Extended Shelf Life Milk

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Fresh milk with an extended shelf life is referred to as Extended Shelf Life (ESL) milk. An exact, generally accepted definition of the term ESL milk with regard to shelf life does not yet exist. ESL milk fills the gap between high-temperature short-time (HTST) pasteurized milk with a shelf life of about 1 week at cold storage and ultra-high temperature (UHT) milk, which can be stored for a few months without cooling. ESL milk (120-135°C for 1-4 s) is one of the approaches to extend shelf life of processed liquid milk (Britz and Robinson, 2008).

ESL products are the products that have been treated in a manner to reduce the microbial count beyond normal pasteurization, packaged under extreme hygiene conditions, and which have a defined prolonged shelf life under refrigeration conditions.

Several processing alternatives for the production of ESL milk with sensory properties similar to that of pasteurized milk were propagated and established.

ESL is s applied to milk before or after packaging. The aroma and flavor of ESL milk is slightly less preferable by the consumers comparing to the HTST pasteurized milk. Commercial ESL milk has a shelf life varying from 30 to 90 days at 4°C. ESL milk can be prepared using direct and indirect heating of milk.

The combination of microfiltration and pasteurized has proved to be a very efficient way to produce ESL milk (Hoffmann *et al.*, 1996).

Quality of raw milk to produce ESL milk

To produce ESL milk, a low original bacterial count in the raw milk is recommended. A microbial count of 100,000 cfu should not be exceeded (TeGiffel *et al.*, 2005).

Preparation of ESL whole milk using microfiltration

It reduces the bacterial load of milk by mechanical separation without heat-induced chemical alterations. Therefore, the necessary time/ temperature combinations of a subsequent heat treatment to attain a certain shelf life.

This process and its variants comprise microfiltration of separated skim milk resulting in a permeate, which was added with or without subsequent HTST pasteurization to the highly heated (115–130 °C, 4–6 s) mixture of microfiltration retentate and required amount of cream. Finally, the recombined and fat-adjusted milk is filled aseptically. Microfiltration is carried out with a ceramic membrane having an average pore size of 1.4 µm (Hoffmann *et al.*, 1996).

Preparation of ESL whole milk includes homogenization and high heating of a mixture (15.0% fat) of separated cream (31.5% fat) and part of microfiltration permeate. The remaining permeate was HTST pasteurized and added to the highly heated mixture before the final whole milk (3.5% fat) was filled, cooled and stored.

Preparation of ESL whole milk using microfiltration as shown in below Figure 1.

