

# COURSE TITLE: MICROBIOLOGY OF MILK PRODUCT

COURSE NO. - DTM-222: CREDIT HRS-2 (1+1)

## MICROBIOLOGY OF CONCENTRATED MILK (SCM)



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# MICROBIOLOGY OF CONCENTRATED MILK



Concentrated milk is produced by partial removal of water from fresh milk for direct sale to the consumer, which can be used as food ingredients for providing a source of milk solids in manufacturing of a variety of other products. The removal of water from milk gives an advantages in reducing storage and transport costs, ease / convenience in use and increasing shelf life. Concentrated milk is further reconstituted by the consumer with water, to give a similar composition of fresh milk. It is generally produced as a 3:1 concentrate containing approximately 10 - 12% milk fat and 36% total milk solids.

# Introduction

Condensed milk is an important source of milk solids in confectionery, bakery products, ice cream, concentrated yoghurt, chocolates, bakery products and other newer kind of food mix preparation. It may be made from whole, skimmed, or reduced fat milks depending on the consumer need and requirements.

## Uses of Condensed milk

- 1- Condensed milks are mainly used for reconstitution into sweet milk drinks.
- 2- Condensed milks are very commonly utilised in the preparation of tea or coffee.
- 3- They are also used in the ice-cream preparation.
- 4- They are used in candy and confectionary products.
- 5- They are frequently used in prepared foods in various ways and form.



**Indian  
desserts**



**Cakes and  
cookies**



**Ice cream**



**Puddings**



**Drinks**



**Chocolate  
fudge**

# History of condensed milk

Invented by Gail Borden in the early 1850s, canned condensed milk proved invaluable as a military ration in the 1860s. Fresh milk was spoiled due to long distance / supply chains and it was observed that the canned milk was nutritious, portable, long-lasting and, crucially, safe. At the same time, sales were exploded in US towns and cities after the war.

## Objectives of manufacturing condensed milk

- 1- Preservation of milk and
- 2- Reduction in bulk for the purpose of long distance transport

## Shelf life of Condensed milk

- 1- While still in the can and sealed container, condensed milk will have a shelf life about a year.
- 2- Once opened, the shelf life is reduced
  - Sweetened condensed milk; two to three weeks.
  - Unsweetened condensed milk; only for two week.

Mostly condensed milk is made by evaporation process under vacuum drying and the degree of concentration is usually within the range 2.5:1 to 4:1. Condensed milk prepared from whole milk should contain at least 8% fat and 28% total milk solids while made from skim milk contains at least 0.5% fat and 24% milk solids. After evaporation, sufficient amount of sugar is added as sucrose or glucose specially to prevent microbial growth. The sugar concentration in the aqueous phase (known as sugar ratio, sugar number or sugar index) of final products is usually in the range of 63.5 - 64.5, giving a water activity (aw) of about 0.86, but it is much lower in bulk products. For bulk, whole milk products the sugar index is about 42; this is because the product is stored under refrigerated condition for fairly short periods. The product is packed in hermetically sealed metal containers for retail marketing and milk SS cans, SS barrels, steel drums or bulk tanks for industrial use. Now a days huge quantities of sweetened condensed milk are used in the confectionery, bakery and prepared food industries.

Evaporated milk is same in composition to condensed whole milk, but it is additionally heat processed as well as canned to give a commercially sterile product. Evaporated milk is produced by the removal of about 60% water from whole milk, which results in the lactose content being about 11.5%. Evaporated milk contains at least 7.5% fat and 25 - 26% total milk solids and also contain permitted stabilising salts for maintaining required viscosity level after sterilisation. Some products are made from skimmed milk, and some are 'filled milk' where other fats are used to replace milk fats. Mostly, evaporated milk is sold directly to consumers for use in home cooking.

Condensed milk is relatively a new type of dairy product made from evaporated milk with added sugar. Mostly found in the market and known as sweetened condensed milk. Used in numerous dessert recipes. Water content is partially removed from this milk.

