صنایع لبنی 2

دکتر علی نصیرپور

مهر 1390

سرفصل درس:

نظری: سالم سازی شیر، باکتوفوگاسیون، میکروفیلتراسیون، فرآیند حرارتی، پاستوریزاسیون، استریلیزاسیون، تهیه شیر نوشیدنی، تولید فرآورده‌های تخمیری شیر، تعریف انواع تخمیر فرآورده‌های لبنی، شرائط و عوامل مؤثر بر تخمیر، تولید ماست، خامه کشت داده شده، دوغ کشت داده شده،آب کره کشت داده شده، کفیر،کومیس، تولید کره، انواع مختلف کره، آماده سازی خامه برای کره زنی، کره ترش، کره شیرین، کره زنی متناوب، کره زنی دائمی، آروماى کره، بسته بندی، نگهداری، فساد کره، تولید پنیر، طبقه بندی، مصرف پنیر در ایران و جهان. ارزش اقتصادی و غذایی پنیر، روشهای مختلف تولید پنیر، انعقاد اسیدی، انعقاد آنزیمی، مکانیزمها، آنزیمها، استارترها، شرائط تولید، شرائط رسانیدن وانبار کردن پنیر. بسته بندی فرآورده‌های تغلیظ شده شیر، تبخیرکننده‌ها، تولید شیر کندانسه شیرین و غیر شیرین. خشک کردن غلطکی، پاششی، تولید شیر خشک فوری، تولید پودر آب پنیر، تولید شیر خشک بچه، تولید فرآورده‌های خاص، تولید بستنی، مقدمه طبقه بندی، ترکیب و اجزاء تشکیل دهنده فرایند کردن مخلوط، فرایند انجماد، هوادهی، بسته بندی و سخت کردن بستنی، بستنی یخی شیری، بستنی یخی، بستنی یخی مرکب، سیستمهای شستشو و ضد عفونی کردن تجهیزات. کارخانه‌های لبنی، کنترل کیفیت فرآورده‌های لبنی،

تکنولوژیهای جدید، میکروواولترافیلتراسیون تجهیزات در نانوفیلتراسیون، اسمز معکوس

عملی: انجام آزمایشات مربوط به کنترل کیفی شیر وفرآورده‌های لبنی، آزمایشات تعیین کهنگی و تازگی

شیر، کنترل کفایت پاستوریزاسیون، تهیه فرآورده‌های لبنی شامل خامه، ماست، پنیر، کشک و

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مراحل تولید. آزمایشاتی که در خط تولید انجام می‌گیرد و چگونگی کنترل کیفی محصولات لبنی در

کارخانجات و عملیات شستشوی تجهیزات و دستگاههای خط تولید شیر.

Refrences:
1- Dairy science and technology. 2006. Walstra et al
2- Dairy processing handbook. 1995-2005. Tetrapak.
3- Dairy Science and Technology Handbook. 1993. YH HUI
4- Dairy Chemistry. 1997. Fox

هدف از فرایند حرارتی:

1- تضمین سلامت مصرف کننده:

Coxiella burnetii
Mycobacyerium tuberculosis
Staphylociccus aureus
Listeria monocytogenes,
Salmonella species
Campylobacter jejuni

پاتوژن های مقاوم به حرارت ممکن است:

- در شیر وجود نداشته باشند (*Bacillus anthracis*)،
- یا به دلیل رشد سایر گونه ها فرصت رشد نمی یابند (*Clostridium perfringens*)،
- یا در شیر رشد نمی کنند (*Clostridium botulinum*)،
- یا در تعداد زیاد ایجاد مسمومیت یا بیماری می نمایند (*Bacillus cereus*)

2- افزایش عمر نگهداری
3- ایجاد خصوصیات ویژه در برخی محصولات

CHANGES CAUSED BY HEATING:

- **Reversible or irreversible**

Reversible: mutarotation equilibrium of lactose and changes in ionic equilibriums, including pH

Chemical and Physical Changes:

