



Microbiology of Dried Milks



About Dried Milk.....

Dried milk or milk powder is the product obtained by the removal of water from milk by heat or other suitable means to produce a solid containing 5% or less moisture. The dried product obtained from whole milk is dried whole milk or whole milk powder (WMP) and from skim milk is dried skim milk or skim milk powder (SMP).



Types of Dried Milk Products.....



Dried Ice-cream



Cheese Powder

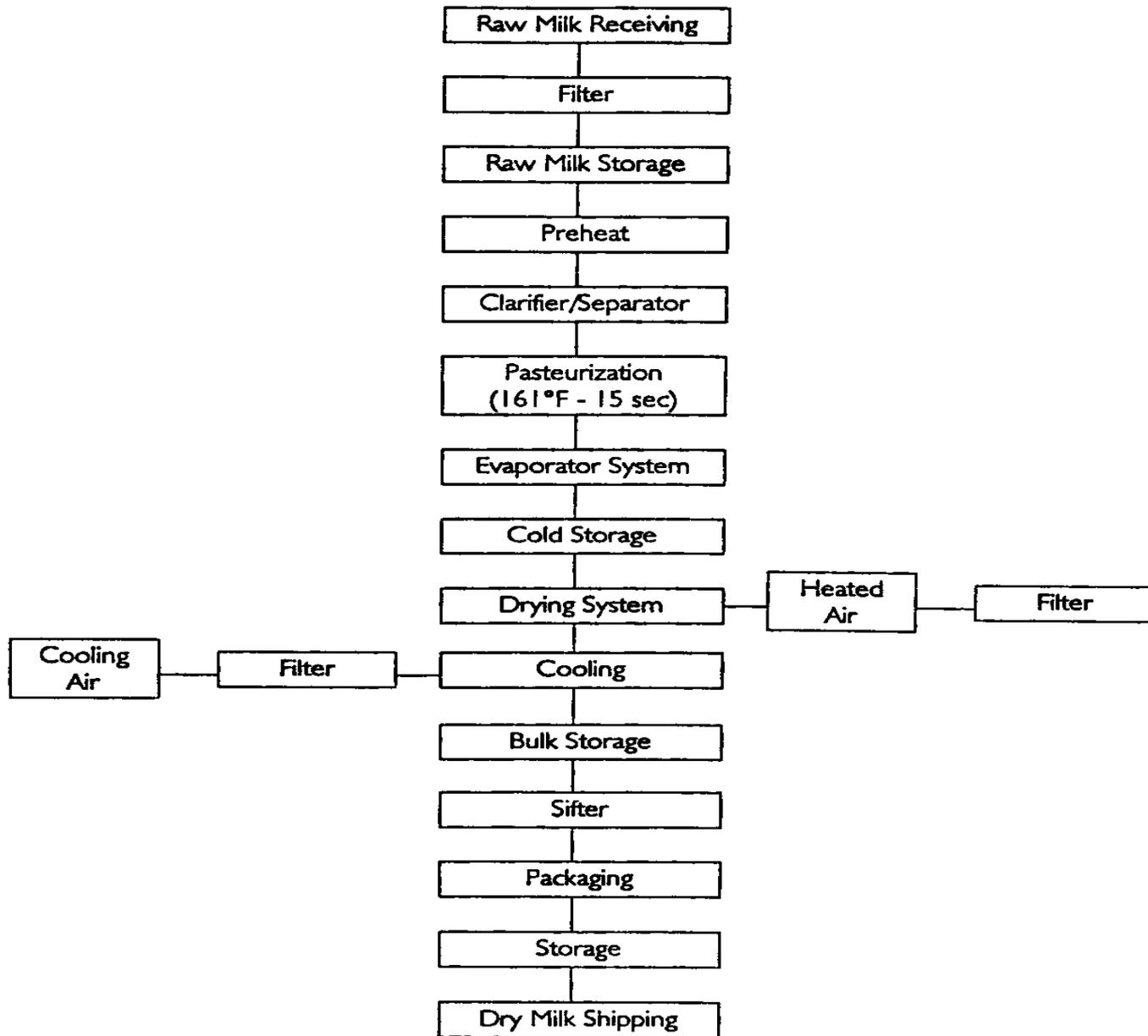


Dried Whey



Malted Milk Food

Processing Scheme of Dried Milk.....