# Indian Standard Specifications for condensed milk

<b>Characteristics</b>	<b>Requirement for</b>	
	<b>Condensed milk</b>	<b>Skim sweetened</b>
Total milk solids (%wt.) Min	31.0	26.0
Fat (% wt)	Not less than 9.0	Not more than 0.5 %
Sucrose (% wt.) Min	40	40
<u>Acidity</u> (% lactic) Max	0.35	0.35
Bacterial count (per g.)	500	500
<u>Coliform count</u> (per g)	Negative	Negative
<u>Yeast and mould count</u> (per g.) Max	10	10



## BIS Specification for Condensed Milk: ( IS: 1166-1986 (1&3)

Sr. No.	Characteristic	Full Cream Sweetened	Full Cream Unsweetened	Skim Sweetened	Skim Unsweetened
1	Total Milk Solids, % by Wt., Min.	31.0	31.0	26.0	20.0
2	Fat, % by Wt.,	NLT 9.0	NLT 9.0	NMT 0.5	NMT 0.5
3	Sucrose, % by Wt., Min.	40.0	-	40.0	-
4	Titratable Acidity (as lactic acid), % by Wt. Max.	0.35	0.30	0.35	0.30
5	Colour	Whitish to light brown	Whitish to light cream	Whitish to light brown	Whitish to light cream
6	Bacterial Count, per g. Max.	500	-	500	-
7	Test for Coliform Organisms	Negative	-	Negative	-
8	Yeast & Mould Count per g., Max.	10	-	10	-

### Nutritive value of condensed milk

It is having high nutritive value and are rich in fat and fat-soluble vitamins A, D, E and K as all body building proteins, bone forming minerals and energy-giving sucrose is present.

## **SWEETENED CONDENSED MILK**

- Concentrated milk produced from whole milk or nonfat milk
- 60% of H<sub>2</sub>O removed
- Sweetened with sucrose or dextrose prior to concentration 40-45% sugar level,
- may cause grittiness
- Pasteurized not sterilized due to high concentration of sugar

### Global Sweetened Condensed Milk Manufacturers

- Nestle
- Arla
- Fraser and Neave
- Friesland Campina
- Marigold
- DMK GROUP
- Eagle Family Foods
- Holland Dairy Foods
- DANA Dairy

# Physico-chemical properties of sweetened condensed milk

- **Specific gravity/density:** Evaporation of water in the manufacture of condensed milks increases its specific gravity/density, which is important in controlling their composition. Baume hydrometers are industrially used for getting idea about specific gravity.
- **Freezing point:** The freezing point of condensed milk is  $-14.9^{\circ}\text{C}$  and that of evaporated milk is  $-1.3^{\circ}\text{C}$ .
- **Colour and flavour:** Heat treatment during manufacture of condensed milks darkens its colour and develops cooked flavour, the darkening / browning-discoloration results from the interaction of the amino-compounds with sugar (casein and lactose). This is based on Maillard reaction (browning). The brown pigment formed is called melanoidin.

# Processing of condensed milk

1.Receiving milk

2.Filtration/clarification (pre-heating)

