Fresh Products – Yoghurt, Fermented Milks, Quarg and Fresh Cheese*

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Introduction

Fresh fermented dairy products in general are the oldest milk products. In the early days they were home-made and served as basic food. The introduction of industrial food processing allowed great diversification and a large variety of products is now available to the consumer. The combination of milk, sweet or fermented, with other foods, primarily with fruits and herbs, as well as the development of processes which led to prolongation of the shelf life for up to several months, contributed to the popularity, i.e. to the increase of consumption of these products.

According to the latest survey of IDF (1) on the consumption of dairy products in the world, fermented milks are very popular and, with increasing health consciousness of consumers worldwide, new fermented milks are being developed.

Fermented Products

When considering the progress in the development of this group of dairy products, the most important step was the introduction of selected cultures in the production, leading to a more controlled quality of the final product. The great success and popularity, however, meaning also the possibility to make fermented milks available in almost every food store, has to be attributed to the progress of hygienic standards during production, of packaging material and filling machines, as well as the improvement of cooling chain during distribution. The latest progress in the science and technology of fermented milks has been reviewed in two very recent IDF monographs (3, 4). Driessen (4) presented a very comprehensive chart summarizing new developments in technology including products with special microorganisms (Fig. 1).

The technology of yoghurt is well established and comprehensively covered in the above mentioned IDF-Bulletins (3,4). In the future it is important to gain more knowledge about the yoghurt microorganisms role e.g. the contribution of microbial B – galactosidase for utilisation of lactose by humans. The new General Standard of Identity for Fermented Milks (5) explicitly states that these products have to contain alive lactic acid bacteria of specific types. This requirement has to be justified by reliable scientifique evidence for the claimed advantage.

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Table 1: Annual consumption of yoghurt, fermented milks and fresh cheese for 1992 in kg per caput (1,2)

Tablica 1.: Godišnja potrošnja jogurta, fermentiranog mlijeka i svježeg sira 1992. u kg/caput (1,2)

Country Zemlja	Fermented milks Fermentirano mlijeko			Compared Uspoređeno s to 1990[1]	Fresh cheese Svježi sir (Quarg, Cotta-) ge and Fresh) Quarg. »Cotta- ge« i svježi	Compared uspoređeno s to 1990
	Yoghurt Jogurt		Others Drugo			
Austria	8.7		2.6	↑	4.0	↓
Australia	4.4			↑	0.7	→
Belgium	5.7		3.3	↑	3.8	↓
Canada	3.4			↑	1.0	↑
Czech. + Slovak. Rep.	3.4		5.1		3.6	↓
Germany	11.4		0.7	↑	8.0	↓
Denmark	8.7		7.2	↑	1.0	↓
Spain		8.2		↑	2)	
Finnland	12.0		22.9	↓	2.4	→
France		17.2		↑	7.4	→
United Kingdom	4.7		0.2	↑	2)	
Hungary	1.6		1.4	↑	3.7	↑
Ireland		3.7		↑	2)	
Israel	10.7		10.4		12.4	
Iceland	9.2		16.1	↓	5.8	↑
Italy		5.0		↑	5.7	↑
Japan	4.3		3.8	↓	2)	
Lithuania			8.4		4.0	
Netherlands	21.7			→	1.8	→
Norway	6.5		10.1	↑	0.2	→
Sweden	7.1		21.4	→	0.8	→
Switzerland	16.9			→	2.8	→
South Africa	1.8		1.8		0.1	
USA	2.0		0.2	↓	1.4	→

