Functional and therapeutic effects of fermented milk

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Introduction

Milk is a composite liquid that provides nutrients and biological active compounds which enhance the postnatal adaptation of newborn by improving the digestive maturity, development of gut-associated lymphoid tissues and synbiotic microflora (Ebringer *et al*., 2008). Skim milk is produced by removing all the milk fat from whole milk. Skim milk has less fat as compared to whole milk, and nutritionists recommend it for persons who are trying to reduce or maintain a healthy weight. The skim milk fat content ranges between 0.1-0.3%. Drinking milk is an extensive nutritional source for the children as well as for adults. Milk is the mixture of bioactive components such as vitamins, proteins, saccharides and lipids which regulate the development of gastrointestinal tract (Donovan, 2006). Milk contains several antimicrobial agents which show bactericidal and bacteriostatic effects. Milk proteins play important role in food intake, satiety and obesity related disorders. Enzymes with antimicrobial and antioxidant properties are important in milk stability and protection of mammals from pathogens (Ebringer *et al.,* 2008). The dairy products with high protein content particularly whey proteins may help in minimizing the deposition of fat and improve insulin sensitivity (Dunshea *et al.,* 2007). Dairy peptides and proteins also enhance the availability of minerals and trace elements (calcium, zinc, iron, magnesium, manganese, selenium (Vegarud *et al.,* 2000).

Fermented dairy products

Fermented dairy products are the economical source of many nutrients (Gonfa *et al*., 2001). Lactic acid is produced by fermentation of lactose. It reduces the pH, affects the casein physical properties and consequently enhances digestibility. It also meliorate usage of

calcium and different other minerals and suppresses the development of potentially injurious bacteria. Fermented milk can be endured by individuals having a reduced ability for lactose digestion due to its smaller lactose content (Parvez *et al.*, 2006). Fermented dairy products include cheese, buttermilk, yoghurt, kefir, doogh, ice cream etc. Fortunately lactobacilli, lactic acid bacteria and streptococci are the dominant bacteria in fermented milk that effectively suppress the pathogenic and spoilage micro-organisms. Fermentation was used in the former days to inhibit the proliferation of some pathogens and harmful bacteria during the manufacturing of indigenous milk products. The fermented products nature varies from region to region. Therefore, it depends upon the local microbial culture that reflects the climatic environment of a particular region.

Figure 1: (Source: https://www.google.co.in)

Milk products are eminent as natural healthy products. Dairy products comprise the most crucial components of the balanced diet. In additions to nutritional benefits milk plays a significant role in the control of diseases. In Europe, dairy products are the major contributors in the functional food market by contributing approximately 60% of the total functional food spellings (Shortt *et al.*, 2004). They are the second well-liked class of functional foodstuff in the US and the consumers spend almost $5.0 billion on dairy functional products in 2004 (Vierhile, 2006). The Australian functional foods market is in its early life and is presently expected at $57.0 million where yogurt having the probiotic characteristics is being the head in this zone that is growing at 22% and the soy yogurt

resides at second. FAO/WHO standards describe the yogurt as ‘lactic acid fermentation by the activity of *Lactobacillus delbrueckii* and *Streptococcus thermophilus* (*St. thermophilus*) to produce a coagulated milk (Krasaekoopt *et al*., 2005). Shah (2007) quoted that fermented milk is a prepared through mixed starter fermentation by using a culture comprising of *St. thermophilus* and *L. delbrueckii*.

In Australia, lactic acid bacteria are allowed to employ as a starter cultures. Consequently, some yoghurt producers use *L. jugurti* and *L. helveticus* for manufacturing of yoghurt. Conversely, the standards in US do not allow any starter culture to be used other than *St. thermophilus* and *Lactobacillus delbrueckii*. The supplementation of different fruit provision in fermented milk products further endorse the healthy image of fermented milk that incorporate the fruits benefits. They provide antioxidants and fibre as described by O’Rell and Chandan (2006). Recently, corn milk (Supavititpatana *et al.*, 2008), soy milk (Cruz *et al*., 2009 and Champagne *et al*., 2009) and peanut milk (Isanga and Zhang, 2009) based fermented milk products are being synthesized as an alternate of vegetarian bovine milk fermented products that also overcome the allergencity of milk protein. Moreover, addition of plant extracts such as antioxidative and tea catechin is also considered significantly to enhance functionality of fermented milk (Jaziri *et al*., 2009). Various essential nutrients and different components are provided by fermented milk that regulates various body functions in an optimistic way. It is confirmed by various scientific evidences that chronic disorders i.e. coronary heart disease, osteoporosis, hypertension and cancer can be controlled by the ordinary utilization of probiotic or prebiotic supplemented fermented milk. Therefore the fermented milks meet with the functional food standards.

