

# **REVIEW OF LITERATURE**

According to FIL-IDF (1981), fermented milk is defined as product prepared from milk—whole, partially or fully skimmed, concentrated milk or milk substituted from partially or fully skimmed dried milk homogenized or not, pasteurized or sterilized and fermented by means of specific microorganisms.

Fermented milk products are generally classified into four types: (1) acid/alcohol-type such as kefir and koumiss, (2) high acid-type such as Bulgarian sour milk, (3) medium acid-type such as acidophilus milk and yoghurt and (4) low acid-type such as cultured buttermilk and cultured cream (Kosikowski, 1977). Today, there are more than 70 bifidus- and acidophilus containing milk products produced worldwide (Shah, 2001). Some of the widely consumed fermented milk products are listed in Table A.

### **Acidophilus milk**

Acidophilus milk is sour milk where starter culture *Lactobacillus acidophilus* is inoculated to sterilized milk (Robinson and Tamime, 1981). Acidophilus milk contains from 1.5 to 2.0 % acid (as lactic) and no alcohol and is used therapeutically but its high acidity makes it poor table beverage (Kosikowski, 1977). Acidic conditions produced by *Lactobacillus acidophilus* in the intestinal tract discourage the growth and proliferation of gas-forming putrefactive bacteria in the gut (Oberman, 1985). *Lactobacillus acidophilus* has probiotic properties (Shah, 2001). Acidophilus milk fermented by *Lb. acidophilus* reduce serum cholesterol level through several mechanisms (Ashar and Prajapati, 2001a,b).

Table A. Traditional fermented milk products of the world (Campbell-Platt, 1987)

Product	Milk type	Nature	Regions of production
Acidophilus milk	Cow milk	Sour milk	Russia, East Europe, Greece, Turkey, North America, Scandinavia
Bulgarian buttermilk	Cow milk	Sour milk	Yugoslavia, Bulgaria, Greece, Turkey, Albania, Romania
Butter	Milk	Soft paste	All parts of the world
Buttermilk	Cow milk	Sour milk	USA, Canada, Russia, Scandinavia, Middle East, Egypt, Ethiopia, India, Australia, New Zealand
Cheese	Milk	Soft or hard solid	All parts of the world
Dahi	Cow or buffalo milk	Yoghurt-like fermented milk	Indian subcontinent
Ghee	Milk	Soft paste	Indian subcontinent, Middle East, Africa, South East Asia
Kefir	Goat, sheep, or cow milk	Acidic, mildly alcoholic, effervescent milk	Russia, Europe, Middle East, North Africa
Kishk	Sheep milk-wheat	Milk-wheat mixture; dried balls	Greece, Turkey, Egypt, Libya, Middle East, Iran
Koumiss/Kumiss	Horse, donkey or camel milk	Acid/alcoholic milk	Scandinavia, Russia, Mongolia, China
Lassi	Milk	Buttermilk or dahi, sometimes sweetened	Indian subcontinent, Mongolia, Middle East, North Africa, West Africa, Europe
Laban	Milk	Yoghurt-like fermented milk	Egypt, Turkey, Middle East
Misti dahi	Milk	Sweet yoghurt-like	Eastern India
Paneer	Buffalo, cow, milk	Cheese-like solid	Indian subcontinent, Middle East
Rabri	Buttermilk, cereals, pulses	Thick slurry-like product	India
Shrikhand	Cow or buffalo milk	Sweetened dewatered dahi	Western and southern India
Trahanas	Sheep milk, wheat	Wheat- fermented sheep milk; consumed as sweet-sour soup or biscuit	Cyprus, Greece, Turkey
Yoghurt	Cow, goat, sheep, buffalo or camel milk	Fermented milk	All parts of the world