1) The arrows indicate only tendencies

2) Data available only for total cheese consumption

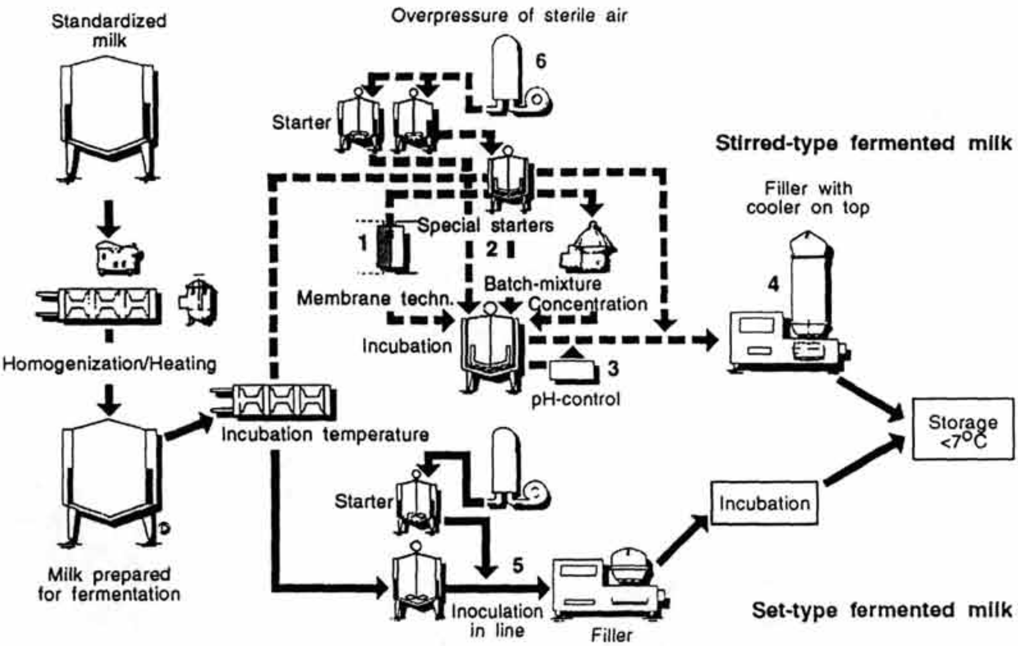

Figure 1: Summary of the fermentation process developments (4)
Slika 1.: Sažetak razvoja postupka fermentacije (4)

1 Membrane techniques provide the possibility of utilizing the required properties and of avoiding the unwanted properties of microbial metabolites
2 Separate cultivation provides the possibility of combining microorganisms needing different conditions for their proliferation, for example mesophilic and thermophilic strains
3 By applying automatic pH control system to end the fermentation proces, a more consistent product can be obtained
4 By mounting the cooler on top of the filler, higher viscosity can be achieved in stirred fermented milks
5 The manufacture of set fermented milks becomes more flexible by applying in-line inoculation
6 An overpressure of sterile air has been proved to be very effective in protecting starters against contamination with other microorganisms and bacteriophages

Fermented milks with probiotic microorganisms

One of the most important aspects in future development of fermented dairy products will be the incorporation of probiotic microorganisms in the culture for fermentation or their addition to already fermented milk. Today, only few microorganisms are used for manufacutre of fermented dairy products with probiotic microorganisms, all belonging to the genera *Lactobacillus* and *Bifidobacterium*. The main claims for having these microorganisms »alive and abundant« in the final products are associated with »health and well being«. It is beyond the scope of this paper to discuss the health aspects of this subject in detail. However, we shall rather be more concerned with how to achieve technologically that they are present in high counts in the product until the end of its shelf-life. The most recent comprehensive review about fermented milks with bifidobacteria was published by Tamime et al. (6).

Starters for the manufacture of fermented milk contain a mixture of various microorganisms. Changes in the composition of the starter will lead to changes in the characteristicts of the product. For making special fermented milk products, different combinations or types of starter cultures are needed. The starters which are commonly used in Western Europe originate from milk and traditional dairy products and consist of a mixture of microorganisms. These cultures have a mutual relationship and are depending on each other, possess advantageous characteristics for the manufacture of fermented milk products and are inhibitory to pathogenic microorganisms. In general, starters form a tight ecological community, in which each species or even strain possesses a specific and essential function. Microorganisms, which do not belong to such an ecosystem, are supressed (7). On the other hand, such an ecological system can be disturbed by incorporation of bacteria with special characteristics, which contribute to a better performance in manufacturing of traditional products, e.g. the use of bacteria originating from the intestinal flora of humans for nutritional purposes. The benefits of these new developments can not be applied unless the ecology and physiology of the microbial strains of the starter are sufficiently understood.