Fermented milk

Fermented milks are the milks fermented by good bacteria (lactic acid bacteria) which may be incorporated to the milk or naturally present in the milk. For even distribution of milk fat throughout the structure milk and milk products may or may not be mixed vigorously (homogenized) and must be pasteurized (Santosa *et al.*, 2006). When the milk is utilized these good bacteria remain active in milk. Both Lactic acid bacteria and Bifidobacteria are major species of good bacteria. *Lactobacilli* GG, *Lactobacillus acidophilus* and *Lactobacillus reuteri* are helpful in minimizing diarrhea from rotavirus, shigella or antibiotics.

Lactobacillus casei subsp. *rhmnosus* and *Lactobacillus acidophilus* assist to inhibit *Helicobacter pylori*. *Bifid breve* is helpful in prevention of diarrhea. *St. thermophilus* and *Bifido bifidum* are useful in diarrhea prevention. Erythromycin induced diarrhea is decreased by *Bifido longum*. Milk should not be heated nor should the whey (liquid part of the milk) be removed after fermentation. The fresh products should preferably be refrigerated as their shelf life is limited.

Figure 2: (Source: https://www.google.co.in)

Milk fermentation produces substances which have immuno-stimulatory and antitumor effects (Matar *et al.*, 2001). Yoghurt is one of the most popular and oldest fermented milk product prepared by using starter culture *Streptococcus thermophilus* and *Lactobacillus bulgaricus.* By using in a proper way, these cultures intricate particular metabolites during the process of fermentation. These metabolites enhance the fermented food digestibility in conjunction with milk (lactose, fat and proteins) hydrolysis and their therapeutic and nutritional qualities are also improved. In fermented foods products various cultures (based on lactic acids) produce a number of B vitamins and also improve the elaboration of lactose and different enzymes. These species are also used with probiotics which enhance health benefits (Kailasapathy *et al.*, 2008).

Various products are derived by spontaneous fermentation of lactic acid bacteria of milk arose decades ago through the influence of local traditions and climatic conditions in the

milk handling. Basically the fermented milk products were synthesized to preserve the nutrients. It has proved that it is possible to synthesize a product having particular texture, flavor, functions, and consistencies by fermenting the milk with a variety of various microorganisms. The fermented milk can be produced by using thermophilic bacterial strains using lactic acid fermentation method. Viili is other product, popular in Finland that can also be made through process of lactic acid fermentation but a mold and mesophilic bacteria are added to give slimy consistency characteristic to viili by partial fat hydrolyses. Fermented foods have gained a wide acceptance by consumer in the Britain within the past few decades and have an emerging image as a healthy food. Though, their fame must be due their wide range of varieties i.e. their taste and convenience as a snack or dessert food products.

Functional ingredients of fermented milk

For several thousand years people have been consuming fermented milks. It is an old consideration that they are health beneficial. They itself have all the milk components modified by lactic acid bacteria (LAB) fermentation. Lactic acid is produced by fermentation of lactose. It minimizes the pH, affects the casein physical properties and consequently enhance digestibility. It also meliorates the usage of calcium and different other minerals and suppress the development of potentially injurious bacteria. Fermented milk can be endured by individuals having a reduced ability for lactose digestion due to its smaller lactose content (McBean, 1999). Protein degradation is due to the effect of proteolytic activity of LAB that results in some bioactive peptides and free amino acids. Bioactive peptides are a common supplement to the functional foods and milk proteins are the major source of a variety of biologically active peptides for instance, casokinins, casomorphins, immunopeptides, lactoferricin, phosphopeptides, and lactoferrin. Several bioactive peptides derived from milk protein are inactive inside the parent protein sequence and can be generated by enzymatic proteolysis in food processing or gastrointestinal digestion. Immunomodulation, anti-thrombotic activity, mineral or vitamin binding, blood pressure regulation and anti-microbial activity are the major biological activities of such peptides. The fermented milks also are main source of whey proteins like lactalbumin, lactoperoxidase, lactoglobulin, immunoglobulins and lactoferrin. These proteins have exhibited a number of biological

effects having various effects on the functions of digestion and anti-carcinogenic activities (McIntosh *et al*., 1998).

