# Technews

**National Dairy Development Board**

**For Efficient Dairy Plant Operation**

**November-December 2006** **No. 65**


# EXTENDED SHELF LIFE (ESL) MILK

This bulletin includes technical information based on latest developments on products, systems, techniques etc. reported in journals, companies' leaflets and books and based on studies and experience. The technical information in different issues is on different areas of plant operation. It is hoped that the information contained herein will be useful to readers.

The theme of information in this issue is **Extended Shelf Life (ESL) Milk**. It may be understood that the information given here is by no means complete.

***In this issue:***



**Very Happy New Year to all Readers**

# 1. INTRODUCTION

In India most of the packaged milk is pasteurized milk in sachet. The quantity of ultra-high temperature (UHT) aseptic milk manufactured is small.

The shelf life of pasteurized milk varies, and could be 1-3 weeks at refrigerated storage depending on the initial quality of milk and control of post process contamination. If, however, the shelf life of processed milk is required to be longer than this, and the characteristics of processed milk are desired to be similar to those of pasteurized milk, then milk would be required to be processed as extended shelf life (ESL) milk.

Pasteurized milk is almost universally processed at high temperature short time (HTST) time-temperature conditions. It needs refrigerated storage and has comparatively a short shelf-life. Ultra-high temperature (UHT) sterilized milk, also called UHT aseptic milk, is processed at UHT sterilization time-temperature conditions which are more severe than HTST. It needs only ambient temperature storage and has long shelf-life.

The ESL milk is processed at more stringent processing conditions than pasteurized milk but lesser than UHT aseptic milk.

There is no formal definition of ESL milk. ESL milk is milk the shelf life of which has been significantly extended as compared to that of the typical pasteurized milk, using appropriate heat treatment with or without bacterial removal processes, and with hygienic handling and packaging. It has characteristics intermediate of pasteurized milk and UHT aseptic milk: It needs refrigerated storage and has shelf-life (10-90 days) [(1)] longer than pasteurized milk but shorter than UHT aseptic milk. The ESL milk should have near to fresh taste and white colour.[(2-4)] A typical characteristic of the ESL milk is that it is free from the cooked flavour and dark colour common for Ultra-high temperature (UHT) milk, as it is not subjected to over-processing normally encountered in UHT milk.[(2,5)]

It is preferable to achieve a thermoduric count of less than 1000 /ml and an aerobic spore count of less than 10/ml in ESL milk. [(6)] The product should be free from pathogenic bacteria.

ESL milk has not been categorized separately. For statistics, it is usually combined with pasteurized milk, but in some countries it is combined with UHT aseptic milk. The production statistics of ESL milk for some countries are provided in Table 1.

**Table 1: Production of ESL milk (2001) [7]**

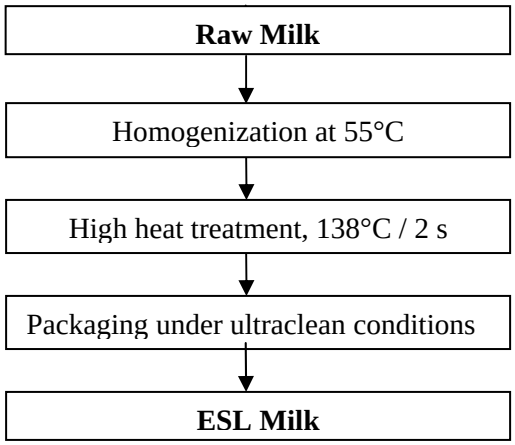
| Country | Total packaged | UHT | Paste-urized | ESL milk | |
|---|---|---|---|---|---|
| | | | | Shelf-life | |
| | | | | 12-14 days | Over 20 days |
| | Million tonnes | Percent of packaged milk | | Percent of pasteurized milk | |
| Western Europe | 29.1 | 48 | 48 | 25-30 | 1-2 |
| UK | 5.7 | 6 | 92 | 50 | 1 |
| Germany | 4.7 | 60 | 40 | - | 5 |
| Italy | 3.3 | 54 | 45 | Some | Some |
| Netherlands | 1.0 | 14 | 80 | Some | - |
| Greece | 0.7 | 32 | 68 | - | 15 |
| Eastern Europe | 8.8 | 23 | 77 | Some | Some |
| Czech Rep. | 0.6 | 56 | 44 | Some | - |
| Poland | 1.4 | 32 | 68 | - | Some |
| North America | 25.9 | 1 | 98 | Most 14-20 days | |
| USA | 23.3 | 1 | 99 | -do- | |
| Canada | 2.6 | 4 | 94 | -do- | 10-15 |
| Australia | 1.7 | 9 | 91 | Most | Some (for exports) |
| Japan | 5.7 | 2 | Most | 5 (total ESL) | |
| Middle East | 2.0 | 41 | 58 | Some | - |
| Israel | 0.3 | 10 | 90 | Some | - |

