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ESL milk production

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Although abbreviations are popular in modern society, they can often awaken a sense of mistrust among consumers, because ultimately they are relatively meaningless. ESL milk is no exception in this respect. The product has been available in stores for several years and is driving the previously familiar fresh milk off the shelves. ESL stands for the English term *extended shelf life* that has been adopted in the German market. The sense of mistrust is further fuelled by the absence of any legal definition of the milk's production method. This document aims to explain how ESL milk is produced and how it differs from traditionally produced fresh milk and from ultra heat treated milk (UHT).

Freshly drawn milk is, in essence, a highly perishable foodstuff. This is partly down to its natural composition and partly down to the fact that it always contains micro-organisms, which can potentially include organisms that cause the milk to spoil or even lead to illness in the consumer. To prevent the process of deterioration, the majority of the micro-organisms must be eliminated, which is traditionally achieved through thermal processing, i.e. heat treatment. The effect this process has on the milk depends on the relationship between temperature and time, i.e. what temperature is applied and how long the milk is exposed to it.

ESL milk

ESL (extended shelf life) milk is labelled as 'longer-lasting', but just like regular fresh milk, it must be stored in the chiller or in the fridge. As its name suggests, the 'longer-lasting' milk does not spoil as quickly as fresh milk. Whereas traditional fresh milk can be stored unopened in the fridge for six to twelve days, an unopened bottle or carton of ESL milk stored in the fridge (maximum 8 °C) will keep for 21 to 30 days. UHT milk, by contrast, can be stored at room temperature for up to 12 weeks. In terms of shelf life, ESL milk is therefore positioned between traditional fresh milk and UHT milk.

ESL milk can be produced in various ways, though there are no statutory regulations governing its production. The following methods are currently used to manufacture ESL milk:

1. Indirect heating using tubes or plates
2. Direct heating through steam injection/steam infusion
3. Membrane process (microfiltration)
4. Depth filtration
5. Bacteria removal separators

The type of milk produced varies depending on the combination of temperature and time used, and until now these varieties were covered by the categories shown in the table. Cartons of fresh or pasteurised milk must be kept refrigerated both before and after opening. UHT milk, by contrast, can be stored at room temperature in its unopened state. As soon as the packaging is opened, however, this must be kept refrigerated.

Nevertheless, heating the milk not only kills off the micro-organisms (germs), it also brings about chemical changes, such as vitamin degradation, or sensory changes like taking on a cooked taste. As with the sterilisation of the micro-organisms, the effect of these changes varies according to the combination of temperature and time. It is therefore little wonder that experts are still researching how we can extend the shelf life of milk further without enduring the unwanted side effects.

The development of ESL milk is a result of this continued research. It benefits manufacturers, retailers and consumers equally: stored at a maximum temperature of 8 °C it will keep for between 21 and 30 days, depending on the processing conditions, with virtually no change to taste or smell when compared to fresh milk. Nevertheless, just like pasteurised milk, ESL milk must be kept refrigerated both before and after opening.

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Standard heat treatment and shelf life of the different milk varieties

Milk variety	Treatment temperature	Time	Usual shelf life
Raw milk	Not heat-treated, must be boiled before consumption		Under controlled refrigeration: 1-3 days
Fresh milk or pasteurised milk	72-75 °C	15-30 seconds	Refrigerated at max.< 8 °C: 6-12 days
UHT milk (ultra heat treated)	135-150 °C	1-4 seconds	Stored unopened at room temperature: up to 12 weeks
Sterilised milk	110-120 °C	10-30 minutes	Stored unopened at room temperature: 6-12 months
	Depending on size of bottle/carton (heat treated in packaging)		

The method a manufacturer adopts to maintain the sensory quality of its milk is more a matter of cost than the quality of the end product.

It is important to note that, irrespective of the method used to produce ESL milk, the manufacture of this dairy product is only possible if it is seen as an integrated, contiguous process, and as a value chain spanning from the dairy farmer to the consumer, via the dairy and the retailer. As such, the process must be organised and implemented in a systematic fashion. For instance, the hygiene and quality of the raw material starts in the cow stall, a seamless refrigeration chain must be maintained from the milking stage onwards, and the packaging and the standard of processing equipment (standard, clean, ultra clean, aseptic) must be fine-tuned to achieve the target product quality, i.e. the target shelf life.

Indirect heating equipment

ESL milk production

Indirect heating

The base product for ESL milk manufactured using indirect heating is heat-treated standardised milk. Indirect heating can be carried out using machines fitted with tubes or plates. In this method the milk flows through hot metal tubes or plates, whereby it is gradually heated and at the final stage the temperature is held at 127 °C for one to three seconds. In the final stage of processing the milk is cooled down gradually to its storage temperature of 5 °C.

Direct heating

The direct heating process also takes a standardised and heat-treated milk as its starting point. This is then normally heated in two stages to between 70 and 85 °C before being heated by direct contact with steam to a maximum of 127 °C. After around three seconds at this temperature, the milk is cooled down to between 70 and 85 °C under specific vacuum conditions inside what is known as a flash cooler, whereby the drop in temperature removes the steam that had been taken on. After a further cooling to 70 °C, the milk is then aseptically homogenised and is finally cooled down to 5 °C in stages.

