

Science & Principles Behind Milk & Milk Products



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What is Milk?

- Natural food for mammals
- Colostrum with antibodies
- Milk from different animals cows, buffalo, goat, camel, human
- India largest producing country
- 186 million tons production in 2018



Composition of milk from different species

Nutrient (in 100g)	Cow	Human	Buffalo	Goat	sheep
Water(%)	87.99	87.50	83.39	87.03	80.70
Calories	61	70	97	69	108
Protein(g)	3.29	1.03	3.75	3.56	5.98
Fat(g)	3.34	4.38	6.89	4.14	7
CHO(g)	4.66	6.89	5.18	4.45	5.36
Cholesterol(mg)	14	14	19	11	–
Ca (mg)	119	32	169	134	193
Phosphorus(mg)	93	114	117	111	158
Sodium(mg)	49	17	52	50	44
Potassium(mg)	152	51	178	204	136
Vit C(mg)	0.94	5.00	2.25	1.29	4.16
Vit A (IU)	126	241	178	185	147
Riboflavin(mg)	0.162	0.036	0.135	0.138	0.355

Standards of Milks as per FSSAI

Class of Milk (Locality)	Designation	Min% Fat	Min% SNF
Buffalo milk (Guj, Mah, Hry, Pun)	Raw, past, boil, flav, steri	6	9
Buffalo milk (AP, HP, Ker, Goa, Raj, TN)	Raw, past, boil, flav, steri	5	9
Cow milk (Chand, Hry, Pun)	Raw, past, boil, flav, steri	4	8.5
Cow milk (AP, Del, Guj, HP, Kar, Ker, MP, Mah, Raj, TN)	Raw, past, boil, flav, steri	3.5	8.5
Cow milk (Miz, Orissa)	Raw, past, boil, flav, steri	3.0	8.5
Goat or Sheep (Hry, MP, Mah, UP, Pun)	Raw, past, boil, flav, steri	3.5	9.0
Goat or Sheep (AP, Bih, Del, HP, Kar, Raj, TN, WB)	Raw, past, boil, flav, steri	3.0	9.0
Mixed (All India)	Raw, past, boil, flav, steri	4.5	8.5
Standardised milk (All India)	Past, flav, steri	4.5	8.5
Toned milk (All India)	Past, flav, steri	3.0	8.5
Double toned (All India)	Past, flav, steri	1.5	9.0
Skimmed milk (All India)	Raw, past, boil, flav, steri	Not >0.5	8.7
Full cream milk (All India)	Past, flav, steri	6.0	9.0

Milk Analysis: Chemistry & Microbiology

- Why analyse?
- Adulteration detection
- Safety
- For Uniform Quality of processed milk



Adulteration of Milk

- Water may be added to milk or fat may be removed from milk to make illegal gains
- This changes the composition of milk which can be detected by milk analysis to determine protein, fat, SNF etc.
- To avoid getting detected by these means adulterers may add substances that show higher levels of protein, fat, SNF etc.
- If milk is not fresh and undergoes microbial fermentation acid forms with lower pH
- To neutralise this acid alkali may be added
- Also to avoid milk spoilage in poor handling some preservatives may be added
- There are methods to detect all these substances



Adulteration II

- Substances may be added to improve quality parameters to lower quality milk
- If water is added to milk, then protein, carbohydrates and fat contents get reduced
- To make up for that cheaper substances may be added such as sugar, starch, glucose, urea, sulphates, foreign fat, gelatin, detergent,
- Alkali may be added to neutralise the acid produced due to microbial activity (spoilage)
- Antimicrobial compounds may be added to stop microbes growing and spoiling milk e.g. hydrogen peroxide, formalin, hypochlorites, chloramines, etc



The advertisement features a blue background with a glass of milk being poured from a blue stream. To the right of the glass, a list of common adulterants is provided. At the bottom, a yellow banner with a skull and crossbones icon warns of health risks. The Braj Dhara logo is in the top right corner.