# 2. MANUFACTURE OF ESL MILK

## ESL Processes [2-11]

The ESL process has not been standardized internationally and manufacturers have adopted processing conditions according to their preferences and market requirements. ESL milk is typically produced by a combination of thermal processing (conventional or higher), bacterial removal (optional - by micro-filtration / bactofugation), filling under increased sanitation and sanitizing the containers just prior to filling.

ESL milk is traditionally produced using the principle of ultra-high temperature for a short time (85-145ºC for a few seconds to fraction of a second) and is ideal for all types of liquid dairy products. Direct heat treatment (steam injection) is commonly used as it yields products with better sensory quality as compared with indirect heating systems. Processing temperatures range from 135-150ºC, with holding times between 8-2 seconds **(see Fig 1).**




**(Longer extension in shelf life)**

**Figure 1: ESL process - High heat treatment**

This is the most widely reported process for production of ESL in USA. A shelf life of 30-50 days or more is achievable.

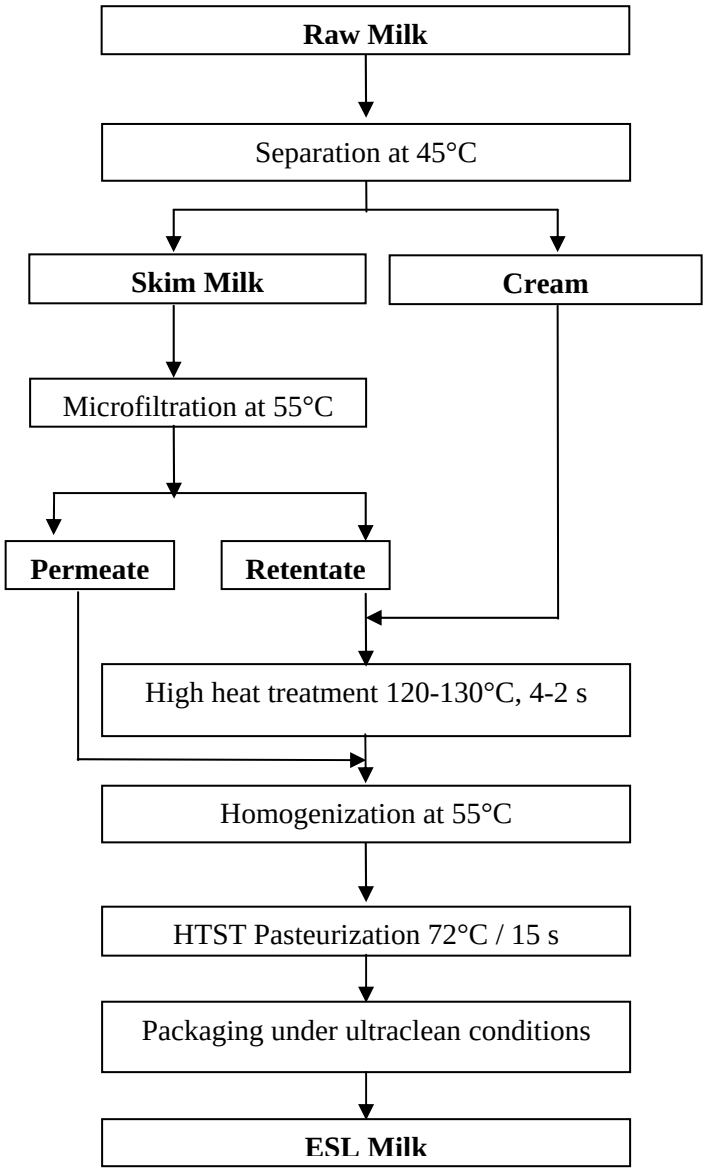
Alternative processes are described below:

**HTST heat treatment with micro-filtration:** It involves a combination of micro-filtration for removal of bacterial cells and spores, and HTST pasteurization. The efficiency of spore removal is higher than that in bactofugation, as it is not dependent on the initial count in milk. The common process is: Milk is separated into skim milk and cream; the skim milk is microfiltered using membranes (1.4 micron pore size or less) at around 50°C; retentate is combined with cream and mixture heated to 120-130°C for 4-2 seconds; microfiltered skim milk permeate and heated mixture (of cream and retentate) are mixed together, homogenized and pasteurized **(see Fig 2)**.

This process is claimed to be suitable when taste and quality of milk is first priority and medium extension of shelf life (10-20 days extra) is desired. This is commonly used in UK, Canada and Argentina. Certain highlights of the micro-filtration process are:

- ESL milk has a shelf life of 45 -60 days at below 7°C.[6, 12]
- Carried out on skim milk after separation of fat. Otherwise, milk fat globules would be trapped in the microfilter membrane.
- Can provide reduction effects up to 99.5-99.99% on bacteria and spores.
- Typically, retentate is about 5% of the feed. It contains about 9-10% of total solids of which some 3.9% is protein (including bacterial protein) and about 0.25% is fat.

**HTST heat treatment with bactofugation**: Bactofugation is a complementary processing to conventional HTST pasteurization of milk. Bactofugation employs centrifugal force for removal of bacteria from milk. Bacteria, especially heat resistant spores, have a significantly higher density than milk and can be efficiently removed by application of centrifugal force. Bactofugation is normally carried out at 55-60ºC **(see Fig 3)**.