Method of Manufacture (Outlines).....

Roller Drying

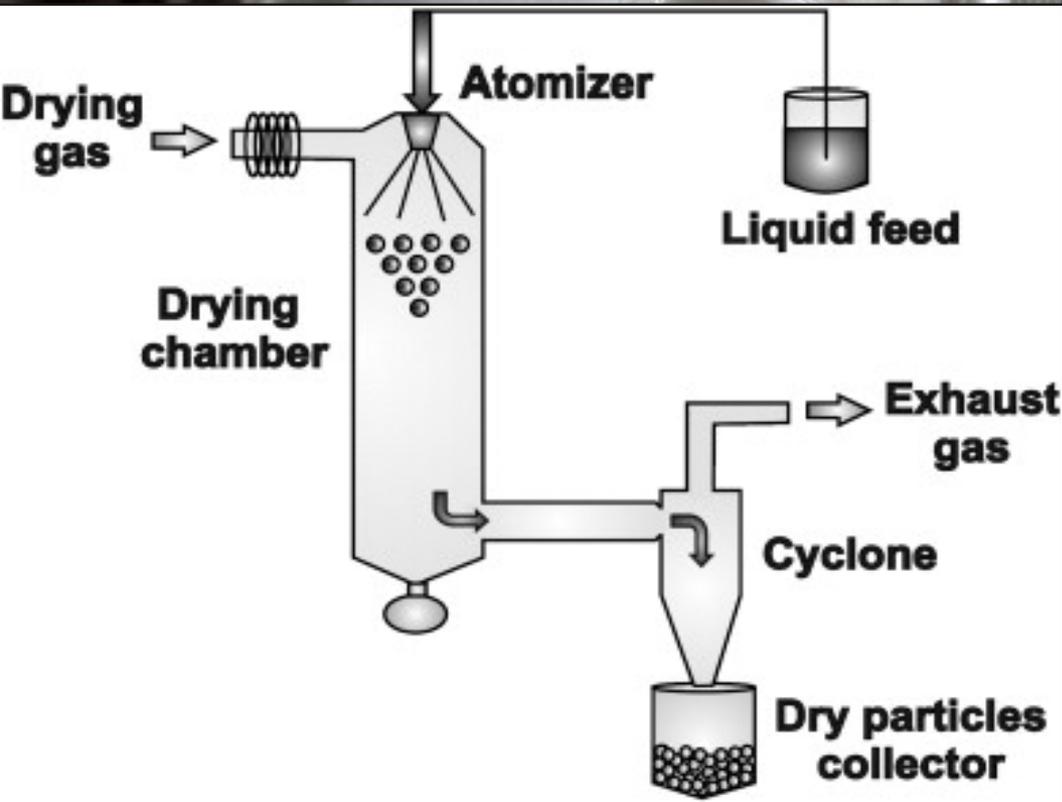
- Involves the application of milk in the form of thin film over the continuously rotating steam heated metal drum, roller or cylinder and the film of dried milk is continuously scraped off by the scrapper.

Spray Drying

- Atomizing the pre-heated and concentrated milk to form a spray of very minute droplets which are directed into a large, suitably designed drying chamber, where they mix intimately with a current of hot air.



The procedure that involves incorporation of post-processing operation is instantization (it increases the wetting property of dried powders and makes them dissolve instantaneously).



Microbiological Quality of Dried Milk.....