Common Adulterants In Milk

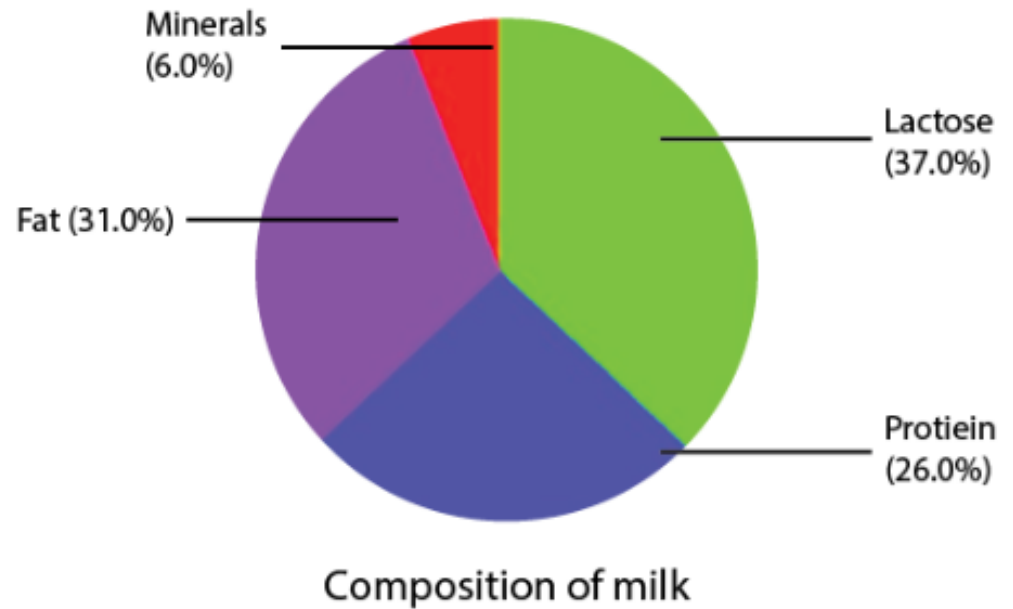
- Urea
- Detergent
- Vanaspati
- Ammonium Sulphate
- Formalin
- Hydrogen Peroxide

The adulterants in milk leads to cause Impairments, Heart Problems, Cancer or even Death!

Braj Dhara Nutrition India Pvt. Ltd.
Contact at : info@brajdhara.com | Customer Care : +91 7000622688, 7000743334

Components of Milk

- Carbohydrate
- Fat
- Protein
- Vitamins & Minerals
- Enzymes



Carbohydrates

- Milk contains about 5% carbohydrates
- Lactose (disaccharide of glucose & galactose) is predominant
- Trace amounts of monosaccharides & oligosaccharides

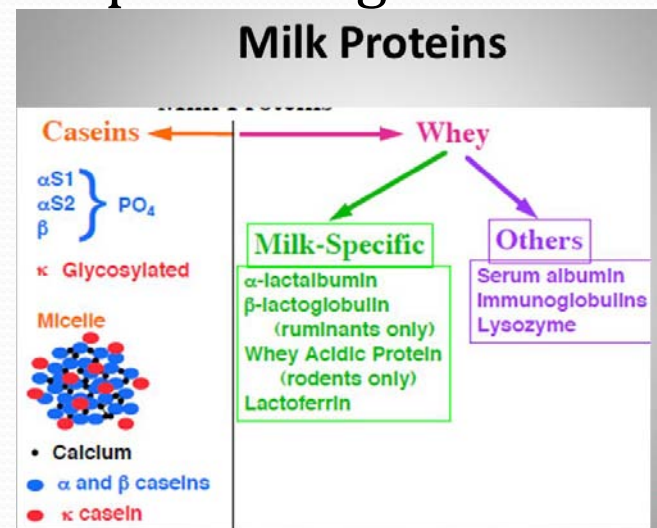
Lactose

- **Also known as Milk Sugar.**
- **Glucose + Galactose = Lactose**



Proteins

- Cow's milk contains 3.3% proteins
- Contains 2 parts
- Major portion (>80%) is casein which coagulates at pH 4.6
- Minor portion (<20%) is serum or whey protein soluble at pH 4.6
- Casein is heat stable while whey protein is sensitive
- Immediately after calf is born cow may give milk which is very thick as it contains antibodies for protecting calf from diseases and is called colostrum