It is a coincidence that bacteria chosen for their beneficial aspects also grow well in milk. Several possibilities exist for manufacturing special fermented milks with probiotic microorganisms, as desribed by Driessen and Loones (8), e.g. separate cultivation of starter cultures, separate fermentation of milk before mixing to obtain the final product, and/or addition of concentrated cultures with characteristics other than those used for the manufacture of the fermented milks. All these possibilities are used during the manufacture of such products today. The survival of the probiotic microorgamisms, particularly *Bifidobacteria spp.*, however, is very dependent on the strain and its pH tolerance. Table 2 gives an overview of the fermented milks with bifidobacteria produced in different countries.

An example of the production of a special fermented milk with intestinal flora, for which the producer is claiming nutritional benefits, is Yakult®. This product is based on milk fermented with one microorganism, *Lactobacillus casei* subsp. *casei* (biovar *Shirota*). The strain, which originates from Japan, was isolated in 1930 and has been used since 1935. Because of the poor growing ability of this strain in milk, a special technology was developed. Milk is sterilized by UHT treatment and the incubation vessel is of the aseptic type. After inoculation, the milk is incubated for 5 days at 37°C. These incubation conditions are necessary

Table 2: List of current fermented milks containing Bifidobacteria in different markets (6)
Tablica 2.: Popis fermentiranog mlijeka koje sadrži bifidobakterije u prometu na različitim tržištima (6)

Product/trade name Proizvod/Trgovački naziv	Country of origin Potječe iz zemlje	Microflora present Prisutni mikroorganizmi	Comments Primjedbe
AB milk products	Denmark	1) 6)	Chr. Hansens's Laboratory
Aciaophilus bifidus yoghurt	Germany	1) or 3) 6) 7) 12)	Produced in many countries
BA®	France	3) Yoghurt culture	Known as »Bifidus Active«
Bifidus milk	Germany	1) 3)	Dev. in 1948 as baby food
Bifidus milk with yoghurt flavour	UK	1), 3) or 5)	
Bifidus yoghurt	Many countries	1) or 3), Yoghurt culture	
Bifighurt®	Germany	4) 12) (slime forming)	Similar to Bifidus yoghurt
Bifilakt® or Bifilact®	CIS	*Bifidobacterium spp. Lactobacillus spp.*	
Biobest®	Germany	1) or 3), Yoghurt culture, Bifidobacteria type BAT	Visby; »biogerm« grain
Biogarde	Germany	1) 6(12)	
Bioghurt®	Germany	Similar to Biogarde®	No bifidobacteria
Biokys®	Czechoslovakia	1) 6) 11)	
Biomild®	Germany	6), *Bifidobacterium spp.*	Plain and low fat product
Cultura®	Denmark	1) 6)	Related to AB product
Diphilus milk®	France	AS above	As above
Mil-Mil®	Japan	1) 2) 6)	With glucose/fructose and carrot juice
Olifus®	France	1) 6) 12) or 1) 6) 8)	With 3.6 or 10% fat
Progurt®	Chile	1) 6) 9) 10)	
Sweet acidophilus bifidus milk	Japan, USA	1) 6)	Not fermented
Sweed Bifidus milk	Japan, Germany	*Bifidobacterium spp.*	As above

1) B. bifidum; 2) B. breve; 3) B. longum; 4) B. longum CKL 1969 or DSM 2054; 5) B. infantis; 6) L. acidophilus; 7) b. delbrueckii subsp. bulgaricus; 8) Lac. lactis subsp. lactis; 9) Lac. lactis subsp. cremoris; 10) Lac. lactis biovar diacetylactis; 11) P. adicilactici; 12) Str. thermophilus

for the culture to ferment milk. The product is aromatized and sweetened to obtain the right sensorial properties.