- Gases, including CO_2, are partly removed
- The amount of colloidal phosphate increases and the $[Ca^{2+}]$ decreases
- Lactose isomerizes and partly degrades to yield, for instance, lactulose and organic acids
- The pH of the milk decreases
- Most of the serum proteins are denatured
- Part of the serum protein (especially of β-lactoglobulin) becomes covalently bound to κ-casein and to some proteins of the fat globule membrane.
- Enzymes are inactivated
- Reactions between protein and lactose occur, Maillard reactions in particular
- Casein micelles become aggregated. Aggregation may eventually lead to coagulation

- Several changes occur in the fat globule membrane, e.g., in its Cu content
- Some vitamins are degraded

Consequences:

- Bacterial growth rate of the organisms surviving, or added after heat treatment, can be greatly affected, generally increased:

  IgM (agglutinin) → Bacillus cereus

  lactoperoxidase system → lactic acid bacteria

  Lactoferrin → Bacillus stearothermophilus

  Bacteriophages can be inactivated, depending on the heating intensity
- Nutritive value decreases
- The flavor changes appreciably
- Color may change
- Viscosity may increase slightly
- Heat coagulation in evaporated milk → serum protein is denatured before concentrating
- Age gelation in sweetened condensed milk is also reduced when the milk is intensely heated before concentrating.

- The *rennetability of milk and the rate of syneresis of the rennet gel* decrease (serum proteins bound to k-casein)
- *Creaming tendency of the milk decreases*

PASTEURIZATION: The terms "pasteurization", "pasteurized" and similar terms shall mean the process of heating every particle of milk or milk product, in properly designed and operated equipment, to one (1) of the temperatures given in the following chart and held continuously at or above that temperature for at least the corresponding specified time:
*If the fat content of the milk product is ten percent (10%) or greater, or a total solids of 18% or greater, or if it contains added sweeteners, or if it is concentrated (condensed), the specified temperature shall be increased by 3°C (5°F).

Temperature	Time
63°C (145°F)*	30 minutes
72°C (161°F)*	15 seconds
89°C (191°F)	1.0 second
90°C (194°F)	0.5 seconds
94°C (201°F)	0.1 seconds
96°C (204°F)	0.05 seconds
100°C (212°F)	0.01 seconds

The term "Ultra-Pasteurization", when used to describe a dairy product, means that such product shall have been thermally processed at or above 138°C (280°F) for at least two (2) seconds, either before or after packaging, so as to produce a product, which has an extended shelf-life under refrigerated conditions.

In the European Union, according to Council Directive 92/46/EEC, industrial heat treatments of milk can be classified, depending on temperature and time of heating, into:

•*Pasteurized milk* obtained by means of a treatment involving a high temperature for a short time (HTST, at least 71.7°C for 15 sec) or a pasteurization process using a different time and temperature combination to obtain an equivalent effect.

•*Ultra-high-temperature (UHT) milk* obtained by applying a continuous flow of heat at high temperature (not less than 135°C) for a short time (but at least 1 sec). This treatment has the aim to destroy all residual spoilage microorganisms and their spores, thus considerably extending milk shelf life, permitting milk to be transported or held for a long period before using. According to the European law, no deterioration should be observed in the UHT milk product after 15 days in a closed container at a temperature of 30°C; where necessary, provision can also be made for a period of 7 days in a closed container at a temperature Of 55 ° C. Two main types of UHT thermal processing are distinguished:
direct and indirect heating. If the UHT milk treatment process is performed by direct contact of milk and steam (*direct UHT*,(the steam should be obtained from potable water. Moreover, the use of this process must not cause any dilution of the treated milk.
In the *indirect UHT* thermal processing, tubular, plate, or scraped-surface heat exchangers are employed to transfer heat to milk.

• *Sterilized milk* heated and sterilized in hermetically sealed wrappings or containers, the seal of which must remain intact.