Dried milks, owing to their low moisture content, have a long keeping quality. Microorganisms in dried milk cannot grow and thus do not play any direct role in their spoilage. The application of powders in baking or processed cheese, the microorganisms present may cause defect in the derived products.

Types of Microflora

- ❖ Thermotolerant flora originating from raw milk.
- ❖ Bacteria that survive and multiply during drastic processing conditions (temperature, agitation, viscosity and osmotic pressure in the evaporator).
- ❖ Residual flora from various equipments are added as contaminants.
- ❖ Post manufacturing contaminants from utensil, air etc.
- ❖ Microorganisms associated with personnel handling of product.

The nature of microflora in the product is dependent on the mode of drying milk.

Roller dried powders	Spray dried powders
Micrococci	Micrococci
Aerobic sporeformers	Streptococci
<i>Sarcina</i> sp.	Corynebacteria

Factors Affecting Microbiological Quality of Dried Milk.....

❖ **Quality of raw milk:** Milk should be periodically examined for the presence of thermodurics. Clarification by centrifugation will improve the quality of product. During separation, the skim milk obtained from centrifugal separator may contain fewer organisms as many bacteria are trapped in slime. Standardization may contribute additional microflora and some contaminants can come from homogenizer.

❖ **Processing**

❖ **Preheating:** It destroys most of the heat resistant bacteria. Pre-heating at higher temperature inactivates milk enzymes and also reduces thermolabile vitamins.

❖ **Concentration:** There is hardly any chance of aerial contamination as air enters at a very high temperature in spray-drying. In roller drying, inclusion of UHT heads in the evaporator design results in powder of high microbiological quality.

❖ **Drying:** The concentrated milk can be directly fed to the dryers but some manufacturers use feed tanks which may pose microbiological hazards as these provide suitable temperature for the growth of microbes and lead to a build-up of contaminants. Staphylococci may grow at this stage and produce heat stable enterotoxins resulting in food poisoning outbreaks.

Drying causes instant death of a majority of microbes and the remaining microbes that survive die slowly as a result of oxidative damage. Few bacteria still survive because of protective layer of milk solids around them. Powders prepared by roller drying contain lower number of microbes than spray dried powders.

❖ **Instantization:** It is a process of forming agglomerates of powder to improve the wetting and dispersing properties. This process increases microbiological hazards.

❖ **Packaging:** Dried milks are hygroscopic and should be packaged in an atmosphere of inert gas. Since, handling procedures used in packaging may introduce contaminants, a hygienic approach during packaging is desirable.

❖ **Storage:** Powder should be stored at cool and dry place.

❖ **Hygiene:** Complete control of product contamination during manufacturing. The sources of contamination can be from: Air (using of ultra high-efficiency air filters), Calandria vacuum pan (cleaned by acid and alkali), pipelines, concentration tanks, packaging rooms (properly located), personnel hygiene

Effect of Reconstitution on the Bacteriological Quality of Dried Milk.....

Reconstituted dried milks are used for the propagation of starter cultures and for preparation of cultured milk products. If the initial quality of raw milk used for powder making is not good, it may lead to inhibition of starter cultures because of presence of inhibitory substances (antibiotics, sanitizers, detergents etc.). The product may show tendency towards proteolysis and off-flavours because of destruction of lactic microflora. Reconstituted spray dried milk has little numbers when held at 15.5C for 24 h but holding at 22C will lead to increase in total bacterial numbers whereas, storage at 37C cause clotting of milk mainly due to growth of *Streptococcus faecalis*. The various factors affecting bacterial count and flavour of reconstituted dry milks are type of water, sanitary condition of utensils and consumer practices. Unboiled water can be source of coliforms during milk reconstitution.

Public Health Significance and Survival of Pathogens in Dried Milk.....