A fermented milk product, »mona Vifit®«, containing a benefical microorganism, was recently launched in the Netherlands. This product contains *Lactobacillus casei* strain GG, which was isolated from a healthy human in 1984 (9). Because of its probiotic characteristics, this strain is incorporated in fermented milks and other dairy products. However, this strain is lacking β-galactosidase activity and is, consequently, not proliferating in milk. The problem has been solved during product development by studying the ecological and physiological properties of various lactic acid bacteria and a new starter, based on yoghurt culture, was developed. It contains *Streptococcus thermophilus, Lactobacillus delbrueckii* subsp. *bulgaricus, L. acidophilus* and *B. bifidum.* This mixture of microorganisms ferments milk well and the specific compounds, which are needed by *L. casei* GG for good growth in milk, are produced in excess during the fermentation. The product contains about 5×10^7 cfu/g *L. casei* GG and the number remains stable during the shelfe life of 21 days at 7°C.

A Danish company recently launched a »revolutionary dairy product« called Gaio. This special yoghurt shows a clinically proven cholesterol-lowering effect and is produced with a culture originating from Abkhasia, a region between the Caucasus mountains and the Black sea (10).

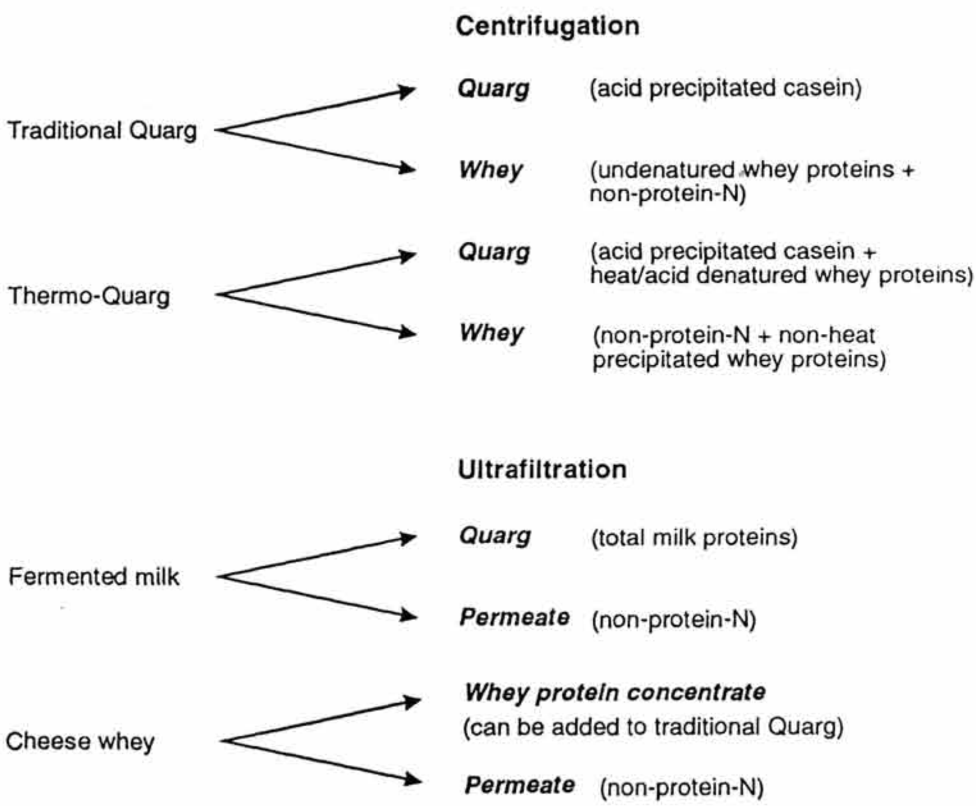

Figure 2: Possibilities for separation of precipitated milk proteins in the manufacture of Quarg-type fresh cheese

Slika 2.: Mogućnosti izdvajanja oborenih bjelančevina mlijeka u proizvodnji svježeg sira tipa »Quarg«

Fresh cheese

The traditional fresh cheese manufacture differs from that of fermented milks in one important step, i.e. the separation of whey after fermentation. This results in an increase of casein in dry solids and reduction of the Ca-content to a greater or lesser extent, depending on the pH. Since introduction of ultrafiltration (UF) in dairy industry, it became possible to retain all the whey proteins, nutritionally the most valuable proteins, in fresh cheese. Figure 2 summarizes technological possibilities for the separation of proteins from fermented milk in the manufacture of Quarg-type fresh cheese.