Heat treatment

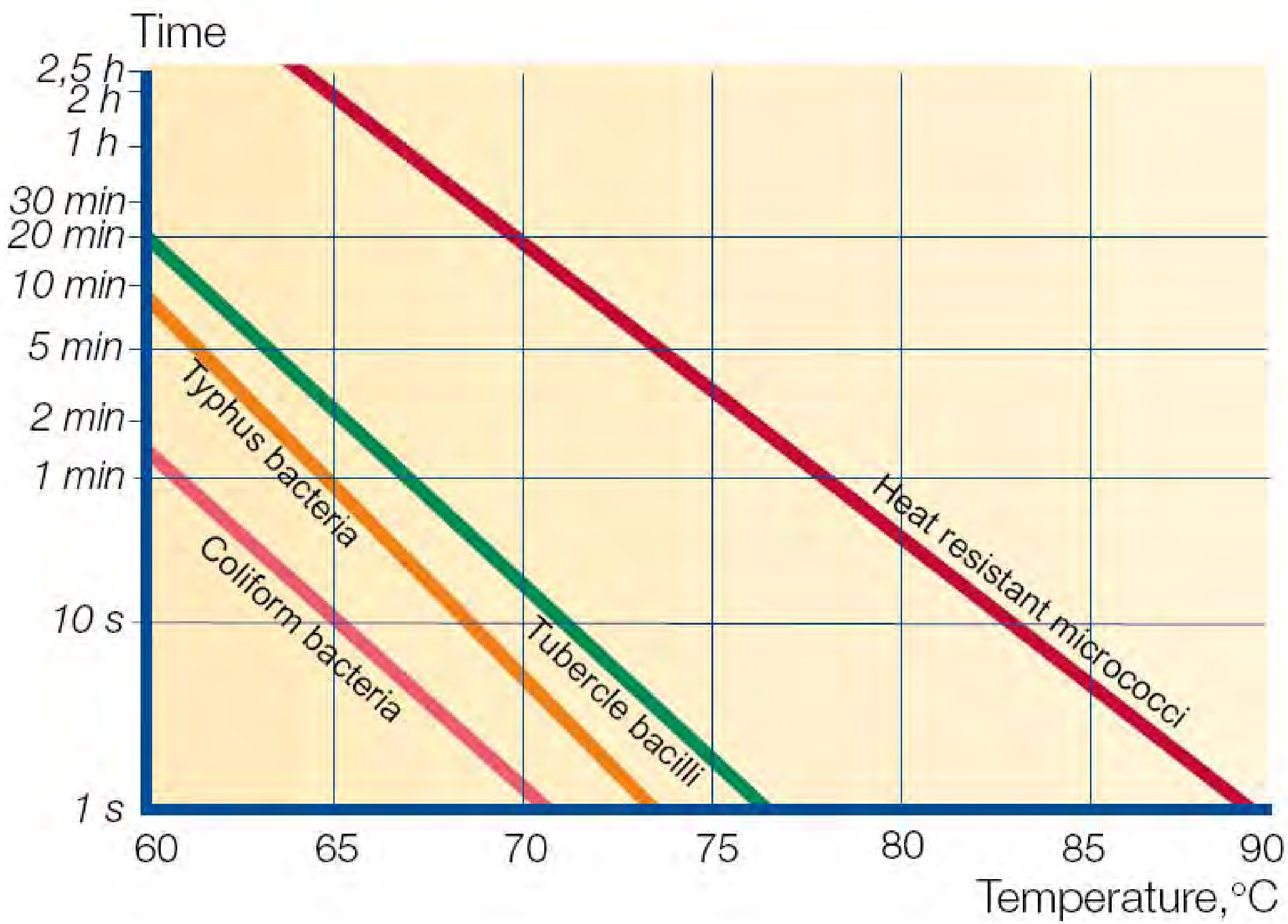


Figure 1 lethal effect of heat on micro-organism

Table 1

The main categories of heat treatment in the dairy industry

Process	Temperature	Time
Thermisation	63 – 65°C	15 s
LTLT pasteurisation of milk	63°C	30 min
HTST pasteurisation of milk	72 – 75°C	15 – 20 s
HTST pasteurisation of cream etc.	>80°C	1 – 5 s
Ultra pasteurisation	125 – 138°C	2 – 4 s
UHT (flow sterilisation) normally	135 – 140°C	a few seconds
Sterilisation in container	115 – 120°C	20 – 30 min

