to reduce a microbial population by 90% (1 log).
Z-Value	Temperature change required to change the D-value by a factor of ten. Useful for designing alternative time-temperature combos.

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Principle

Explanation

Thermal Resistance Varies by organism, spore-forming ability, and food matrix (pH, fat, water activity). Spores are the most heat-resistant.

4. Common Pasteurization Methods

Method	Typical Conditions	Typical Applications	Advantages	Limitations
Low-Temperature Long-Time (LTLT)	63°C (145°F) for 30 min	Milk, cream	Simple, low equipment cost	Longer processing time; less suitable for high-throughput
High-Temperature Short-Time (HTST)	72°C (161°F) for 15 s	Milk, liquid eggs, fruit juices	Fast, continuous flow; high capacity	Requires precise control; may affect heat-sensitive nutrients
Ultra-High-Temperature (UHT) / Sterilization	135–150°C (275–302°F) for 2–5 s	Shelf-stable milk, cream, soy/almond drinks	Very long shelf-life (months) without refrigeration	Slight cooked flavor; higher energy use
Batch Pasteurizer (Plate or Tubular)	Variable (e.g., 71.7°C for 15 s)	Small-scale dairies, specialty juices	Flexible batch size; good for low-volume products	Labor-intensive; slower turnaround
Flash Pasteurization (for juices)	71.5°C for 15–30 s	Fruit/vegetable juices, cider	Retains flavor/color; effective pathogen kill	Not suitable for high-acid low-pH drinks with resistant spores
Cold Pasteurization (Non-thermal)	High-pressure processing (HPP), pulsed electric fields (			