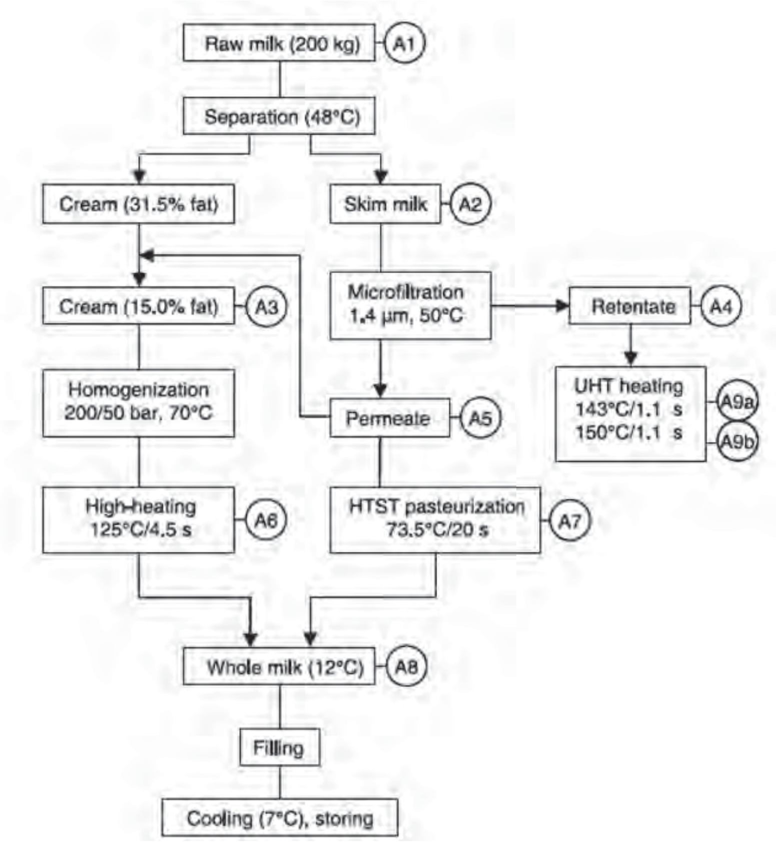

Fig. 1 Prepatation of ESL Whole milk using micrlfiltration

Table 1- Selected results from products during the processing of ESL milk

Product	Casein/ Protein ratio	α- lactalbumin (mg/100 ml)	Immunoglobulin G (mg/100 ml)	Adenosine deaminase (U/L 37°C)	Total bact. count (cfu/ml)	Thermodurics (cfu/ml)
Raw milk (A1)	0.794	111.4	59.9	0.27	3600	49
Skim milk (A2)	0.792	109.3	61.8	0.32	9500	160
Adjusted cream (A3)		109.7	57.5	0.61	1500	118
Retentate (A4)	0.807	106.1	54.4	0.83	58000	2550
Permeate (A5)	0.791	109.5	59.5	0.56	59	51
Adjusted cream HH (A6)		73.2	0	< 0.013	0	0
Permeate HTST (A7)		109.7	45.4	0.71	40	44
ESL Whole milk (A8)	0.795	108.8	35	0.52	24	28
RententateUHT(A9a)		63.1	0	< 0.013	0	0
RententateUHT(A9b)		64.4	0	< 0.013	0	0

(Hoffmann *et al.*, 2006)

The analysis of lactulose was restricted to the heated cream and the final ESL milk.55 mg/kg lactulose in cream (A6) were distinctly above the limit of detection (10–30 mg/kg), whereas the 18 mg/kg in the ESL milk (A8) were within this limit. Only if the heat treatment of cream induced lactulose formation clearly above 140 mg/kg would the final whole milk contain more than the detection limit (30 mg/kg).

β-Lactoglobulin was not affected by HTST pasteurization either, (results of A5 and A7), but denatured to about 90% by high heating or UHT heating (A6, A9a, A9b). Therefore, the final whole milk of trial A (A8) contained about 20% less acid-soluble β-lactoglobulin.

The determination of furosine should both estimate the degree of the thermal load of the different products and reflect the effect of microfil trationon the Maillard reaction. The raw milk used contained 5.3 (A1) which was in the normal range of 5–7 mg/100 g protein. The high furosine content in highly heated cream (about 28 mg/100 g protein, A6) and the slight increase in permeate after pasteurization (A7) resulted in an ESL milk that exceeded the discussed limit for peroxidase-positive pasteurized milk of8.5 mg/100 g clearly (about 12 mg/100 g protein,A8). UHT heating of retentate A4 raised furosine to more than 80 mg/100 g (A9a, A9b).

Advantages of ESL milk

High quality

- The reduction in process time due to higher temperature (UHTST) and the minimal come-up and cool-down time leads to a higher quality product.

Shelf life

- 30 days to 90 days at 4^0c.

Packaging size

- Processing conditions are independent of container size, thus allowing for the filling of large containers for food-service or sale to food manufacturers

Cheaper packaging

- Both cost of package and storage andtransportation costs
- Lactulose and furosine content is low compared to UHT milk and less denaturation of α-lactalbumin and β-lactoglobulin in ESL compared to UHT milk
- Less costly capital installations than for UHT.
- Longer production runs than with fresh milk because of capacity for longer storage.

Table 2 - Comparison of different heat treatment to milk

	HTST pasteurization	ESL	UHT
Reference enzyme	Phosphatase (-)	Phosphatase (-)	Phosphatase (-)
	Lactoperoxidase (+)	Lactoperoxidase (-)	Lactoperoxidase (-)
Storage conditions	Refrigerated	Refrigerated	Room temperature
Packaging	Clean	Aseptic	Aseptic
Shelf-life	10-14 d	30-60 d	>6 months
Flavour	Little cooked flavour	Mild cooked flavour	Definite cooked flavour
Lactulose(mg/l)	Trace	20 - ≤ 40	80-500
Furosine(mg/g protein)	Trace	200	400-1200
α-lactalbumin denaturation(%) [a]	~5	~5	30-80
β-lactoglobulin denaturation (%) [b]	~13	~22	60-100
Immnoglobulindenaturation (%)	~67	~100	100

(Ozer and Akdemir-Evrendilek, 2014)

[a]Assuming concentration in raw milk: 1200 mg/l

[b]Assuming concentration in raw milk: 3000 mg/l

- Longer production runs for niche milk products.
- A variety of options for packaging besides cartons.
- Simplified product distribution, and greater distribution efficiencies, compared to fresh milk.

There are also major advantages for the consumer:

- Better taste than UHT milk. UHT milk, being sterilised at a higher temperature, often has a burnt or caramelised taste.
- Less frequent shopping trips (Ozer and Akdemir-Evrendilek, 2014).

Application

ESL milk is used in preparation of flavored milk, fermented products,"'cream, dairy desserts, soy drinks, and iced tea and coffee (TeGiffel *et al.*, 2005).

Conclusion

The combination of microfiltration and pasteurized has proved to be a very efficient way to produce ESL milk. Microfiltration in addition to pasteurization is most commonly used in present scenario as it gives good result in production of ESL milk. With increasing of consumer awareness, more and more aseptic packaging come across to present good quality product in market. Novel concept of ESL milk provides more the shelf life extension at refrigerated temperature. Microfiltration provides minimum nutritional loss (α-lactalbumin, β-lactoglobulin and Immunoglobulin) of products.

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