### **Bulgarian buttermilk**

Bulgarian or bulgaricus buttermilk is extremely sour milk prepared from boiled milk of goat or cow, inoculated with a portion of previous fermented milk (Oberman, 1985). Bulgarian buttermilk might have originated from Trak's tradition i.e. from the tradition of the sheep breeders who came to Asia from Bulgaria in the 15<sup>th</sup> century (Oberman, 1985). *Lactobacillus bulgaricus* is the primary fermenting organism in Bulgarian milk and is high acid milk in which total acidity (as lactic acid) may reach from 2.0 to 4.0 % (Kosikowski, 1977). Incubation temperature for bulgaricus buttermilk is from 38° C to 47° C (Steinkraus, 1983). *Lactobacillus bulgaricus* convert the milk lactose to lactic acid, and produce the flavour compounds acetaldehyde (Marshall, 1982).

### **Buttermilk**

True buttermilk is the fluid remaining after the cream is churned into butter (Oberman, 1985). However, cultured buttermilk is made from fresh skim milk or from partially skimmed pasteurised milk fermented commonly with one or more selected strains of *Lactococcus lactis*, *Lactococcus cremoris* and one or more species of citric acid fermenting streptococci, *Leuconostoc cremoris*, sometimes and *Lactococcus lactis* subsp. *diacetylactis* (Robinson and Tamime, 1981). Increase in bacterial population was very rapid, the fungal and yeast population increased gradually in buttermilk (Viajayalakshmi and Murugesan, 2001).

## Cheese

Cheese and cheese products derived from the fermentation of milk are of major nutritional and commercial importance throughout the world (Galloway and Crawford, 1985). According to USDA (1978), cheese can be classified into four major groups: very hard (grating) type, hard, semi-soft and soft. Some of the common varieties of cheese are: asiago old, parmesan, romano, sapsago, spalen, cheddar, caciocavallo, swiss, emmentaler, gruyère, brick, munster, limburg, port du salut, trappist, roquefort, gorgonzola, blue stilton, blue wensleydale, brie, camembert, neufchâtel, cottage, etc. (Androuet, 1976). Conversion of lactose to lactic acid in cheese is achieved by LAB, particularly *Lactococcus* spp. (Carr, 1981).

Biogenic amines which are organic basic compounds are found to occur in cheese, fish products, wine, beer, dry sausages and other fermented foods (Ten Brink *et al.*, 1990; Halász *et al.*, 1994). Cheese is the most commonly implicated food associated with histamine poisoning (Silla-Santos, 2001). The first reported case of histamine poisoning occurred in 1969 in the Netherlands and involved gouda cheese (Stratton *et al.*, 1991). Many studies have been undertaken to determine the amine contents of cheese products, and a variety of amines, such as histamine, tyramine, cadaverine, putrescine, tryptamine and phenylethylamine, have been found in different cheeses (Besancon *et al.*, 1992; Abd-Alla *et al.*, 1996; Schneller *et al.*, 1997; Vale and Gloria, 1997). Lactic acid bacteria frequently produce histamine and tyramine in fermented foods including dairy products (Stratton *et al.*, 1991; Leisner *et al.*, 1994). *Enterococcus faecalis* has been associated with tyramine in cheese and other fermented milk products (Holt *et al.*, 1994; Celano *et al.*, 1996).

## **Dahi**

Dahi is the most popular fermented milk product in India and is obtained by lactic acid fermentation of cow or buffalo milk (Ramakrishnan, 1979). Dahi is well known for its palatability and nutritive value (Rathi *et al.*, 1990). It resembles plain yoghurt in appearance and consistency and differs in having less acidity (Batra and Millner, 1976; Mital, 1977; Shuaib and Azmey, 1977). Preparation and consumption of dahi has been recorded since 2000 B.C. (Prakash, 1961). *Lactobacillus bulgaricus*, *Lb. acidophilus*, *Lb. helveticus*, *Lb. casei*, *Lb. brevis*, *Streptococcus thermophilus*, *Lactococcus lactis*, *Lactococcus cremoris*, *Enterococcus faecalis* were isolated from dahi (Laxminarayana *et al.*, 1952; Ranganathan *et al.*, 1964; Ramakrishnan, 1979; Mohanan *et al.*, 1984).