3.Standardization

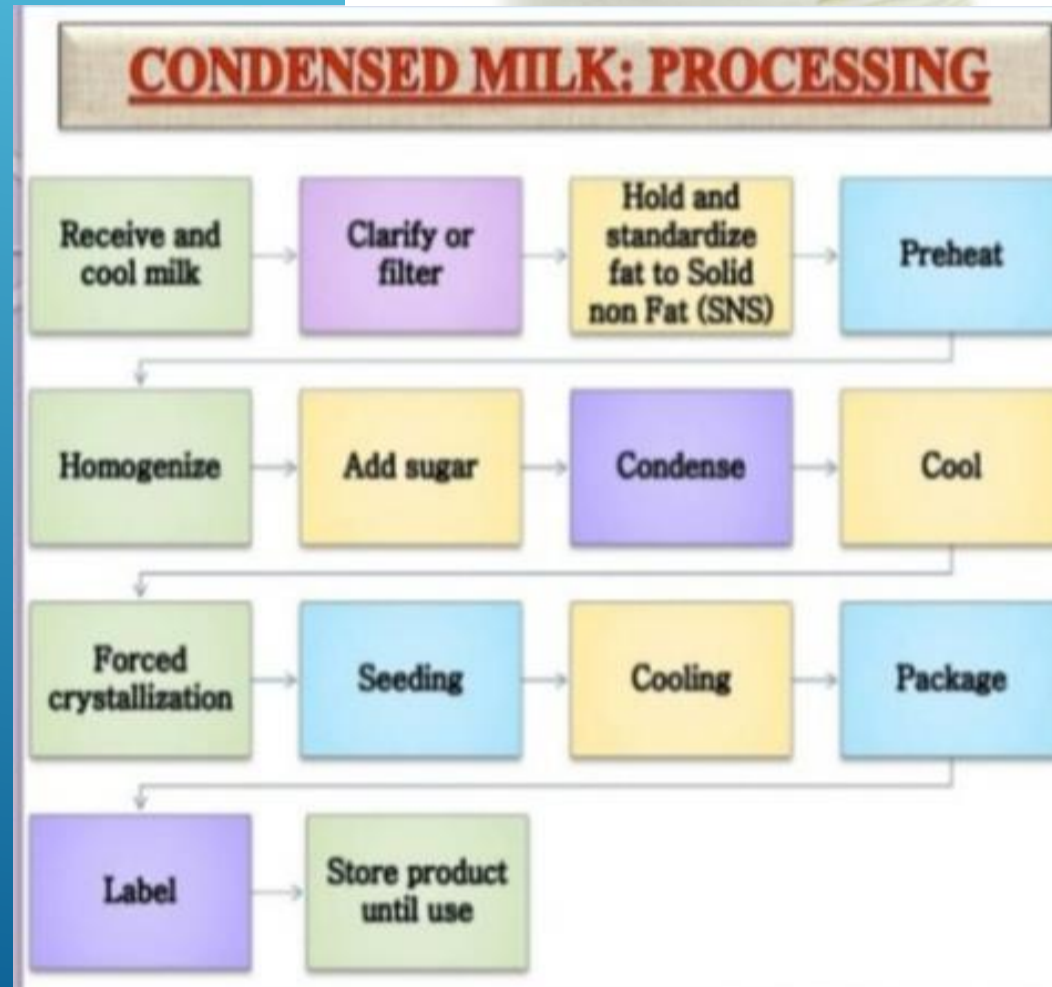
4.Fore-warming / pre-heating

5.Addition of sugar

6.Condensing

7.Homogenization

8.Cooling and Crystallization



## **Initial Microflora**

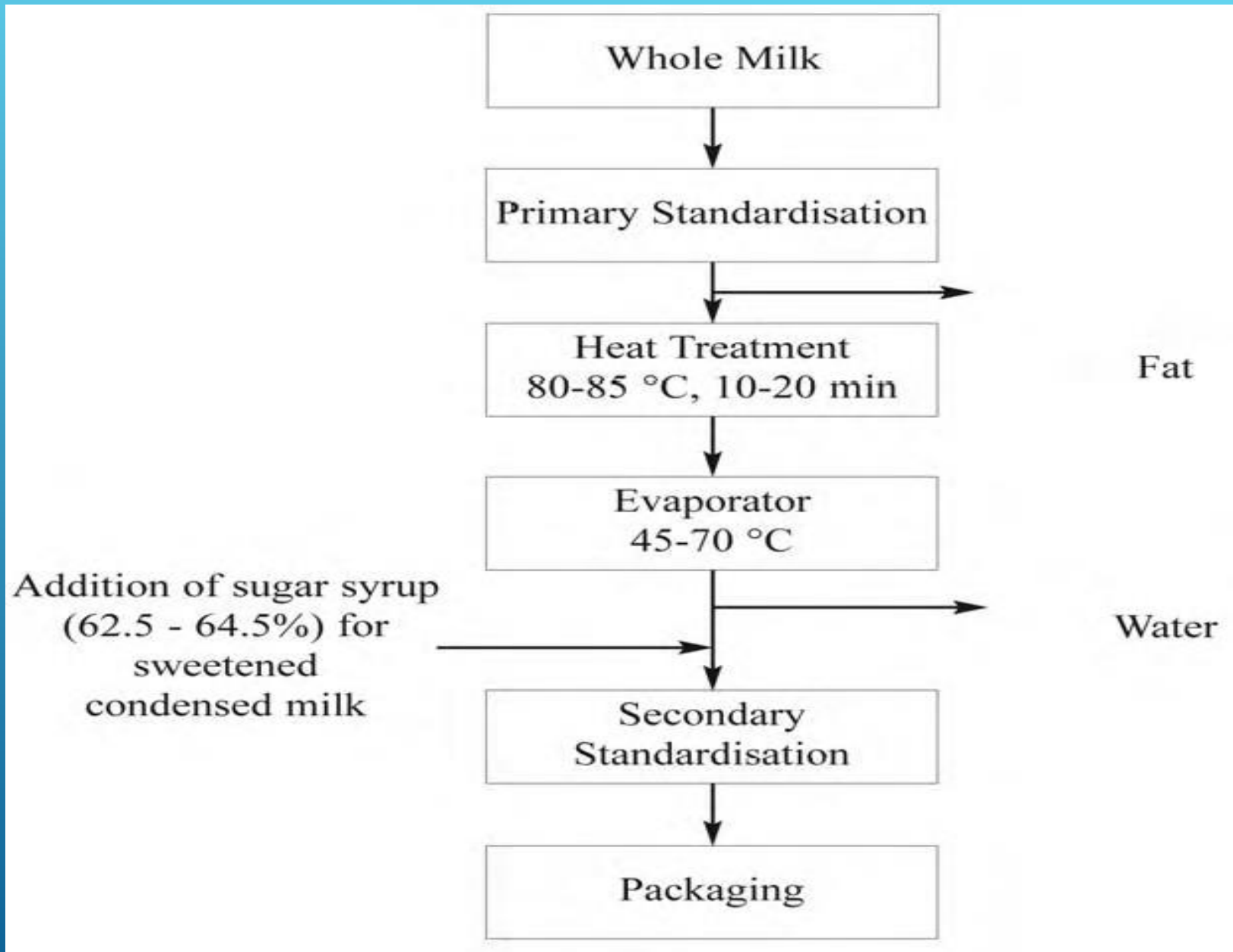
The initial microflora of concentrated milk is same as the raw milk which is used for the production. Sugar used during production of sweetened condensed milk is an additional source of yeasts and molds and bacterial spores especially thermophilic spores.