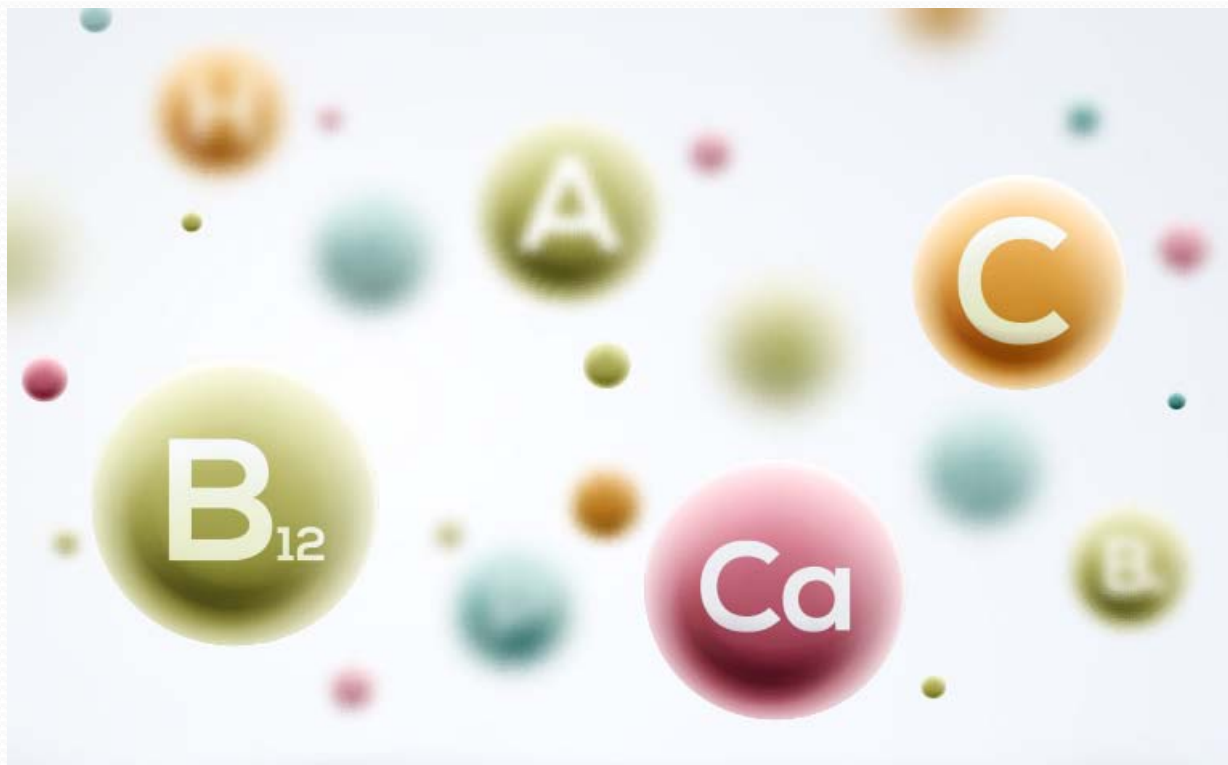
Fat

- Fat in milk may be from 3-4% in cow to almost 7% in buffalo
- Different states have different standards
- Most complex fatty acid composition of edible fats with >400 fatty acids identified
- Some found in small quantities but affect flavour giving typical butter flavour
- Contains 65% sat, 30% mono & 5% poly-unsat f.a.
- Milk fat melts over a wide range of temp
- It is hard at refrigerated temp but is softer at room temp
- Fat present in milk as globules (<1 to >10 μ m) surrounded by protein & phospholipid membrane that stabilises them in water phase
- Larger globules tend to float causing creaming at the top
- Homogenisation reduces size of large globules minimising creaming
- Cream separators are used to remove fat from milk to prepare butter and low fat or skim milk



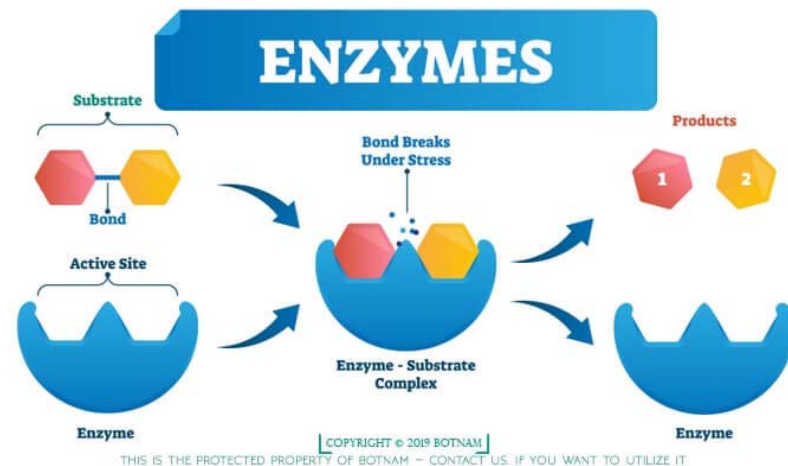
Vitamins & Minerals

- Milk is good source of vitamins A, B1, B2, B12
- Contains good amounts of Calcium & Potassium