Microfiltration

A combination method has been developed to further reduce the thermal stress placed on milk during the preservation process. This method firstly purifies the milk using a separator that splits it into skimmed milk and cream. The skimmed milk undergoes thorough sterilisation using microfiltration. This involves a technique called cross-flow filtration that uses ceramic membranes with a pore size of 0.8 to 1.4 µm. Most bacteria are between 0.6 and 1.0 µm in size and so can be held back by microfiltration. This method removes more than 99.5 per cent of the germs from the milk, which then collect in the microfiltration retentate. This retentate and the cream are then heated to an ultra-high temperature of between 90 and 110 °C for four to six seconds and are finally homogenised. Once the cream, skimmed milk and retentate have been combined to give milk of the desired fat content (skimmed, semi-skimmed, whole), the standardised milk is pasteurised and cooled down to its storage temperature.

Microfiltration equipment

Depth filtration

As with microfiltration, the depth filtration technique (carried over from the drinks industry) sees the milk firstly split into cream and skimmed milk by a separator. The cream that is needed to correct the fat content at a later stage is ultra heat treated and homogenised.

The skimmed milk is passed through a pre-filter unit and a final filter unit, both of which consist of several polypropylene filter candles. The particles do not collect on the surface of these filter candles, but rather in the pores of the filter material itself. These pores measure 0.3 µm in the pre-filters and 0.2 µm in the final filters. The pre-filters capture around 80 per cent of the micro-organisms, as well as other solids found in milk. The two filters combined can capture over 99 per cent of the germs in the milk. After filtration, the milk is combined with the cream required to achieve the desired fat content and is then heated to 74 °C for 15 to 30 seconds. Lastly, the milk is cooled down to storage temperature.

Bacteria removal separation

The newest method for producing fresh milk with a longer shelf life is essentially an enhancement of the traditional process of pasteurising milk, with the integration of two bacteria removal separators connected in series before the skimming separator. This ensures that solids, bacteria and spores are removed from the entire raw milk flow mechanically and effectively. The spores that shorten milk's shelf life have a higher specific density than skimmed milk and cream. Consequently, they can reliably be separated from the raw milk using centrifugal force, i.e. with the two bacteria removal separators. The spores that are separated this way are then removed from the separator drums at regular intervals, and so do not remain in the milk. The fresh, pasteurised drinking milk produced using this method can have a shelf life of 20 days or more.

Nutrient content and taste

Any intake of energy (heat) by a foodstuff causes changes to that foodstuff, depending largely on the level and duration of the energy intake, and the water content of the foodstuff. These changes can include vitamin loss and changes to sensory properties such as smell and taste. For this reason traditional pasteurisation of fresh milk causes up to 5 per cent of heat-sensitive B vitamins and vitamin C to be lost. For UHT milk, this figure is up to 20 per cent.

This raises questions as to whether and to what extent nutrients and taste are affected by the methods of ESL milk production. This has been the subject of studies by various institutes, most of which yielded the same results.

One of these studies was carried out by the Max Rubner Institute (MRI, formerly the Federal Research Institute for Nutrition) in Kiel/Germany. It investigated the quality and sensory properties of ESL milk compared with pasteurised milk produced using traditional methods. To summarise the results without going into great detail, the study concluded that there was very little difference between the quality of the ESL milk and that of the traditional pasteurised milk.

Though the different studies revealed slightly higher vitamin losses in ESL milk, owing to the higher temperatures involved in its manufacture, experts agree that these differences are negligible. However, in the case of ESL milk the loss of oxidation-sensitive vitamins increases during storage, though this is less to do with the production process and more to do with the length of storage, the storage temperature, the residual oxygen content in the product and the packaging conditions (air gap, translucency).

As expected, the components, such as milk fat, lactose or minerals (including calcium), did not vary according to the preservation method used.

Given that the production of ESL milk involves the application of higher temperatures than those used to pasteurise milk, there are, as anticipated, minor changes to the molecular structure of the milk protein. However, this denaturation does not represent any loss in nutritional value – in fact, it makes the milk slightly more digestible.

As for the sensory properties, studies by the MRI and other researchers concluded that traditionally pasteurised milk tends to fare slightly better. The differences are so small, however, that the production method of each milk could not reliably be identified through taste. It must also be borne in mind that the newer production methods for ESL milk have not yet been examined in these studies.

To conclude, it is therefore beyond dispute that ESL milk is as nutritious as the traditional pasteurised milk. Furthermore, ESL milk constitutes a product that – in terms of sensory properties – is more than merely a foodstuff. It is a pleasure to drink. The fact that its shelf life is significantly longer than traditional pasteurised fresh milk is an interesting and welcome bonus for manufacturers, consumers and the food

From left to right: the homogenizer by GEA Niro Soavi and the GEA Westfalia Separator Group respectively a Standomat MC, a skimming separator type MSI 140 and two bacteria removal separators type CSI 140 for extending shelf life.

retail sector, and could even help to reduce the shameful destruction of food that is a particular talking point at present.

Labelling ESL milk

When it comes to labelling ESL milk, there are no statutory regulations in place as yet. The regulation for labelling drinking milk only permits the labels 'pasteurised' (fresh milk) or 'ultra heat treated' (UHT milk) to indicate the preservation method used. Because of its properties and the production methods used, ESL milk often carries descriptions such as 'fresh for longer', 'extra fresh' or 'maximum freshness' on its packaging, which has led to criticism from consumer rights groups. That's why in Germany, the dairy industry and the retail sector entered into a voluntary obligation with the Ministry of Food and Agriculture in 2009 to mark traditionally pasteurised drinking milk with the extra label 'traditionally manufactured' and to mark ESL milk with the label 'longer-lasting' in a clearly visible position on the milk carton or bottle.

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