The legal designations for fresh cheese varies from one country to another. However, the majority of legislation is based on chemical compositional standards, expressed as maximum moisture content, minimum fat in dry matter (FDM) and the permitted added ingredients. This type of cheese is known as fresh unripened, soft unripened or sour milk cheese. In the early 1980s, the International Dairy Federation made available specifications regarding 510 cheese varieties in its member countries, about 60 cheeses of which fall into the fresh/soft category (11). Some examples are: Quarg (or Quark in German spelling), Cottage cheese, Fromage frais, Neufchatel, Cream cheese and Queso blanco. In general, the moisture and fat contents of these cheeses may range between 60 and 80% and

Table 3: Chemical composition (% w/w) of various fresh cheese (16, 27, 28, 29)
Tablica 3.: Kemijski sastav (% m/m) različitog svježeg sira

Variety Vrsta	Moisture Voda	Fat Mast	Protein Bjelančevine	Lactose[1)] Laktoza	Salt Sol	pH
Cream						
Double	60	30	8-10	2-3	0.75	4.6
Single	70	14	12	3.5	0.75	4.6
Neufchatel	64	20	12	–	0.75	4.6
Quarg						
Low-fat	82	0.5	13	3-4	–	4.5
Creamed	73	12	10	2-3	–	4.6
Cottage						
Low-fat	79	2	14	–	–	4.8
Creamed	79	5	13	–	–	4.8
Fromage Frais	86	1	8	3.5	–	4.4
Ricotta						
High-fat	72	13	11.5	3.0		5.8
Low-fat	75	8	12	3.6		5.8
Ricottone	82	0.5	19	–	–	–
Baker's	74	0.2	19	–	–	–
Queso Blanco	48-55	15-27	19-24	–	2.3-2.5	5.2-5.7

[1)] Data include lactate

<1-10% respectively. Some closely related products may be included in this category of fresh cheese although their characteristics may be different: Labneh (Middle East countries), Shirkhand (India), Skyr (Iceland), Ymer (Denmark), Stragisto or Sakoulas (Greece) and Zimme, Kiselo mleko or Mleko-slano (Balkan countries) (6). Table 3 contains data on the chemical composition of various fresh cheese.

Manufacture of Quarg-type cheese

The principal manufacturing stages of all types of unripened fresh cheese will have much in common: preliminary treatment of the milk (i.e. standardisation of the fat content and/or fortification with the milk solids); homogenization (optional); heat treatment (ranging from 72°C for 15 s to 95°C for 8 min); coagulation and/or fermentation followed by de-wheying or concentration; post-production heat treatment (optional); cooling or in some instances hot filling; blending with other ingredients (optional), and packaging, storage and display. With the advent of equipment development and mechanisation, the processing plant installations may not be universal. An example of this is the use of mechanical separators or UF equipment compared to traditional methods (Fig. 3).