Enzymes

- Milk contains lipase lipoprotein lipase which is deactivated in pasteurisation
- Protease in milk is plasmin
- Alkaline phosphatase is heat sensitive enzyme taken as indicator of pasteurisation in which it gets deactivated
- Lactoperoxidase has antimicrobial properties



Milk & Health

- Milk is a rich source of calcium which along with vit D benefits bone health & may reduce risk of colon cancer
- Milk is a source of potassium that can help dilate blood vessels & reduce blood pressure which reduces risk of heart disease & stroke
- Milk contains saturated fat and cholesterol. Although dietary cholesterol in moderation is not a problem. So excess consumption of milk & dairy products may increase risk of CVD
- Milk with high quality of protein is extremely useful for babies for growth, for sportspersons and body builders for muscle growth & maintenance
- Lactose in milk may not be acceptable to lactose intolerant people



Good bacteria

- Milk contains many friendly bacteria
- Collectively they are lactic acid bacteria
- Many of them have health benefits such as
 - They improve digestive health incl control of diarrhea, irritable bowel syndrome, ulcerative colitis
 - They help weight loss
 - They also reduce inflammation, depression & anxiety, bad cholesterol, blood pressure, vaginal infection, enhance immune function & skin health



Lactose Intolerance

- Milk contains lactose which is a disaccharide sugar and the major carbohydrate in milk
- Many individuals have lack or absence of enzyme lactase in gut which is needed to hydrolyse lactose to glucose & galactose before they being absorbed from gut
- If lactose is not hydrolyse it passes through gut to large intestine where bacteria can use it as food and produce large amount of CO₂ which causes vomitting, bloating, cramps, diarrhea etc.
- This is lactose intolerance and lactose intolerant people cannot drink milk



Lactose intolerance

Lactose Intolerance II

- Fermented products like yogurt, curd, buttermilk etc. are tolerated well by many lactose intolerant people as these products have substantially lower lactose and there is lactase enzyme from microbes present which can continue to hydrolyse lactose in gut
- Specially treated Low Lactose Milk & Products are prepared where milk is treated by lactase before being converted to various products. Such products have very low levels of lactose to cause problems
- There are some lactase enzyme preparations available in liquid form or tablets. Some could be added to milk which will convert lactose to glucose & galactose and then treated milk may be consumed.
- Some preparations could be consumed along with milk preparations so while milk is being digested this enzyme will act in gut to hydrolyse lactose



Principles of Processing & Preservation

- Milk – highly perishable
- Bacteria grow, cause acidity & spoil milk
- Pathogens may cause disease
- Processing of milk for making it safe, to prevent spoilage and also to make different products



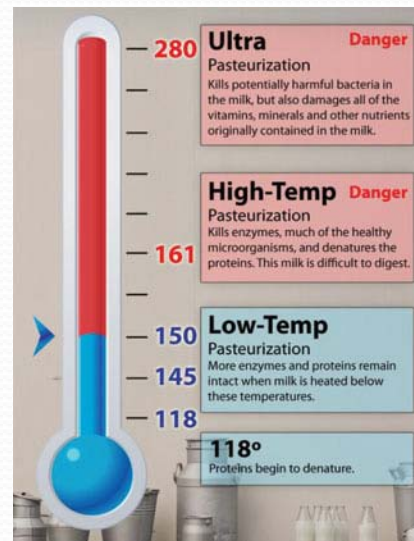
Pathogens in Milk

- Illnesses associated with consumption of raw milk are associated with following pathogens
- Salmonella, Listeria, Campylobacter & E coli
- Pasteurisation is heat treatment that ensures destruction of all pathogens commonly present in milk.
- Treatment should be adequate to destroy Coxiella burnetii which causes Q fever is the most resistant of pathogens generally found. This ensures all others being destroyed