According to BIS (1980a) specification, dahi is either plain or flavoured and should have 0.6 to 0.8 % acidity, not more than 18 coliforms/g, 100 yeast and moulds/g and a negative phosphatase test. A commercial production of dahi using starter culture combination of *Lactococcus lactis* subsp. *lactis*, *Lactococcus lactis* subsp. *diacetylactis* or with *Leuconostoc* spp. has been described by Misra (1992).

## **Kefir**

Kefir is acidic, mildly alcoholic, distinctly effervescent milk in Russia (Hartles *et al.*, 1977). It can be made from the milk of goat, sheep or cow. Kefir is served in a glass and can be either drunk or eaten with a spoon, or it may be sweetened with sugar like yogurt or combined with fruits or biscuits (Mogilevsky, 1977). The essential material, along with the milk substrate, is the kefir grains (Hartles *et al.*, 1977).

Predominant yeasts in kefir include *Torulopsis holmii* and *Saccharomyces delbrueckii* in a ratio of about 10:1, both of which are lactose-negative (la Rieviere, 1963; Hartles *et al.*, 1977). The total number of viable lactose negative yeasts per g wet weight of grains amount to 1.4 to  $3.3 \times 10^8$  (la Rieviere, 1969). Predominant bacterium is *Lactobacillus brevis* (la Rieviere *et al.*, 1967). Both lactose and non-lactose fermenting species of yeasts *Klyuveromyces marxianus*, *Candida kefir*, *Candida pseudotropicalis*, *Saccharomyces cerevisiae*, *Saccharomyces exiguous* and *Torula holmii* were isolated from kefir (Chin Wen *et al.*, 1999).

During kefir fermentation, pH may drop below 3; total acid increases from 0.85 to 1.0% (as lactic), carbon dioxide is produced, making the product effervescent (la Rieviere *et al.*, 1967). Generally, less than 1% ethanol is produced. All these changes produce desirable organoleptic qualities (la Rieviere *et al.*, 1967). Kefir is a low-cost method of preserving milk (Steinkraus, 1983).

### **Kishk**

Kishk is a fermented milk-wheat mixture stored in the form of dried balls of Egypt (Abd-el-Malek and Demerdash, 1977). Kishk is a popular food among the rural populations and the Bedouins of Egypt, Syria, Lebanon, Jordan, Iraq and North Africa (Basson, 1981). Kishk is a balanced food with excellent keeping quality, richer in B vitamins than either wheat or milk and well adapted to hot climates by its content of lactic acid and has a therapeutic value (Morcos *et al.*, 1973). The principal lactobacilli involved in kishk fermentation are *Lactobacillus casei*, *Lb. plantarum*, *Lb. brevis* (Abd-el-Malek and Demerdash, 1977). *Bacillus* spp. were also reported in kishk (Mahmoud, 1977).

## **Koumiss**

Koumiss is an effervescent acid/alcoholic fermented milky white/greyish liquid made primarily from mare milk (Kosikowski, 1977). It has been known since ancient times and is the principal food of wandering tribes in European Russia and the plains of south, western and central Asia (Auclair and Accolas, 1974).

The description of traditional method is illustrated below (Kosikowski, 1977; Steinkraus, 1983; Campbell-Platt, 1987). In early times mare milk was stored in smoked horse skins, but now fresh mare or goat milk is placed in a wooden vessel. Boiling water is added to the warm mare milk in the proportion of 1:6 (v/v). An eighth part (v/v) of old koumiss is added and the mixture is covered and held for 15 to 24 h. Additional heat and agitation is applied if necessary to stimulate the fermentation. The fermentation is complete when the milk is thoroughly sour and sends up a thick mass to its surface. It is then beaten and stirred until the curd is thoroughly broken and forms a thick liquid. It is again covered and fermented for an additional 24 h or longer, and blended until perfectly smooth. Koumiss is then ready to drink.