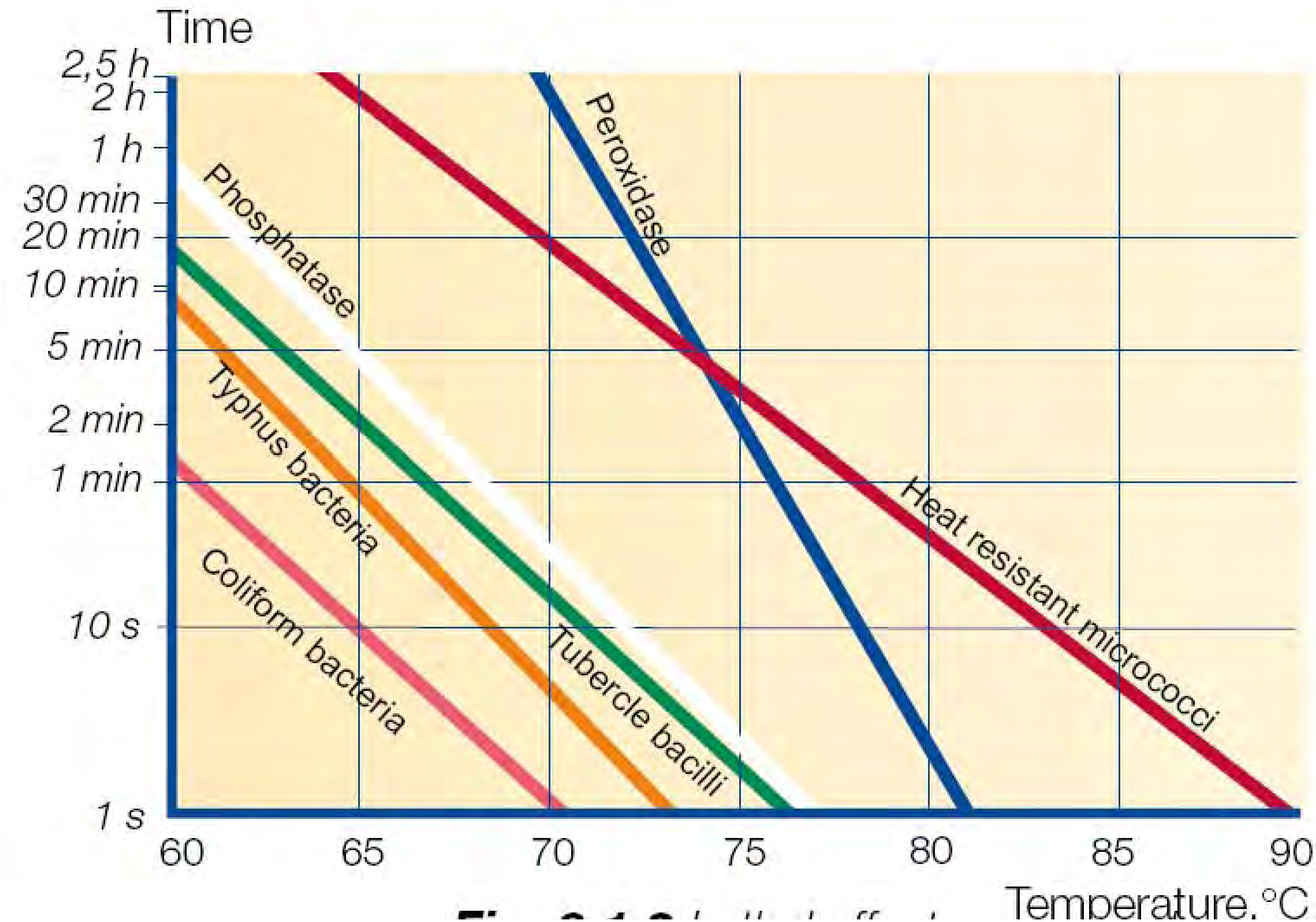


Figure 2 *Lethal effect curves and time/temperature curves for destruction of some enzymes and micro-organisms*

Denatuation of serum proteins

Unfolding in peptide chains (temperature 80 °C): reaction in or between side groups chains → preventing refolding

These changes happen for serum proteins specially BLG, ALA, serum albumin, Immunoglubolins.
Proteose peptones are not denaturable (caseins)
In high temperature, thiol group reacts with –s-s- groups → Dimer, trimer, tetramer, ….