**(Medium extension in shelf life)**

**Figure 2: ESL Process – Microfiltration & heat treatment**

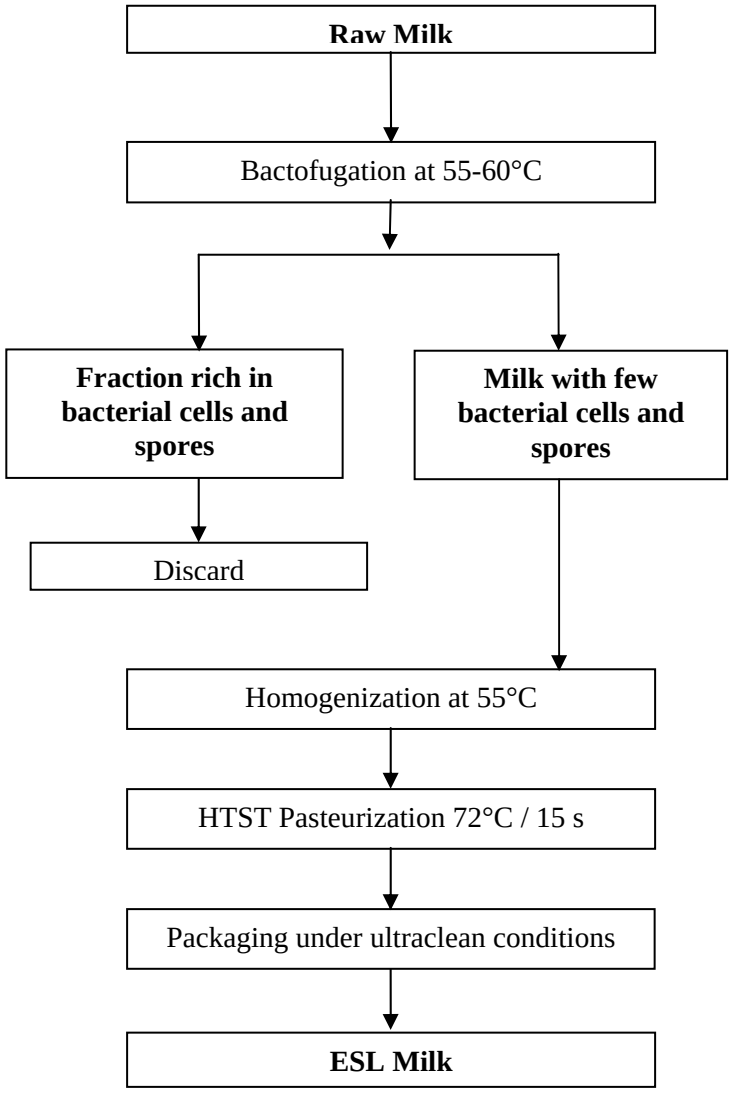



**Figure 3: ESL process –Bactofugation & heat treatment**

This approach provides a shorter extension (2-3 days extra) in shelf-life. This process is also commonly used in UK and Canada. Certain highlights of the process are:

- It is a process in which specially designed hermetic centrifuge - the bactofuge - is used to separate bacteria, and specially the spores formed by specific bacteria strains, from milk.

- It can provide reduction effect of bacteria up to 99% when 2-stage centrifugation (two bactofuges in series) is employed. Thus, single stage bactofugation reduces bacteria by a factor of 10 (1 log reduction or 90% reduction).

- The concentrate (bactofugate) containing spores and bacteria is about 3% of the feed to the bactofuge in 2-stage bactofugation and can be as low as 0.15% in case of single stage bactofugation. This is normally discarded.

- This process is not considered good enough if extended shelf life is required at 7ºC or higher.

Post processing handling and packaging of ESL milk is required to be done in ultra-clean (limit recontamination to minimum level) or aseptic (no recontamination) conditions by placing fillers in clean rooms, pre-sterilization of filler with hot water/steam at 99ºC for 30 minutes, air filtered through High Efficiency Particulate Air (HEPA) filters in packaging room (under positive pressure) and product tank, packaging material disinfection/sterilization, condense free pipes, etc.

**Packaging material disinfection** [2, 3, 6] **:** Empty plastic bottles are sealed on machine, necks are trimmed for filling under sterile environment and caps are disinfected by condensing sterilant on their surface. Cartons are treated by UV rays plus hydrogen peroxide or only by hydrogen peroxide.

**Packaging material** [3, 4, 13-15] **:** The packaging material should have light and gas barrier properties. Bottles used are made of glass, polyethylterepthalate (PET) or high density polyethylene (HDPE).

Polyethylene coated cartons/sachets that have been skived (secured folds and joints on inner sides to prevent contamination from and liquid absorption by bare cardboard edges) are also used for ESL milk.

The success of ESL process is dependent on the hygienic strength of the entire production and distribution chain. One weak link in that chain can jeopardize the gains made in the other parts of the process.

## 3. MICROBIOLOGY OF ESL MILKS [2, 5, 6, 10]

**Raw milk:** The raw milk should have low somatic count, low total microbiological counts, freedom from adulterants and level of contaminants within prescribed limits, as required for producing a safe product of good quality. Milk should be heat stable (when temperatures beyond conventional HTST pasteurization are used) and have good microbiological quality. Low counts of psychrotropic organisms including spore forming species are desired. [5]

Specifically, the raw milk for ESL milk manufacturing should meet following conditions:

- In US, the milk should be cooled to below 7ºC within 2 hrs of milking and should have specific plate count (SPC) less than 100,000 cfu/ml, somatic cell count less than 750,000 cells/ml and freedom from antibiotics and adulterants.

- The spore forming psychrotrophic bacteria count should be low. Milk with high counts of pseudomonas species is not recommended. Psychrotrophic spore formers have considerable spoilage potential in ESL milk due to production of heat resistant enzymes that can cause product spoilage.