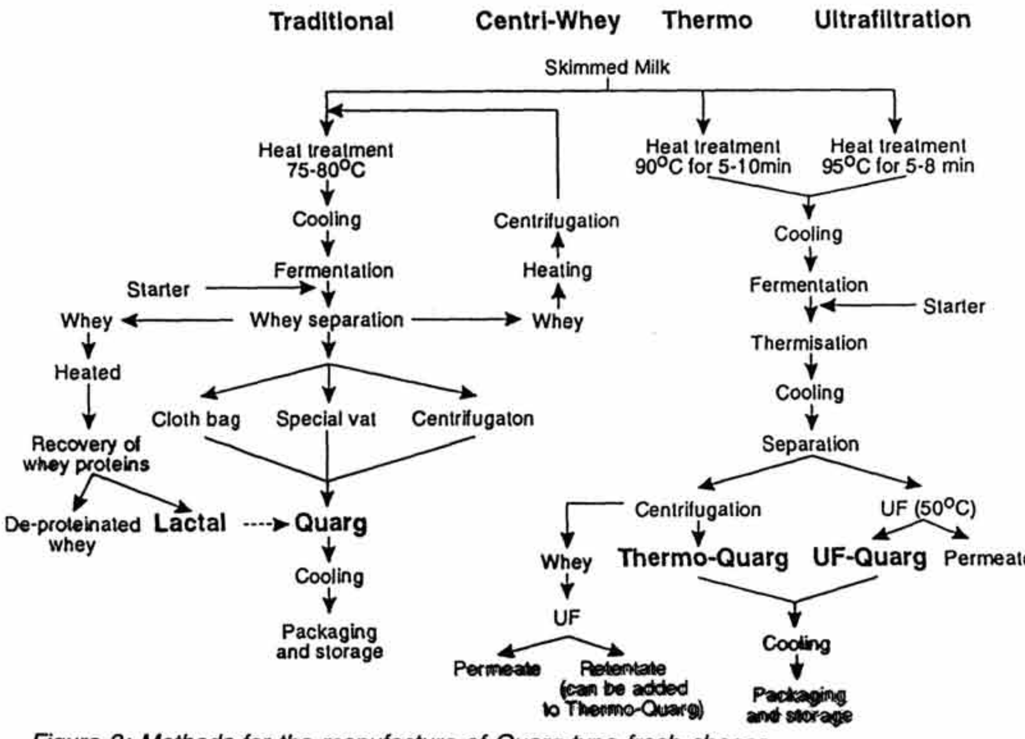

Figure 3: Methods for the manufacture of Quarg-type fresh cheese
Slika 3.: Metode proizvodnje sirne mase tipa svježi sir

During the manufacture of fresh cheeses mesophilic lactic acid bacteria (*Lactococcus* spp., *Leuconostoc* spp. and/or *Pediococcus acidilactici*) are widely employed as mixed cultures. In some instances, yoghurt organisms (*L. delbrueckii* subsp. *bulgaricus* and *Str. thermophilus*) have been used in combination with mesophilic starter cultures (12, 13). A recent Czech patent, cited in (14), features the use of unconventional cultures containing *Candida valida* and *Brevibacterium linens* in Quarg manufacture. Immobilization of *Lactococcus lactis* subsp. *lactis* in calcium alginate beads was studied for development of highly concentrated freeze-dried starter culture for Quarg production (15). Subsequent Quarg production trials indicated possible advantages in substantial time saving. However, without the removal of the immobilized culture beads, the calcium alginate content of the obtained Quarg resulted in a noticable textural difference. A number of cultures, which are considered as therapeutic/probiotic organisms originating from humans and have limited acidification rate below – pH 4.8, are also used for the manufacture of fresh cheeses (16). Some examples include *Bifidobacterium* spp. and. *L. acidophilus*. These organisms are blended with cool and concentrated curd before packaging. Quarg and other fresh unripened cheeses appear to be especially suitable for the incorporation of various probiotic cultures capable of colonizing the intestinal tract because the intestinal passage time for these products can be expected to be much longer than that of liquid fermented milks, thus contributing to the colonization process (17, 18).

Other health-related aspects of the fresh cheese manufacture, which may become increasingly important, concern the contents of calcium and whey proteins. As many fresh cheeses are characterized by drainage of the whey after fermentation or direct acidification of milk, the natural calcium content of most fresh cheeses is quite low. Various attempts to increase the calcium content of Cottage cheese have been reported in the literature and a recent example being the addition of hexametaphosphate or calcium gluconate/calcium-D-saccharate (19). The use of membrane processing in the preparation of calcium rich Cottage cheese dressing has also been investigated by several researchers (20, 21). However, excess calcium in Quarg has been considered to be one of the main causes of bitterness in the final product (21). Finding new ways for increasing the calcium content in fresh cheese without negatively impairing their sensory qualities could be a challenging task.

