CREAM

According to the UK Food Labelling Regulations 1996, cream is defined as that part of cows' milk rich in fat that has been separated by skimming or otherwise and which is intended for sale for human consumption.

Cream is often perceived as a luxury item, and therefore purchasing patterns are different from those that apply to milk. For this reason, the required shelf life is longer than for milk, and therefore heat processes are usually greater for cream than for milk. There are a number of different types of cream, usually classified according to their fat content.

All creams are subjected to heat treatment such as pasteurisation or sterilisation. Based on the heat treatment that cream has been subjected to, they are classed as:

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• Untreated cream that has not been treated by heat or in any manner likely to affect its nature and qualities, and has been derived from milk which has not been so treated.

• Pasteurised cream that has been either (a) heated to a temperature not less than 63 C for 30 minutes, or (b) heated to a temperature not less than 72 C for 15 seconds, or (c) subjected to equivalent temperature and time, other than those already mentioned, so as to eliminate vegetative pathogenic organisms.

• Sterilised creams have been subjected to sterilisation (>108 C for 45 minutes or the equivalent) by heat treatment in the container. It is supplied to consumers in the same container as that containing the cream during sterilisation.

• Ultra High Temperature (UHT) creams are subjected by continuous flow to an appropriate heat treatment (>140 C for 2 seconds or the equivalent) and are aseptically packaged.

Initial Microflora:

The initial microflora are essentially those of the raw milk (influenced by microflora on the cow's udder, milk-handling equipment, and storage conditions) from which the cream is made.

Processing and its Effect on the Microflora

Storage and transport of raw milk

Generally, the same comments apply to raw milk for cream production as for fresh

milk products, and the milk should be of equivalent microbiological quality. It is important to ensure the milk is produced hygienically, as the heat that cream is subjected to kills vegetative cells but not spores. However, the high fat content of cream means that it is more susceptible to spoilage by extracellular lipases produced by psychrotrophic Pseudomonas spp. and other organisms in raw milk.

These enzymes can survive heat treatment, and therefore it is preferable to minimise the refrigerated storage time of raw milk for fresh cream production, and process as soon as possible after collection.

Spoilage

The spoilage of cream is generally similar to that described for liquid milk products. However, because of the difference in purchasing patterns, cream is often required to have a longer shelf life than milk (up to 14 days for pasteurized cream), and containers may be opened and then used by the consumer over several days. The keys to obtaining sufficient shelf life are the microbiological quality of the raw milk, good hygiene in processing, and effective temperature control during distribution and storage.

Cream usually receives more severe heat processes than milk, and the post-heat treatment microbial population therefore consists almost entirely of relatively heat-resistant species. Aerobic spore-forming bacteria survive pasteurisation, and psychrotrophic strains of Bacillus cereus may cause 'sweet curdling' and ‘bittycream’. Other, more heat-resistant species, such as *Bacillus licheniformis*, *Bacillus coagulans*, and *Bacillus subtilis*, may survive sterilisation and even UHT processes, and may cause bitterness and thinning in sterilised creams. *Bacillus pumilus* and *Bacillus sporothermophilus* are now recognised as potentialcontaminants in cream, primarily carried over from raw milk. Under UHT conditions, B. sporothermophilus has D-values of 3.4 - 7.9 sec and z-values of Heat-resistant lipases produced by psychrotrophic bacteria growing in the raw milk may also survive high-temperature processing and cause spoilage in UHT cream.

The keeping quality of cream is greatly affected by the introduction of post process contamination. Psychrotrophic bacteria such as *pseudomonads* may contaminate pasteurised cream during processing and are important spoilage organisms. The high fat content of cream means that lipolytic species, such as *Pseudomonas fluorescens* and *Pseudomonas fragi*, are a particular problem. A study of pasteurised double cream showed that *pseudomonads* were the predominant spoilage organisms (3). Psychrotrophic members of the Enterobacteriaceae are also sometimes involved. Yeasts and moulds are rarely implicated in the spoilage of cream. Few yeasts are able to ferment lactose, but species such as *Candida lipolyticum* and *Geotrichum candidum* may occasionally spoil bakers' whipping cream where sucrose has been added (4). If, however, other organisms hydrolyse lactose, then the yeast can grow rapidly to produce yeasty or fruity flavours and gas; *Torula cremoris*, *Candida pseudotropicalis* and *Torulopsis sphaerica* have been implicated with such defects where cream is stored at very low temperatures (0 - 1 C) to prolong the shelf life, mould growth, usually *Penicillium spp.* May develop on the cream surface .

Defective cans or leaking seams could cause spoilage of cream due to entry of bacteria from cooling water or other sources, e.g. a waterborne organism, for example Proteus, can cause bitterness and thinning, coliforms can produce gas, and *lactococci* could result in acid curdling.