- The counts of heat resistant spore formers including *Bacillus circulans* and *Bacillus cereus* should be low.

**Post processing contamination:** Elimination of post pasteurization contamination is essential for production of ESL milk capable of achieving the intended shelf life. Post processing contamination with

Gram - negative psychrotrophic organisms is the main cause of spoilage in ESL milks produced from good quality raw milk. Post process contaminants originate from numerous sources including the atmosphere, piping, packaging material and other food contact surfaces.

**Product storage:** Spoilage occurs mainly due to microbiological changes and associated chemical effects (enzymatic activity, acid development, etc.). [5] The shelf life is influenced by:

- the raw milk quality,
- processing method,
- processing parameters,
- post processing contamination level,
- packaging material,
- temperature conditions during storage and distribution, and
- correct handling by consumer.[2]

Microbial spoilage of ESL milk is most commonly associated with inadequate control of post heat treatment storage temperatures. Psychrotrophic spore forming microorganisms, which pose a potential spoilage and health risk in ESL milk, grow well at 8-10ºC, whereas their activities are suppressed at 2-5ºC. Given the longer shelf life of ESL milks, it is critical that the storage temperature is held well below 7ºC. However, looking to practical conditions that usually prevail in the cold chain, it has been recommended that the ESL process should be designed to achieve the intended shelf-life at storage temperatures of up to 10ºC.

## 4. COMPARISON OF ESL MILK, PASTEURIZED MILK AND UHT ASEPTIC MILK

The differences between ESL milk, pasteurized milk and UHT aseptic milk are presented in Table 2.

**Table 2: Comparison of ESL milk with pasteurized milk and UHT aseptic milk**

| Type of Market Milk | | |
|---|---|---|
| **Pasteurized milk** | **ESL milk** | **UHT aseptic milk** |
| **1. Processing conditions** | | |
| Usually HTST pasteurization (72°C/15 seconds) | Any of the following:<br>* UHT pasteurization. 85-145°C / fraction of a second to 2 seconds;<br>**or**<br>* HTST pasteurization + bactofugation;<br>**or**<br>*HTST pasteurization + ultrafiltration. | UHT sterilization (132-150°C/ usually 8-2 seconds) |
| **2. Hygienic conditions during post process handling and packing** | | |
| Good hygienic conditions | Very good hygienic conditions | Aseptic conditions |
| **3. Product storage conditions** | | |
| Refrigerated | Refrigerated | Ambient temperature |
| **4. Shelf-life** | | |
| Short shelf-life (usually 1 to 3 weeks) | Longer than pasteurized milk, less than UHT aseptic milk (usually 3-9 weeks) | Long shelf-life (usually 3-9 months) |
| **5. Product characteristics** | | |
| Fresh taste | Fresh taste closer to pasteurized milk | Cooked flavour |

## 5. ADVANTAGES AND DISADVANTAGES OF ESL MILKS

The advantages and disadvantages of ESL milk as compared with UHT milk and pasteurized milk are given in the following table:

**Table 3: Advantages and disadvantages of ESL milk**

| Advantages of ESL milk | Disadvantages of ESL milk |
|---|---|
| **1. In comparison to UHT milk** | |
| • Better organoleptic characteristics and, therefore, consumer acceptance [2-6]<br>• Does not develop off-taste due to chemical changes [12] | • Maintenance of cold chain till consumer is compulsorily required for ESL milk [2-6]<br>• Lower shelf life |
| **2. In comparison to conventionally pasteurized milk** | |
| • More flexibility in planning of production (longer production runs and less product wastages due to change-overs) and distribution (covering wide geographic areas and variety of retail outlets) [3,4]<br>• Reduction in spoilage and market returns [3,4]<br>• Useful in packaging of value added milks, e.g. flavoured milk, for which extended shelf life is beneficial [3,4]<br>• It is claimed that there is improved product safety and quality because there is improved hygiene and reduction in risk of recontamination with pathogenic and spoilage bacteria during production. [3,4] | • Any surviving/ contaminating pathogen in the product could severely affect the safety, as there are no competing spoilage bacteria. [16] This could result in ESL milk becoming unsafe without any obvious signs of spoilage<br>• Chances of mold spores, embedded in the paperboard cartons when used, growing in milk over extended storage periods [14]<br>• Higher costs [12] |