Incorporation of whey proteins into fresh cheese has become an important aspect of the fresh cheese technology because of the potential high yield increases (16, 22). Techniques based on the whey protein denaturation in the milk for Quard manufacture by high heating have been used in the main Quarg producing countries (e.g. Germany) since 1960s. In the case of Quarg and Cream cheese, the increased whey protein content obtained by high heating does not seem to cause any major quality problems in these products. However, in the case of Cottage cheese, high heating of milk results in generally lower quality due to textural deffects in the curd. Further yield increases can be obtained by the use of UF technology for the production of fresh cheese including Cottage cheese

(23). In the manufacture of Quarg the currently preferred process is to use UF for separated whey after the fermentation step, in part, because of the retention of total protein nitrogen as opposed to retention of only the heat-denatured proteins when using the nozzle separator. This was further demonstrated in a recent study (24) where the addition of sweet whey UF retentate to Quarg milk was combined with the traditional Thermo-Quarg process. When the amount of the retentate added was higher than 25%, excessive losses of the non-heat coagulable protein in the whey were observed. The incorporation of high amounts of whey protein into fresh cheese is increasing in importance, not only because of the higher yield potential, but also due to their unique nutritional value and their »nutraceutical« properties, anticancerogenic effects (25) and the potential stimulation of the immune function in AIDS patients (Baruchel, Montreal Children's Hospital, unpublished data).

Unfortunately, increased use of UF technology for fresh cheese production may create specific problems for the consumers. The increased retention of lactose in the final product (22) may have prompted the revisions of the stringent German standard for Quarg which now requires not only a minimum 18% total solids, but also not less than 12% protein and not more than 20% of the protein as whey proteins. Even with compliance to this new standard, the UF Quarg has a softer consistency making it less suitable for use in baking recipes and other traditional Quarg uses. In the absence of any labelling distinction of traditional and UF fresh cheese products, this could be a minor inconvenience. However, the lack of labelling requirements could be a more serious problem for consumers with intolerance to β-lactoglobulin. The effect of increased lactose content in UF Quarg on lactose intolerant consumers has not been adequately studied. So far it appears that the lactose in Quarg should be tolerated as well as in yoghurt, mainly due to the slow gastrointestinal passage of the solid food (18, 26).

Manufacture of Queso blanco cheese

This type of fresh cheese is made in Spanish speaking countries including the Caribbean Islands. Different generic names are used, for example Queso de Puna, Fresco, Llanero or Descemendo (using skimmed milk), and Queso de Prensa, del Pais or de Estra (using full fat or partially skimmed milk) (27). These cheeses are made from raw milk or milk pasteurized at 85°C. The production method involves addition of an acidulant (at 70°C) to hot milk (~82°C) to bring the pH to 5.0-5.2, stirring for 3 min, de-wheying, cooling to 32°C and mixing with lactic starter cultures (*Lactobacillus* spp.), salt and flavourings. The mixture is pressed, vacuum packed and stored at 7°C (27, 28). Direct acidification and rennet coagulation are interchangeably used for curd formation. The addition of lactic cultures and post-manufacture contaminating bacteria decreases the pH to 4.9 during storage and is associated with hydrolysis of residual lactose (27).

Manufacture of Ricotta

This cheese was traditionally made in Italy by utilizing the whey from sheep's milk cheese, recovering the protein by heating. The industrial process has been modified in view of widespread popularity, and in particular in North America where it is made from milk (full fat or partidly skimmed cow's milk), whey/skimmed milk mixture and/or addition of acid whey powder (28). In some of the Ricotta manufacturing methods only partial recovery of whey proteins is achieved. In this case, the whey from Ricotta cheese is mixed with citric acid to pH 5.4, heated to 80°C and treated as for Ricotta. This curd is known as Ricottone which is tougher in consistency and normally blended with Ricotta (28). Figure 4 shows the development of the technological processes for Ricotta cheese.