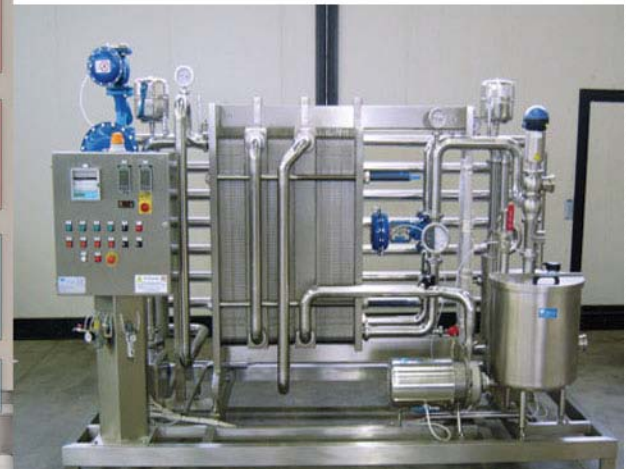


Safety

- Milk may have pathogens so heat processed to kill common pathogens present by Pasteurisation
- Low Temp Holding (LTH) (63°C for 30 min)
- High Temp Short Time (HTST) (71.5°C for 15 sec or 88.3°C for 1 sec)
- Ultra High Temp (UHT) (135-150°C for 4-15 sec)
- Testing: Negative Phosphatase test