The primary fermenting microorganisms in koumiss are *Lactobacillus bulgaricus*, yeasts *Candida kefir*, *Torulopsis* spp. (Kosikowski, 1977; Tamime, 1981). The primary fermentation products are lactic acid (0.7-1.8 %), ethanol (1-2.5 %), carbon dioxide and these products account for the effervescence and sour, alcoholic flavor (Kosikowski, 1977). Koumiss is not only regarded as a food high in nutritional quality, it is also considered to be therapeutic, particularly in the treatment of pulmonary tuberculosis (Auclair and Accolas, 1974).

Kosikowski (1977) reported that more than 50 Russian sanatoria offer koumiss treatment for tuberculosis.

### **Lassi**

Lassi is a by-product obtained in the preparation of country butter (ghee) from dahi by indigenous methods (Mital, 1977). Dahi is churned with frequent addition of water until butter granules are formed. The product obtained by manual removal of butter granules is called lassi (Laxminarayan and Shankar, 1980). The composition of lassi is water, 96.20 %; fat, 0.80 %; protein, 1.29 %; lactose, 1.20 %; lactic acid, 0.44 %; ash, 0.40 %; calcium, 0.60 % and phosphorus, 0.04 % (Rangappa and Achaya, 1974). Patidar and Prajapati (1998) reported that lassi prepared by combination of *Lactobacillus acidophilus* and *Streptococcus thermophilus* was organoleptically acceptable and stable.

### **Laban rayeb**

Laban rayeb (laben) has a slightly acid taste with aroma resembling that of buttermilk (Morcos, 1977; Oberman, 1985). Laban is used as dairy spread and yoghurt cheese (El-Samargy, 1997). The pH of laban varies between 4.1 and 4.8 with acidity ranging from 0.8-1.3 % (Morcos, 1977). The predominating organisms are *Lactococcus lactis* subsp. *lactis*, *Streptococcus thermophilus*, *Lactobacillus bulgaricus* and lactose fermenting yeasts (Vedamuthu, 1982).

### **Misti dahi**

Misti dahi (sweetened dahi, mishti doi, lal dahi or payodhi) is a sweetened fermented milk product from the eastern part of India (Ray and Srinivasan, 1972). Traditionally, milk with cane sugar is heated in

for 6-7 hours to evaporate part of the moisture. After cooling, the mix is inoculated with commercial starter culture kept from the previous day and transferred to earthenware pots. Curdling takes place at room temperature overnight (Ghosh and Rajorhia, 1990). Mixture of starters *Lactococcus lactis*, *Lactococcus diaceetylactis*, *Lactococcus cremoris* and *Leuconostoc* is most appropriate for commercial production of misti dahi from buffalo milk (Ghosh and Rajorhia, 1990). Wide variations in total solids (27-43 %), non fat milk solids (11-16 %) and sucrose (13-19 %) in the market samples of misti dahi (Ghosh and Rajorhia, 1987). Gupta *et al.*, (2000) optimized the production of misti dahi from buffalo milk using starter combinations comprising (i) *Streptococcus salivarius* subsp. *thermophilus*, *Lactobacillus acidophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus*; and (ii) *Lactobacillus acidophilus*, *Lactococcus lactis* subsp. *lactis* and *Saccharomyces cerevisiae*.

### **Rabri**

Rabri, an indigenous fermented milk-based, thick slurry-like product of India, is prepared by fermenting cereals and pulses including wheat, barley, maize, pearl millet, chickpea, etc. with country buttermilk (Gupta *et al.*, 1991; Chatterjee *et al.*, 1994). Cooked maize flour is cooled and combined with buttermilk to make rabdi. The mixture is fermented overnight and consumed. *Pediococcus acidilactici* ( $3.6 \times 10^5$ /g), *Bacillus* sp. ( $1.1 \times 10^6$ /g), and *Micrococcus* sp. ( $7.9 \times 10^5$ /g) have been isolated from fermented rabid (Ramakrishnan, 1977). The pH changes from 6.7 to 6.4 and a slight volume increase of 5% occurs. There is no change in amino nitrogen or free sugar (Ramakrishnan, 1977).