Staphylococcus aureus* and *Salmonella are of great public health significance in dried milks as they cause food poisoning outbreaks. The various possible sources are:

- a. Milk handlers, dirty equipments
- b. Water
- c. Dust, rodents
- d. Contamination during drying, cooling, instantizing, packaging and transportation

The pathogens survive with adoption of modern processing (producing powders with more acceptable flavour and solubility, milder heat treatment during spray-drying and instantization) and modern packaging techniques (modern methods preventing chemical deterioration allow longer survival of pathogenic microorganisms).

***Staphylococcus aureus* could survive spray-drying. The presence of this organism in milk powder may be mainly due to contamination occurring from the plant environment. Although the vegetative cells are destroyed at pasteurization temperatures, preformed enterotoxins are not destroyed even at boiling.**

***Salmonella* may gain access into milk powders through personal contact, air and water.**

Infant Milk Food.....

Infant milk food or baby food is the product obtained by drying cow or buffalo milk or a combination thereof or by drying standardized milk with the addition of specific carbohydrates, dextrose and dextrans, maltose, iron and vitamins. It should contain no starch and antioxidants. Baby food can be processed cereal food or special infant food (humanized milk).



Microbiological Quality of Infant Milk Food...

The microbiological quality of infant milk foods has always been a great concern as the product is consumed by sensitive consumers. Milder heat treatment given to milk during spray drying in comparison to roller drying process affords little protection to the product against the survival of pathogenic bacteria. The instantization step provides additional opportunity for contamination because of wetting and redrying.

The poor microbiological quality of infant foods can lead to food poisoning outbreaks containing staphylococci and preformed enterotoxins. These enterotoxins are heat stable and not destroyed during heat treatment and carried to final product. Salmonellae are completely destroyed during drying of milk and their presence is due to post processing contamination. Staphylococci, *B. cereus*, coliforms and enterococci may serve as an index of hygienic quality of infant milk foods.

Microflora of Infant Milk Food...



Micrococci

Enterococci

Thermophiles

Proteus

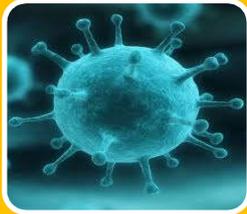


Aspergillus

Penicillium

Geotrichum

Mucor



Salmonella typhimurium

E. coli

C. botulinum

S. aureus

The major cause of food poisoning through baby foods is traced to staphylococcal enterotoxins. The organism can grow and elaborate enterotoxins in a variety of milk products at a minimum population of 10^6 cells/ml.

❖ Effect of storage on microflora of infant foods

The storage temperature and relative humidity play a significant role in affecting the microbial numbers in these products. Storage at relative higher humidity (80-100%), the number of bacteria decreases rapidly followed by overgrowth of yeasts and molds. Direct correlation is there between decrease in bacterial counts and storage period.

❖ Effect of reconstitution on microflora of infant foods

The bacterial count and flavour of reconstituted milk powder may be affected by temperature of reconstitution, type of water (increase in *B. cereus* and *E. coli* counts during storage of reconstituted milk), sanitary condition of utensils and consumer practice. Reconstituted milk held at a temperature favourable for growth of contaminants may lead to food poisoning in infants. Unwashed and non-sterilized feeding bottles and nipples may be source of organisms in reconstituted milk.

Regulatory Microbiological Standards.....

Products	SPC	Coliforms	<i>S. aureus</i>	Yeast and molds
Milk Powder	30x10 ³ /g	Absent/ 0.1g	10/g	5/0.1 g
Infant Milk Food	5x10 ² /g	Absent/ 0.1g	Absent/ 0.1 g	Absent/ 0.1 g

Products	<i>E. coli</i>	<i>Salmonella/ Shigella</i>	<i>L. monocytogenes</i>	<i>Enterobacter sakazakii</i>
Milk Powder	Absent/ 0.1g	Absent/ 25 g	Absent/ 25 g	-
Infant Milk Food	Absent/ 0.1g	Absent/ 25 g	Absent/ 25 g	Absent/ 10 g