### **Processing and its Effects on the Microflora**

Processing steps used in manufacturing condensed milk are shown in Figure. The initial steps of milk collection, storage, transport, separation and standardisation are the same as used in fluid milk. Pasteurisation or pre-heating process is the first important step. The time and temperature generally applied as same as milk pasteurisation (72 °C for 15 seconds). In some cases, much higher processing temperature is used. In large-scale continuous production system of evaporated milks, temperatures as high as 121°C may be applied for several minutes to stabilise milk proteins. Depending upon the nature of the product required, more severe processing temperature than pasteurisation may be used in the manufacturing operation of Condensed milk.

Preheating or application of heat helps to increase viscosity and improve other characteristics of the final product. The process of preheating may be less controlled than conventional pasteurisation method, but it is always better to maintain safe minimum process. In case of fresh milk, most vegetative bacteria will be destroyed during heating, but some thermoduric types and bacterial endospores are likely to survive but the severe treatment may remove all these microorganisms. This preheated milk is now concentrated in a vacuum-pan or in a multiple-effect evaporator at a temperature range of 54.4 - 57.2 °C. After evaporation, sugar is added usually as sucrose or glucose which restrict or prevent most microbial growth. The sugar concentration in the aqueous phase of the product known as sugar ratio/index is usually in the range of 63.5 - 64.5 having a water activity (aw) level is about 0.86 and much lower in bulk packing. For bulk, whole milk products the sugar index is about 42; this is because the product is stored under refrigerated condition for short periods. The product sealed in metal containers for retail marketing and milk cans, barrels, steel drums or bulk tanks for industrial purposes. Significant quantities of sweetened condensed milk are used in the confectionery, bakery and different food industries.