In the case of cream-based desserts, thermoduric organisms are most likely to be an issue due the more aggressive heat treatments that are used. In addition, the added sugar increases the range of contaminants that could grow in the product.

Fruit conserves, if added, will lower the pH of the product thus favouring the growth of yeasts and moulds. With multi-component desserts, both individual components, and blends obtained from their mixing could be responsible for microbial spoilage.

Pathogens: Growth and Survival

In practice, to overcome the protective effect of the higher fat content, cream usually receives a more severe heat treatment than milk. This means that pathogens present in the raw cream are more likely to be destroyed. Un pasteurised cream carries a high risk from the presence of foodborne pathogens, as does raw milk, but the recent safety record of pasteurised cream is good. Although food poisoning outbreaks have been associated with cream, they are often linked to products filled with, or prepared with cream. In these cases, it is probable that poor hygiene during manufacture, and temperature abuse during storage have been important contributory factors.

Salmonella spp.

Salmonellae will not survive the heat treatment applied to cream, and therefore their presence is likely to be due to post-pasteurisation contamination. The cells are likely to survive for extended periods in contaminated cream, but growth is not possible unless significant temperature abuse occurs. Storage at temperatures below 5 C will prevent multiplication.

More recently, in 1998, an outbreak of S. typhimurium DT104 infection affected 86 people in Lancashire. The outbreak was linked to inadequately pasteurised milk from a local dairy, but cream from the same dairy was also recalled.

Listeria monocytogenes

There has been some concern that *L. monocytogenes* might be able to survive cream pasteurisation processes and then grow during chilled storage. However, *L. monocytogenes* strain Scott A recorded a D-value of 6 seconds at 68.9 C in raw cream with a fat content of 38%, indicating that pasteurisation is likely to be effective. The D-value increases to 7.8 sec in inoculated 'sterile' cream. Z-values were calculated as 6.8 C and 7.1 C, respectively. A later study, using two strains of *L. monocytogenes* suspended in different dairy products, including half and double cream, showed that, although heat resistance did vary, minimum pasteurisation processes would be adequate to eliminate the organism in all products. An investigation into the fate of several strains of *L. monocytogenes* in whipping cream at various storage temperatures recorded generation times of 29 - 46 hours at 4 C. Populations of approximately 10^7 cells/ml were reached after incubation for 30 days, and, at 8 C, hazardous levels were reached in only 8 days (This indicates that post-pasteurisation contamination of cream could be a potentially serious problem. The same post-process hygiene precautions should be applied for cream as for other high-risk chilled products.

Yersinia spp.

Yersinia enterocolitica is a common contaminant of raw milk, although the majority of the strains isolated are not pathogenic to humans. The organism is heat-sensitive and does not survive pasteurisation, but is capable of psychrotrophic growth. Therefore, it is a potential hazard in cream if introduced as a post-pasteurisation contaminant.

Staphylococcus aureus

Although *Staph. aureus* can often be isolated from raw milk, and is a common cause of mastitis in cows, it does not survive pasteurisation, and cases of staphylococcal food poisoning from pasteurised dairy products are now uncommon. It may be introduced into cream as a post-process contaminant, particularly from infected food handlers. However, it is incapable of growth below about 7 C, and high numbers will only develop following significant temperature abuse. An investigation of growth and enterotoxin A production by Staph. Aureus in whey cream showed that growth was limited and that enterotoxin was not produced at detectable levels.

Bacillus cereus

B. cereus is common in milk, and its endospores are able to survive pasteurisation. Some strains are also psychrotrophic, and capable of growth in refrigerated dairy products. Nevertheless, there are very few reports of *B. cereus* food poisoning associated with dairy products. There have been a small number of outbreaks associated with the consumption of pasteurised cream.

Verotoxigenic *Escherichia coli* (VTEC)

VTEC, particularly *Escherichia coli* O157, have been found in raw milk and have caused serious outbreaks of infection associated with consumption of raw or inadequately pasteurised dairy products. An outbreak of *E. coli* O157 infection was recorded in the UK in 1998, associated with consumption of raw cream from a small farm dairy. Seven cases were recorded, with four requiring admission to hospital. These organisms are destroyed by properly applied pasteurisation, but if any opportunities for cross-contamination between raw and pasteurized cream exist, recontamination could potentially occur. It is likely that *E. coli* O157 could survive for prolonged periods in cream, but growth in the absence of temperature abuse is improbable. In view of the potentially serious nature of infections caused by VTEC, and the low infective dose, it is important to ensure that such cross-contamination does not occur, since growth may not be required to cause infection.