During the process of fermentation the digestibility of fat is also improved. High percentage of saturated fatty acids is present in milk fat. It is frequently advised to avoid its use as it leads to coronary heart disease and an atherogenic profile of blood. The composition of milk fat shows that only three (palmitic, myristic and lauric acids) of the several different saturated FAs in milk have the property to raise the blood cholesterol level. At least about one third of the FAs are unsaturated having a tendency to lower the level of cholesterol. Moreover, fermented milks contain components that are protective if they do not have hypoholesterolemic effect. These comprise conjugated linoleic acid (CLA), linoleic acid, calcium, probiotic bacteria or lactic acid bacteria and antioxidants (Rogelj, 2000). The milk fat comprises of several components like sphingomyelin, CLA, butyric acid, carotene, ether lipids and vitamins D and A, having anti-carcinogenic effects. Several animal studies reveal that fermented milk inveterate the anti-carcinogenic action of CLA as well as its part in atherosclerosis prevention and in modulation of immune system (MacDonald, 2000).

Texture of fermented milk

Texture consists of both sensory and physical attributes. A physical structure of food is regarded as texture that comprises either rheological or mechanical properties that are associated to the sensation of touch in the oral cavity or other parts of body. Texture is impartially measured by dimension derivatives of time, mass and distance.

Though for the perception of fermented food texture sensory evaluation is best method. It requires a cautiously designed process. Therefore, sensory evaluation result is more significant illustration of fermented milk texture than the physical evaluation. Sensory evaluation is however time consuming and expensive. Texture Profiling Analysis (TPA) was devised by an organization for the sensory of the food texture (Bourne, 2002). Amongst the characteristic textural characteristics, the most preferred is the creamy texture (Jaworska *et al*., 2005). The creaminess is not an exclusive property of texture since it also implies other physical and sensory attributes (Frost and Janhoj, 2007). Another publication described creaminess (smoothness) as a parameter of flavor (Jaworska *et al*., 2005), and was the most

significant component of flavor. More specifically, in set plain yoghurt the creaminess is related to mouthfeel and textural descriptors. Comparatively, it is linked with more viscosity, smooth mouthfeel and fat related flavor in stirred plain yoghurt. Creaminess is also correlated to smoothness (Cayot *et al*., 2008).

Fermented milk texture is interconnected with flavor. One type of flavor exhibits a sticky, thick and poor smoothness in texture. On the other hand yoghurt containing flavors mixtures is observed as less thick having less sticky and smoother structure (Saint-Eve *et al*., 2004). Moreover, yoghurt made by supplementation of fatty flavors for instance butter and coconut is observed as thicker. However, impression of a smoother texture can be perceived by almond or green apple flavor. The desirable texture of yoghurt is exhibited by quick recovery after shearing, shear thinning behavior, and whey expulsion or less syneresis. Syneresis arises from an acid formed gel having low water holding capacity, physical disturbance such as stirring and extensive large pores of gel. Various factors in the processing of fermented milk, that conduct syneresis are low total solid content, high incubation temperature and high casein to whey protein ratio. The high cracks yoghurt and rough texture is manufactured by heating at high temperature 80-90°C. The subsequent syneresis and structural breakdown is directly correlated to less flexible and brittle protein bonds rather than porosity. Depending on the nature of the milk proteins the porosity may or may not be affected by the heat treatment. Significantly, the porosity and the syneresis increased by high temperatures. The gel fracture is also caused by local pressure during continuous aggregation of casein that eventually exceeds the gel pressure resistance. A good resistance to the breakdown is achieved through thick strand of yoghurt network. The same condition can be achieved through low temperature in incubation. Syneresis can be reduced by rising inoculation rate that leads to gel improvement (Lee and Lucey, 2004). An inferior yield stress resulting from lower inoculation levels was associated to larger but fragile pores within network of fermented milk. Syneresis may turn down during the cold storage (Guzel-Seydim *et al*., 2005).

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