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## ***NEWS SECTION***

## *Indian Food laws*

- **Notification GSR 679 (E) of 31 October 2006 of the Ministry of Health and Family Welfare:** The notification amends Rule 47 to allow use of artificial sweeteners acesulfame potassium and sucralose at levels of 800 ppm each in ice lollies / ice candies. This provision has come into effect since 31 October 2006. The notification also amends Rule 49 to restrict the sale of food products, wherein artificial sweetener is permitted under the PFA Rules, except under packed condition. This provision has become applicable from 1 January 2007.

## *Codex Alimentarius Commission (CAC)*

- **Codex Committee on Nutrition and Foods for Special Dietary Uses (CCNFSDU)**: The 28$^{th}$ Session of the CCNFSDU was held during 30 October to 03 November 2006 in Chiang Mai, Thailand. The Committee forwarded the revised Standard for Infant Formula and Formulas for Special Medical Purposes Intended for Infants for final adoption by the Commission. The standard specifies a nitrogen conversion factor (NCF) of 6.25 for calculating protein content in infant formula while recognizing that an NCF of 6.38 was used for other milk products.

- **Codex Committee on Food Hygiene (CCFH):** The 38$^{th}$ Session of the CCFH was held during 04-09 December 2006 in Houston, USA. An important issue under discussion was whether or not to remove

the restriction on use of lactoperoxidase system in milk and milk products intended for international trade. To this end, the FAO/WHO had held a technical meeting to study benefits and potential risks of the lactoperoxidase system of raw milk preservation. The recommendations of this meeting were discussed by the Committee. As the Committee could not reach consensus regarding removal of the above mentioned restriction, it decided to inform the same to the Codex Alimentarius Commission.

The Committee also forwarded the Guidelines on the Application of General Principles of Food Hygiene to the Control of *Listeria monocytogenes* in Foods for final adoption to the Commission.

- The period January – March 2007 features the meeting of the 28th Session of the Codex Committee on Methods of Analysis and Sampling on 05–09 March 2007 at Budapest, Hungary.

## *International Dairy Federation (IDF)*

The IDF has published the following standards recently:

- IDF 7 / ISO 1739: Butter – Determination of the refractive index of the fat (Reference method)
- IDF 52 /ISO 12082: Processed cheese and processed cheese products – Calculation of the content of added citrate emulsifying agents and acidifiers/pH-controlling agents, expressed as citric acid
- IDF 133 / ISO 6736: Milk and milk products - Determination of lead content - Graphite furnace atomic absorption spectrometric method
- IDF 201 / ISO 21543: Milk products – Guidelines for the application of near infrared spectrometry
- IDF/RM 215 / ISO/TS 26844: Milk and milk products – Determination of antimicrobial residues – Tube diffusion test
- IDF 219 / ISO 3889: Milk and milk products – Specification of Mojonnier-type fat extraction flasks

For purchasing the IDF publications, contact Mr. Oscar Chavez, Office Manager, IDF, Brussels, Belgium (Email: OChavez@fil-idf.org).

## Issues of *Technews* during 2006

| Issue | Month | Theme |
|---|---|---|
| 60 | Jan-Feb | Indian Food Regulations Applicable to Milk and Milk Products |
| 61 | Mar-Apr | Pest Management in Dairy Establishments |
| 62 | May-Jun | Good Laboratory Practices for Dairy Plants |
| 63 | Jul-Aug | New Codex Standards Relevant For Dairy Industry |
| 64 | Sep-Oct | The Food Safety and Standards Act 2006 : Salient Features |
| 65 | Nov-Dec | Extended Shelf Life (ESL) Milk |

# EXTENDED SHELF LIFE (ESL) MILK

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