BUTTER

Butter is a water-in-oil emulsion typically consisting of at least 80% fat, 15 - 17% water, and 0.5 - 1% carbohydrate and protein. The two principal types of butter produced are sweet cream butter and ripened cream butter. The UK, Ireland, US, Australia and New Zealand prefer sweet cream butter (pH 6.4 - 6.5), which often contains 1.5 - 2.0% salt. In Europe, cultured (ripened cream), unsalted butter is favoured, in which lactic starter cultures are added to convert the lactose to lactic acid and produce flavour compounds, such as acetoin and diacetyl, from citrate. In many countries, salt and lactic cultures are the only permitted non-dairy additions to butter, although, in the UK and other countries, natural colouring agents, such as annatto, β-carotene and turmeric may be added. Reduced-fat dairy spreads have a milk fat content of about 50 - 60%. Low-fat dairy spreads contain 39 – 41% fat, and very low-fat spreads have <30% fat. These have a much higher water content than butter or reduced-fat spreads. Where the fat content is below about 20%, these products tend to form a continuous water phase and become oil-in-water emulsions. The high water content results in a much lower level of microbiological stability, and the addition of preservatives, such as potassium sorbate or benzoate, may be permitted. The addition of thickeners, such as gelatin and carbohydrates, may be necessary to maintain the physical stability of the product.

Initial Microflora

Butter is produced from cream, and the cream is the main source of microorganisms in hygienically produced butter. There is little difference between the microflora of whole milk and that of cream, and therefore any organisms likely to be present in raw milk are also likely to be present in cream, including *Clostridium spp. and Bacillus spp.*

Spoilage Butter

Bacterial spoilage

Modern hygienic manufacturing methods mean that bacterial spoilage of butter is much less common than in the past. However, defects caused by microorganisms do occasionally occur. Surface taints may develop as a result of growth of *Shewanella putrefaciens* (formerly *Alteromonas putrefaciens*), and *Pseudomonas putrefaciens* or *Flavobacterium spp*. Such spoilage may be apparent within 7 to 10 days of chilled storage. The surface layers are initially affected, but eventually spoilage is apparent throughout the product. A putrid or cheesy flavour develops due to the breakdown of protein (5). Rancidity, proteolytic activity and fruity odours may be caused by the growth of *Pseudomonas fragi* and, occasionally, *Pseudomonas fluorescens*. Black discoloration of butter is reported to be caused by *Pseudomonas nigrificans* *Pseudomonas mephitica* is responsible for a skunk-like odour, and an organism formerly known as *Lactococcus lactis var. maltigenes* may be responsible for a 'malty' flavour defect linked to the formation of 3-methylbutanal. Lipolytic spoilage of butter has been associated with the presence of Micrococcus.

Fungal spoilage

Moulds are still important spoilage organisms for butter, and mould growth may produce surface discolorations and taints. A number of genera have been associated with spoiled butter, including *Penicillium*, *Aspergillus, Cladosporium, Mucor, Geotrichum, Alternaria,* and *Rhizopus*. Yeasts may also cause spoilage of butter. Lipolytic species such as *Rhodotorula* may grow on the surface at chill temperatures and may tolerate high salt concentrations. Other yeasts associated with spoilage include *Candida lipolytica, Torulopsis,* and *Cryptococcus* .

Pathogens: Growth and Survival in Butter

Commercially produced butter is made from pasteurised cream, and that fact, plus its physicochemical characteristics, make it quite inhibitory to bacterial pathogens. It is therefore not surprising that there have been few recorded outbreaks of foodborne disease associated with commercial butter.

Staphylococcus aureus

Outbreaks of staphylococcal food poisoning have been associated with butter. In one case, an outbreak involving 24 customers, recorded in the USA in 1970, was linked to whipped butter and to the butter from which the whipped butter was made. The presence of staphylococcal enterotoxin A was demonstrated in both butters. It appeared that the enterotoxin had formed in the cream used to make the butter and was carried over into the finished product.

Listeria monocytogenes

L. monocytogenes has been shown to grow slowly in butter made from contaminated cream at 4 or 13 C, and to survive for several months in frozen butter without any appreciable decrease in numbers. Listeria will not survive cream pasteurisation, but it is a very common environmental contaminant in dairy settings, and effective cleaning and hygiene procedures are necessary to prevent recontamination. Surveys of the incidence of Listeria in dairy products have not isolated it from butter.

Campylobacter

In 1995, an outbreak of Campylobacter jejuni enteritis in the USA, which affected 30 people who had eaten in a local restaurant, was associated with garlic butter prepared on site. The survival of Campylobacter in butter, with and without garlic, was later investigated, and it was found that *C. jejuni* could survive in butter without garlic for 13 days at 5 C.

Toxins

The stability of aflatoxin M1 through butter production and storage has been investigated. Most of the toxin naturally present in the cream was removed with the buttermilk, with very little remaining in the butter. Chilled and frozen storage of the butter had little effect on the toxin.