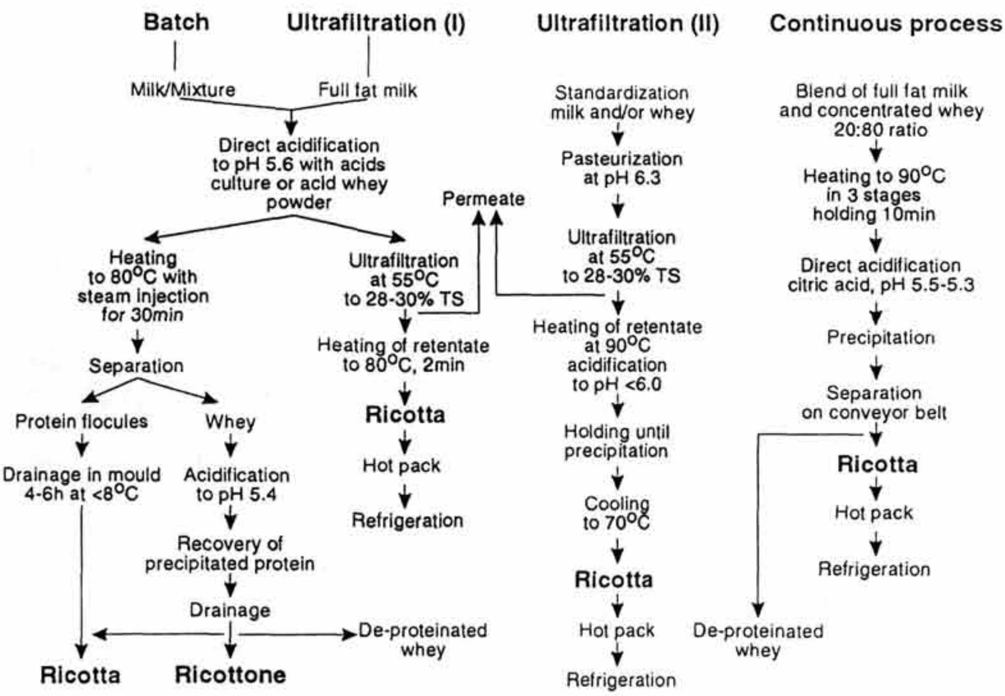

Figure 4: Methods for the manufacture of Ricotta (28)
Slika 4.: Metode proizvodnje skute (28)

Future developments

The process of manufacture of fermented fresh milk products is an effective method of preserving most of the nutritional, valuable components of milk for few weeks. It is likely, however, that the future developments in this field, based on current scientific research work, will target the following aspects:

- Selection of suitable strains of probiotic microorganisms capable of fermenting milk within an acceptable period of time.
- Ultrafiltration will become more widespread in the production of fermented milk products for development of new varieties of fresh cheese and possibly for reduction of the lactose content in fermented milks.
- Fat-substitution – although this variety of chees is inherently low in fat, the present day perception of the consumer is to eat healthy food which is low in calories; however, the potential expansion is the replacement of cream with fat-substitutes such as »light« cream cheese or possibly to improve the flavour of most of these cheeses.
- Greater involvement of medical profession in the studying of beneficial effect of probiotic microorganisms from fermented milks.

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SVJEŽI PROIZVODI – JOGURT, FERMENTIRANO MLIJEKO, SIRNA MASA I SVJEŽI SIR

Sažetak

Potrošnja fermentiranih svježih mliječnih proizvoda naročito jogurta u mnogim je zemljama 1992. bila znatna (podaci IDF).

Najbitniji korak u razvoju ovih proizvoda predstavlja primjena selekcioniranih kultura mikroorganizama što je omogućilo bolju kontrolu njihove kvalitete.

Uključivanje probiotskih mikroorganizama u kulture za fermentaciju ili dodavanje u samo fermentirano mlijeko najvažnije su modifikacije budućih postupaka proizvodnje.

Uvođenje ultrafiltracije u mljekarsku industriju omogućilo je proizvodnju svježeg sira i sirne mase koji sadrže više bjelančevina sirutke. Takvi proizvodi mogu potrošačima stvarati specifične probleme uslijed povećanih količina laktoze i β-laktoglobulina.

Industrijska proizvodnja skute od ovčjeg mlijeka u Sjev. Americi je modificirana i proizvodi se od mlijeka smjese sirutke i obranog mlijeka te i/ili dodavanjem praha kisele sirutke.

Postupak proizvodnje fermentiranih, svježih mliječnih proizvoda je učinkovita metoda konzerviranja većine prehrambenih, vrijednih sastojaka mlijeka tijekom nekoliko tjedana.

Riječi natuknice: Fermentirani proizvodi, fermentirano mlijeko s probiotskim mikroorganizmima, svježi sir, bijeli sir, skuta.

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