In milk during heating: BLG react with k-casein → casein micells cover with BLG (depending on pH)

Whey proteins show different thermal stabilities: alpha-lactalbumin > betalactoglobulin> bovine serum albumin > immunoglobulins.

Reaction of lactose:

Changing in color, nutrition value, pH, taste

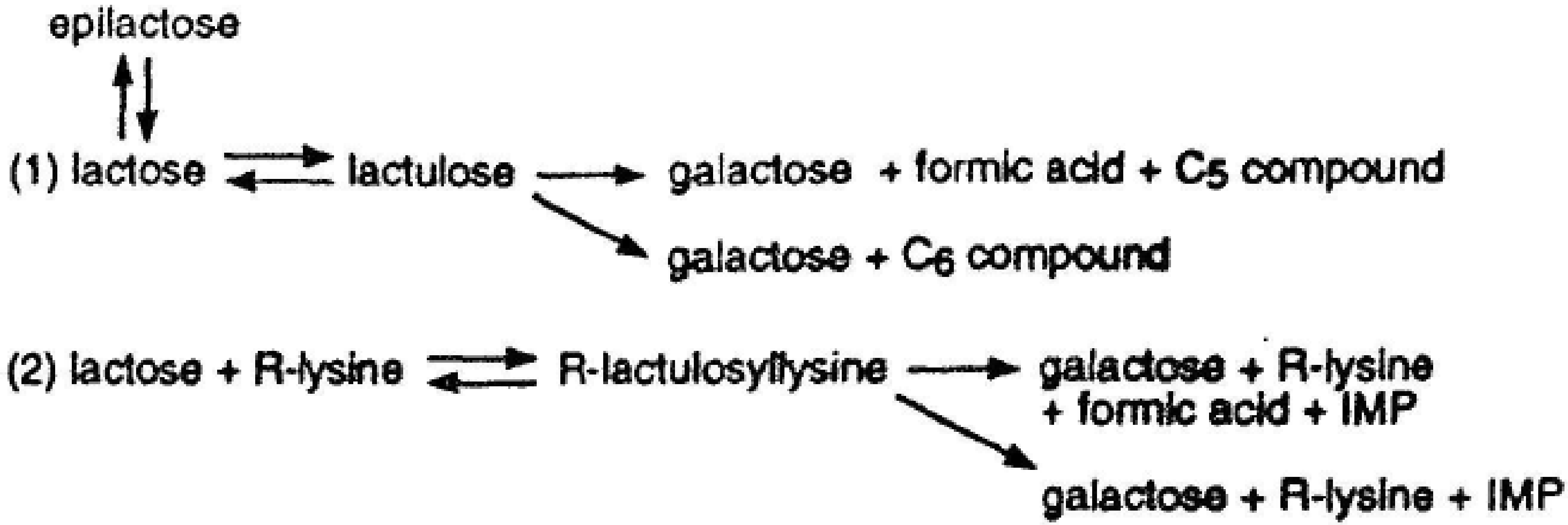
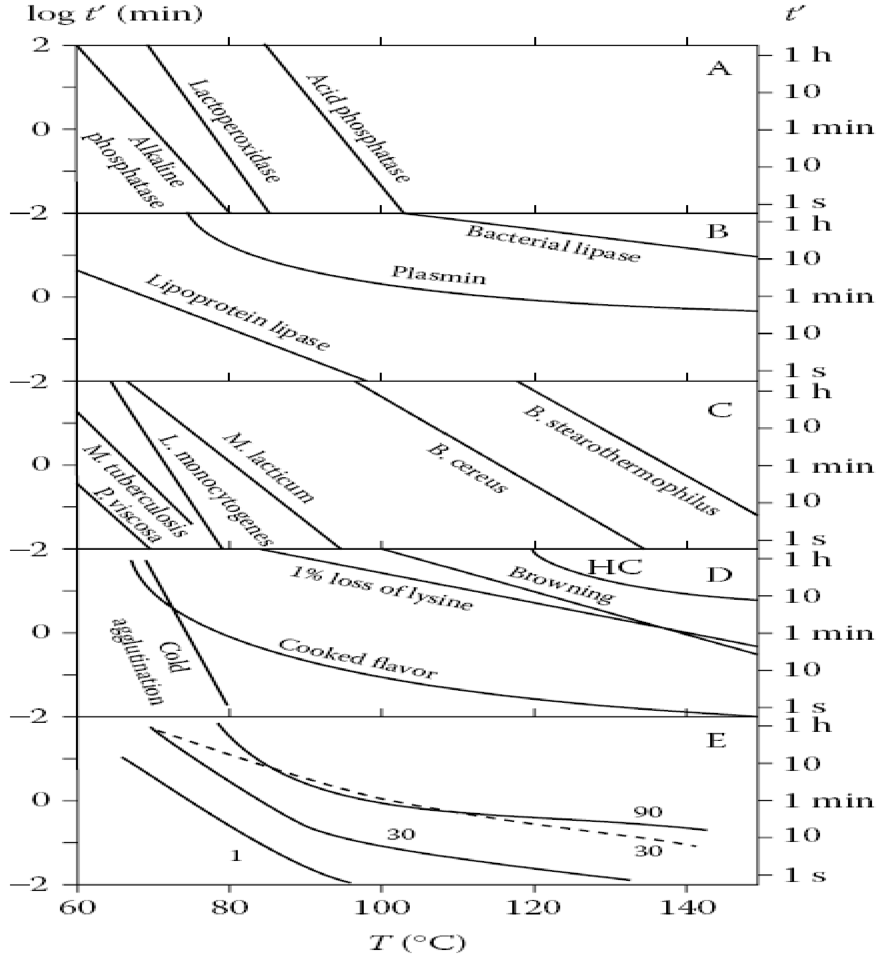