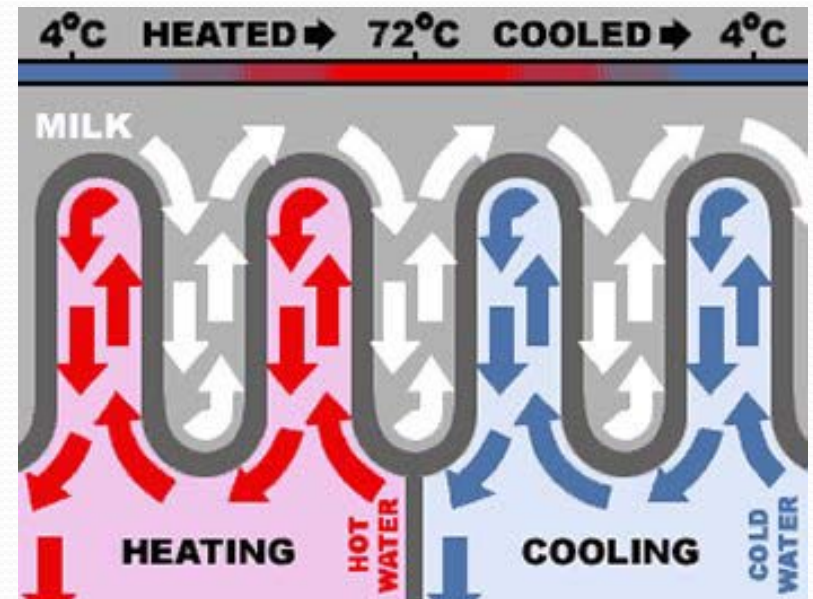


Milk Pasteurization

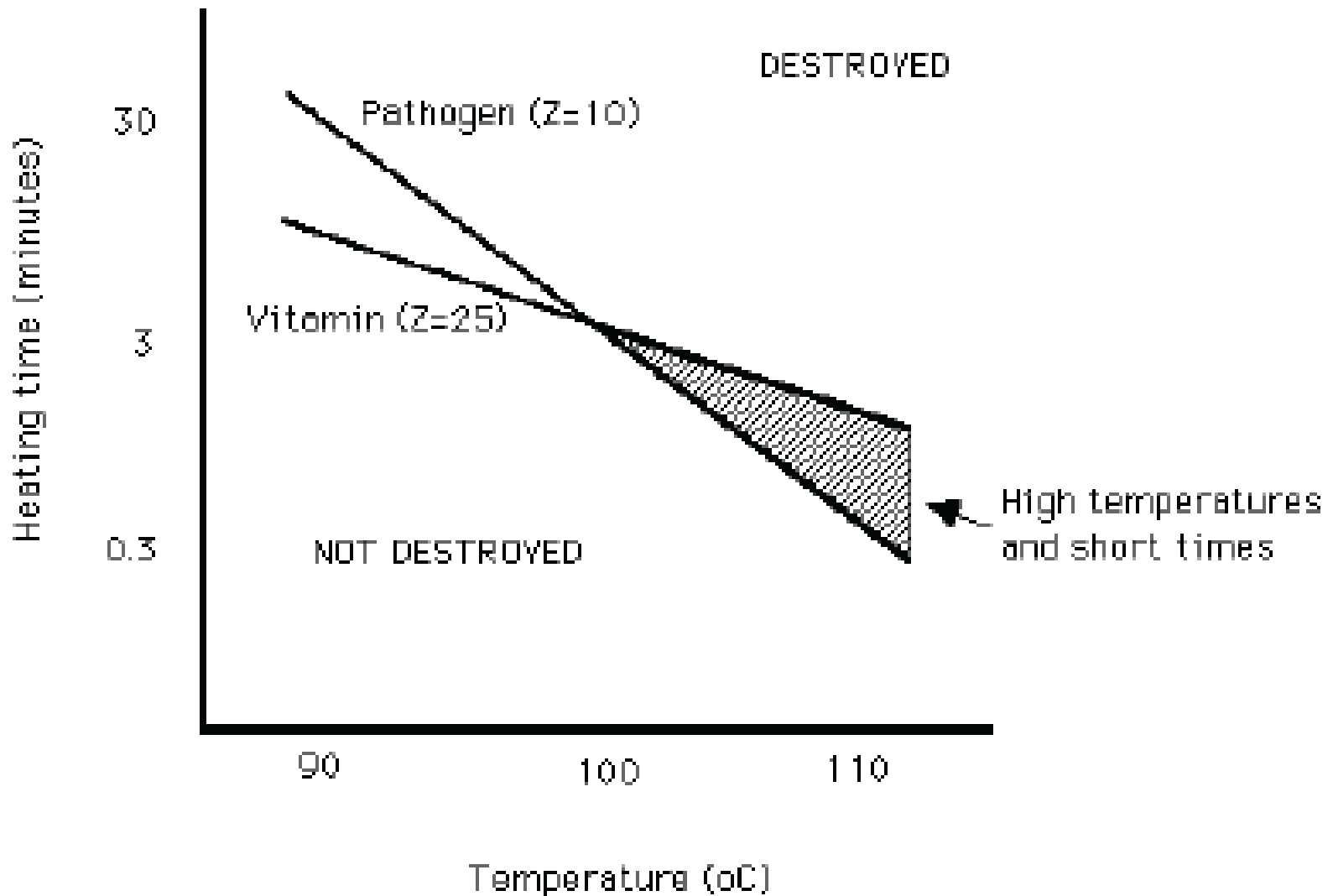


Higher Temperature Preferred

- As temp is increased time needed to destroy microbes decreases
- At higher temperature losses of nutrients higher
- However, much less time needed
- Thus at same effectiveness of destroying pathogens, nutrient destruction is lesser



Principle of Higher Temperature



Prevention of Spoilage

- The pathogens are a small number compared to the total number of bacteria.
- Pasteurisation destroys pathogens so milk becomes safe
- The other bacteria that remain viable after pasteurisation although harmless, are capable of spoilage
- Hence milk after pasteurisation needs to be refrigerated or processed further to increase shelf life



Processing of Milk & Products

- Sterilisation
- Concentration
- Dehydration or Drying
 - Vacuum Drying
 - Drum or Roller Drying
 - Spray Drying
 - Freeze Drying
- Fermentation
- Freezing



Further Processing

- Microbes need food, water and environment favourable for their growth
- Processing to prepare different products aims to disrupt some of these needs of the microbes so they would find it difficult or impossible to grow
- Sterilisation as it is called in industry is commercial sterilisation
- It kills those microbes capable of growing under conditions prevailing after the processing
- Sterilisation kills all microbes although commercial sterilisation kills those which are capable of growing in environment present after heat treatment



Other Processes

- Microbes in milk need water, mild conditions of temperature & pH
- Water is removed from milk to produce powder by various dryers
- Fermentation by lactic acid bacteria produces lactic acid lowering the pH
- Ice cream manufacture lowers temperature at which bacteria cannot grow
- Other substances sugar, stabilisers, etc. also help preservation as they tie up free water