# Production of condensed milk

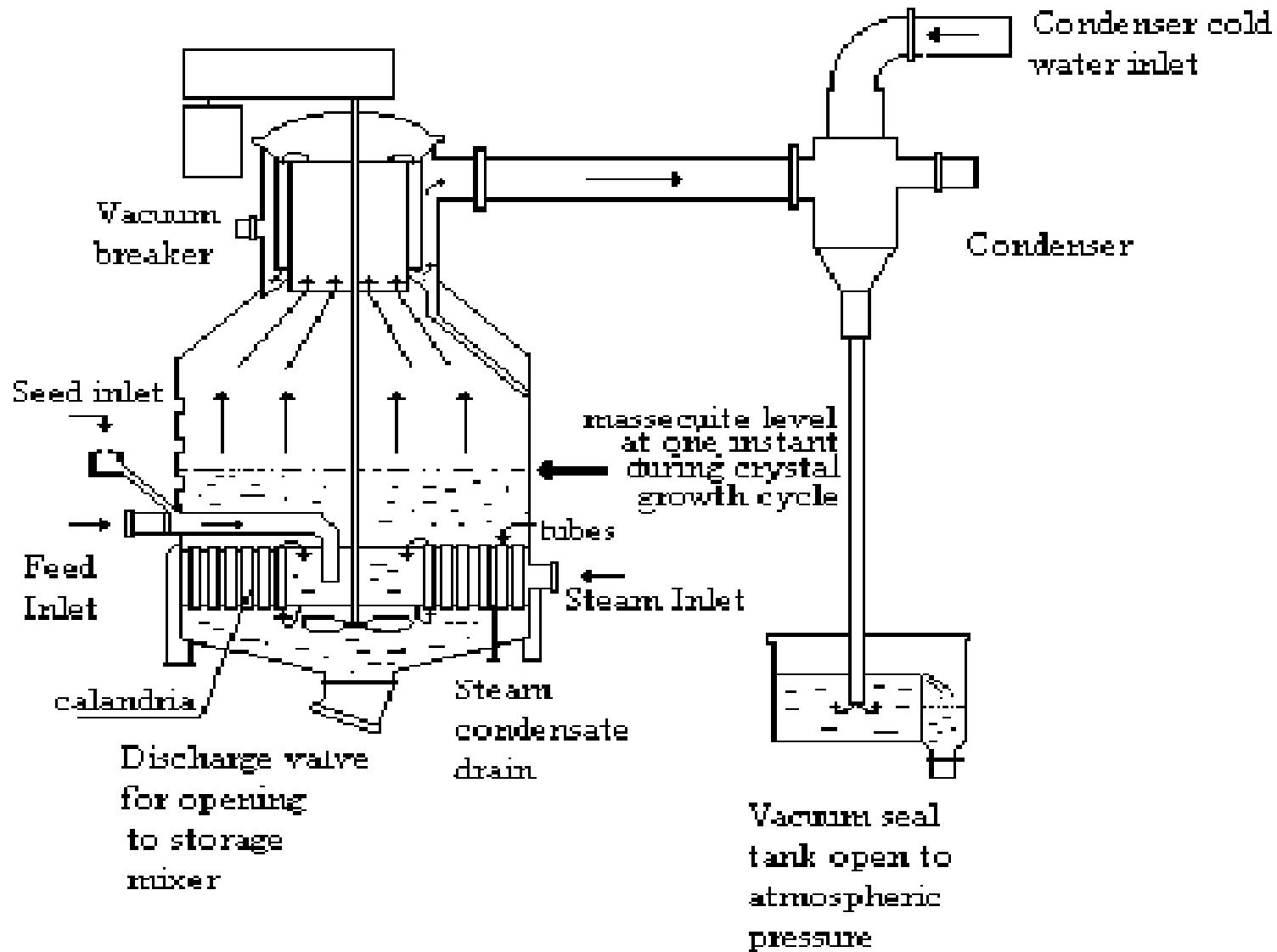




**Complete Condensed milk processing plant**



# Processing of condensed milk



# Microbiological defects

## Sweetened condensed milk

The low aw (0.85) of sweetened condensed milks restrict the bacterial growth and only osmophilic and osmotolerant organisms can grow in this condition. Sometimes canned products may be spoiled by the growth of osmophilic yeast - *Torulopsis* spp., which enter in the product after processing treatment and may produce sufficient amount of gas to cause blowing of cans. In few cases, oxygen is present in the headspace of canned packing or have a small pinhole leakage in the container then molds such as *Aspergillus* and *Penicillium* spp. may grow and produce 'buttons' on the surface of the product. This problem is because of the poor plant hygienic condition. Bulks packing with lower sugar concentrations are more susceptible to spoilage. Mould growth may be observed on the surface of stored milk. Again, *Penicillium* and *Aspergillus* are the main genera responsible for the defect. However, bacterial spoilage created by osmotolerant micrococci and some species of *Bacillus* may create age thickening, and sometimes lipolysis and proteolysis problem.

# Pathogens in Condensed milk

## : Growth and Survival

Concentrated milks are not considered as high-risk products because of the severe heat treatments used during manufacture operation. The main concern for microbial quality of condensed and evaporated milk is based on the post heat-treatment contamination by pathogens as pasteurised and UHT processed milks.

### *Listeria spp.*

Incidence of *L. monocytogenes* has been studied in these products. The organism reduced its number during storage of sweetened condensed milk at 21°C but the population remained stable when stored at 7°C. In case of evaporated milk, growth was observed at both temperatures .

### *Clostridium spp.*

Incidence of clostridium showed that about 40% of the samples contained >100 cfu/100g in sweetened condensed milk. Mainly *Clostridium butyricum* and *Clostridium perfringens* were identified as contaminants. Although, the aw is too low to allow the germination of spores and vegetative cell growth in these products.

## *Staphylococcus aureus*

There is no reported cases of food borne disease found in canned sweetened condensed milk as its aw of 0.85 is close to the minimum value that would required by *Staph. aureus* to grow and there is no chance of toxin at this aw level. In case of bulk container having these products with much lower sugar contents might be at risk if they become contaminated. Therefore, adequate hygiene control should be maintained.

THANK YOU

A decorative graphic consisting of several parallel white lines of varying lengths, slanted diagonally from the bottom right towards the top right, set against the blue background.