FIGURE 6.5 Simplified scheme of reactions occurring in the initial stage of the breakdown of lactose during the heating of milk (sterilization temperatures). IMP, intermediate Maillard products.



Combinations of temperature (*T) and time (t') of heat treatment of milk that* cause (A, B) inactivation (reduction of activity to about 1%) of some milk enzymes and a bacterial lipase; (C) the killing (reduction of the count to 10−6) of strains of the bacteria *Pseudomonas viscosa, Mycobacterium tuberculosis, Listeria monocytogenes, and Microbacterium lacticum, and of spores (10−4) of Bacillus cereus and B. stearothermophilus;* (D) visible heat coagulation (HC), a certain degree of browning, decrease in available lysine by 1%, a distinct cooked flavor and inactivation of cold agglutination; (E) insolubilization of 1%, 30%, and 90% of the β-lactoglobulin, and of 30% of the α-lactalbumin (----). Approximate results.

Heat Inactivation of Some Enzymes in Milk

Enzyme	EC Number	Temperature (°C)	*D* (s)	Q_{10}
Milk enzymes				
Alkaline phosphatase	3.1.3.1	70	33	60
Lipoprotein lipase	3.1.1.34	70	20	13
Xanthine oxidase	1.1.3.22	80	17	46
Lactoperoxidase	1.11.1.7	80	4	230
Superoxide dismutase	1.15.1.1	80	345	150
Catalase	1.11.1.6	80	2	180
Plasmin	3.4.21.7	80	360	3.3
Plasmin	3.4.21.7	120	30	1.5[b]
Acid phosphatase	3.1.3.2	100	45	10.5
Extracellular bacterial enzymes[a]				
Lipase *Pseudomonas fluorescens*		130	500	1.3[b]
Lipase *Pseudomonas* sp.		130	700	2.4
Lipase *Alcaligenes viscolactis*		70	30	2.6
Proteinase *Pseudomonas fluorescens*		130	630	2.1
Proteinase *Pseudomonas* sp.		130	160	1.9
Proteinase *Achromobacter* sp.		130	510	2.1
Chymosin	3.4.23.4	60	25	70

[a] The results may vary widely among strains and may also depend on the conditions during growth.