## **Shrikhand**

Shrikhand is an indigenous, concentrated sweetened lactic fermented milk product, widely consumed in western part of India (Sarkar and Misra, 1997). It has a distinctive rich flavour and fairly long shelf-life due to higher acidity, reduced water content (Garg *et al.*, 1983) and addition of sugar (Patel and Chakraborty, 1988). Shrikhand possesses antibacterial properties against pathogenic as well as spoilage organisms (Sarkar *et al.*, 1996). Shrikhand preparation involves intentional fermentation and coagulation and generally buffalo milk is used for the manufacture of chakka because of higher yield and consumer preference (BIS, 1980b). Chakka, the basic raw material, is obtained by drainage of whey from the acid curd (Boghra and Mathur, 2000).

## **Trahanas**

Trahanas, known as kapestoes or zamplarcicos in Greek and tarhanocirv in Turkish, are fermented food made from crushed wheat and fermented sheep milk, which are boiled together, dried and stored in the form of biscuits (Economidou, 1975). They are made into a thick, sweet-sour soup for consumption, the fermentation and the products are closely related to Egyptian kishk.

Trahanas is found in every home and consumed mainly during the winter and are widely used for feeding weaned infants and young children (Economidou and Steinkraus, 1977). Economidou (1975) reported the presence of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* as the major fermenting organisms in traahanas.

## Yoghurt

According to some sources yoghurt originated in Asia (Oberman, 1985). Yoghurt is prepared from milk of cow, goat sheep, buffalo or camel using 2-5 % lactic starters (Campbell-Platt, 1987). The predominant role in production of yoghurt lie with *Lactobacillus bulgaricus* and *Streptococcus thermophilus* (Robinson, 1999). Widely distributed yeasts (*Candida mycoderma*, *Candida krusei*, *Candida tropicalis*) were regarded as spoilage microorganisms whereas bacterial strains, *Lactococcus lactis*, *Lactococcus lactis* subsp. *diacetylactis*, *Leuconostoc* spp., *Lactococcus lactis* var. *taette* (slime producer), were regarded as supplementary microflora (Robinson, 1990). In original Bulgarian and Yugoslavian yoghurts, *Geotrichum candidum* was also found (Robinson, 1990). The metabolic activity of yoghurt bacteria results in a considerable increase in cell numbers, the total count of viable yoghurt bacteria ranges between 200 and 1000 million per ml of fresh yoghurt but decreases during subsequent storage (Chandan, 1989). Finished yoghurt with pH 4.2-4.3 is thus the end product of a symbiotic culture of *Streptococcus thermophilus* and of *Lactobacillus bulgaricus* growing at temperatures in the range 40-45° C (Gilliland, 1985). A proportion of 1:1 of the 'rods' and 'cocci' forms is considered to be optimum for flavour and texture production but 1:5 or 1:10 or 2.1:1.2 are also favourable (Rasic and Kurmann, 1978; Vedamuthu, 1982). *Lactobacillus bulgaricus* demonstrates a much stronger proteolytic activity than does *Streptococcus thermophilus* (Tamine and Robinson, 1985).

Yoghurts exhibit an antagonistic effect against a number of pathogenic and saprophytic organisms but this effect shows many variations depending on the bacterial strains used, and on their particular

antagonistic properties (Shah, 2001). Yoghurt bacteria produce higher  $\beta$ -galactosidase activity than probiotic bacteria (Shah and Jelen, 1990; Shah, 1994). Yoghurt to be considered as a probiotic product, *Lactobacillus acidophilus* and *Bifidobacterium* spp. are incorporated as a dietary adjunct (Shah, 2000). Yoghurt containing these two probiotic bacteria is referred as “AR” yoghurt (Shah, 2001).