[b] Valid only over a narrow temperature range.

Examples of Thermal Inactivation Data of Bacteria: Conventional Approach

Microorganisms	Heating Medium	Temperature (°C)	*D* (min)	*Z* (K)
Psychrotrophs				
Pseudomonas fragi	Milk	49	7–9	10–12
Pseudomonas fragi	Skim milk	49	8–10	10–12
Pseudomonas fragi	Whey, pH 6.6	49	32	
Pseudomonas fragi	Whey, pH 4.6	49	4–6	10.9
Pseudomonas viscosa	Milk	49	1.5–2.5	4.9–7.9
Pseudomonas viscosa	Whey, pH 6.6	49	3.9	
Pseudomonas viscosa	Whey, pH 4.6	49	0.5	
Pseudomonas fluorescens	Buffer	60	3.2	7.5
Listeria monocytogenes	Milk	72	0.02–0.05	6.8
Other non-spore-forming bacteria				
Salmonella (6 spp.)	Skim milk	63	0.06–0.1	4.0–5.2
Campylobacter jejuni	Skim milk	55	0.7–1.0	6–8
Enterococcus faecalis	Skim milk	63	3.5	
Enterococcus faecium	Skim milk	63	10.3	
Enterococcus durans	Skim milk	63	7.5	
Enterococcus bovis	Skim milk	63	2.6	
Escherichia coli	Skim milk	63	0.13	4.6
Escherichia coli	Whey, pH 4.6	63	0.26	6.7
Streptococcus sp., group D	Skim milk	63	2.6	
Lactococcus lactis ssp. *lactis*	Whey, pH 4.6	63	0.32	7.3
Lactococcus lactis ssp. *cremoris*	Whey, pH 4.6	63	0.036	6.7
Lactobacillus spp.	Milk	65	0.5–2.0	
Microbacterium flavum	Skim milk	65	2.0	
Microbacterium lacticum	Milk	84	2.5–7.5	
Mycobacterium tuberculosis ssp. *bovis*	Milk	64	0.1	5.0
Mycobacterium avium ssp. *paratuberculosis*	Milk	70	0.06	
Yersinia enterocolitica	Milk	58	1.6	4.3

Microorganisms	Heating Medium	Temperature (°C)	*D* (min)	*Z* (K)
Spore-forming bacteria				
Bacillus cereus, spores	Milk	121	0.04	9.4–9.7
Bacillus cereus, vegetative	Water or 2 M sucrose	70	0.013–0.016	6.6
Bacillus cereus, germinating spore	Water	70	0.35	6.5
Bacillus cereus, germinating spore	2 M sucrose	70	39	
Bacillus subtilis, spore	Milk	121	0.03–0.5	10.7
Bacillus subtilis, vegetative	Water	55	1.0–5.6	5.0–5.2
Spore-forming bacteria (Continued)				
Bacillus sporothermodurans, spore	Skim milk	121	2–3.5	13–14
Clostridium sporogenes, spore	Milk, pH 7.0	121	1.7	
Clostridium botulinum, spore	Milk, pH 7.0	121	0.2	
Clostridium tyrobutyricum, spore	Milk	110	0.5	15
Clostridium perfringens, spore	Water	70	8–25	7–8
Other microorganisms				
Aspergillus sp., conidia	Buffer, pH 4.5	55	2	3.5–4
Aspergillus sp., ascospores	Buffer, pH 4.5	75	2	6–8
Saccharomyces cerevisiae, vegetative	Buffer	60	1	5.0
Saccharomyces cerevisiae, ascospores	Buffer	60	10	5.0
Foot-and-mouth disease virus	Milk	63	0.2	10–12