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Buttermilk: An Unrevealed Nutraceutical

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Abstract

Buttermilk is a refreshing drink obtained in the preparation of butter from *dahi* or by churning cream. It is rich source of phospholipids and other constituents of MFGM. Therapeutic Properties of Buttermilk is described in Ayurveda texts. Consuming buttermilk on regular basis offers manly health benefits. Presence of MFGM has given buttermilk an added value. Cultured buttermilk also serves as a good source of bioactive peptide which can offer additional therapeutic values.

Keywords: Buttermilk, MFGM, health benefits

Dairy plants in India are usually challenged with the problem of byproducts utilization in economic manner. Buttermilk is an aqueous phase obtained after churning of cream either fresh or fermented into butter. Buttermilk contains various components like protein, lactose, fat and minerals but among them components of MFGM is particularly of great significance. In Ayurveda text has mentioned buttermilk as medicine for various illnesses. Buttermilk solids are untapped till recently and with the worldwide research focused on their role in health is now recognized. Buttermilk solids consists of milk fat globule membrane (MFGM) and allied material like proteins, phospholipids, sphingolipids and glycolipids which gives it unique properties and various health benefits ranging from anti-viral to anticancer**.**

Classification of Buttermilk

Based on method of preparation

Buttermilk obtained by churning of cream with little or no developed acidity is called sweet cream buttermilk (SCBM); the sour cream buttermilk, is the aqueous phase remaining at the end of churning process of ripened cream to produce butter and *Desi* Buttermilk, end product of churning process of curd to produce *makkhan* (Libudzisz and Stepaniak, 2002; Kumar *et al.* 2015).

According to Ayurveda

Acharya Charak and Acharya Vaghabhata has classified buttermilk into three types based on fat content namely *Ruksha Mandatama* (obtained by churning of curd and completely removing of fat), *Ardhodruta sneha* (prepared by churning of curd from which half of fat is removed), *Anudhruta sneha takra* (prepared by churning of curd from which no fat is removed) (Jyoti and Kavita, 2016).

Another way of classification by Bhavamisra is based on the method of preparation as Ghola (churning of curd without adding water and without removing butter), *Madita* (obtained after preparation of butter using churning curd without water), Takra (by adding ¼th quantity of water to *Madita*), Udashvita (by adding half the quantity of water to *Madita*) and

Chachika (Obtained by adding large quantity of water to *Madita*) (Jyoti and Kavita, 2016).

Chemical Composition of Buttermilk

The chemical composition of buttermilk largely depends on method of preparation and type of buttermilk (Pal and Raju, 2008).

Table 1: Chemical Composition of different type of buttermilk

Components	SCBM	Cultured Buttermilk	Whey based Cultured Buttermilk
Total Solids (%)	7-10	8-10	6.97
Fat (%)	0.3-1	0-2.5	1.34
Lactose (%)	3.5-4.9	4.8-5.8	3.28
Protein (%)	2.66-3.75	3.4-3.8	2.28
Phospholipids (%)	0.075-0.25	ND	—
Minerals (%)	0.6-0.75	0.6-0.9	0.75
Acidity (% LA)	0.13	0.5-0.7	0.67

Libudzisz and Stepaniak, 2002; Aneja et al. 2002; Sonali et al. 2017.

Acidity is the most distinguish components in different type of buttermilk (Table 1). Major components of SCBM is MFGM, consist of protein lipid especially derived from membrane phospholipid of MFGM (Libudzisz and Stepaniak, 2002). A 100 gram of fat contains 0.5- 1.5g of MFGM (Fox . 2015). Keenan *et al.* (2002) reported that MFGM preparations from cows' milk have about 28 different enzymes including xanthine oxidase/dehydrogenase, γ-Glutamyl transpeptidase, 5'-nucleotidase, plasmin, aldolase and catalase. The vitamins levels in buttermilk depends on type of starter culture used in its fermentation and may be higher or lower than in non-cultured milk.

The content of calcium and phosphorus compounds in buttermilk is more or less similar to that of milk (Libudzisz and Stepaniak, 2002) and it is also a good source of potassium and vitamin B_{12}. MFGM components gives the emulsifying properties and foaming capacity, which are higher in sour, sweet and whey buttermilk than milk and whey (Sodini *et al.* 2006).

Utilization of buttermilk

SCBM is used to prepare different type of cheeses like cheddar cheese, processed cheese (Joshi and Thakar, 1996a & b; Gokhale *et al.* 1999; Shodjaodini *et al.* 2000) and is also used to substitute skim milk powder in the preparation of yoghurt (Trachoo and Mistry, 1998). SCBM used in traditional Indian dairy products like channa, paneer, shrikhand, basundi, rasogolla etc., (Sharma *et al.* 1998; Karthikeyan *et al.* 1999 and 2000; Patel and Upadhyay, 2004; Kumar, 2006). Many researchers had prepared beverages using buttermilk added with fruit juice or fruit pulp (Shukla *et al.* 2004; Kankhare *et al.* 2005). Prajapati *et al.* (2014) developed technology for manufacturing of burfi from sweet cream buttermilk standardized to 6% fat and by addition of 34% sugar to buttermilk khoa. Jana and Kadiya (2015) standardized the manufacturing of kulfi replacing 20% of milk solids with sweet cream buttermilk solids.

Novel Ingredients from Buttermilks

Churning of cream ruptures the fat globule membrane which goes into aqueous phase along with whey proteins, milk sugar, minerals and water soluble vitamins (Morin *et al.* 2006).

The MFGM contains traces of carotene and vitamin E (Walstra *et al.* 1984). Factors like breed, fat content and fat globule size, diet and stage of lactation of milch animal influence MFGM composition (Morin, 2006). MFGM contains 25-60% of protein by weight. Fat globule membrane is basically made up of three layers. Proteins and polar lipids encircle the lipid core which forms the inner layer which is followed by a second layer of protein coat. The final outer layer surrounding the entire fat globule comprises of glycoproteins, proteins, enxymes, phospholipids and polar lipids (Walstra *et al.* 1984; Danthine *et al.* 2000).

Butyrophilin (BTN, 40%), Mucin 1 (MUC 1, 40 ppm of skim milk), xanthine dehydrogenase/oxidase (XDH/XO, 20%), CD 36 (PAS IV), periodic acid-Schiff III

(PAS III, Mucin 15), and periodic acid-Schiff (PAS VI/VII, lactadherin), fatty acid-binding protein (FABP) and adipophilin (ADPH) constitute the major protein of MFGM (Smoczynski *et al.* 2012).

The milk lipids (0.5-1.0%) present in MFGM contains neutral lipids and phospholipids in the 2:1 ratio. The 37-68% fraction of neutral lipids is triglycerides, diglycerides being 9%, monoglycerides make up to 0.7%; esters contribute to 0.1-0.8% while the cholesterol content varies between 0.2-2% (Keenan *et al.* 2002; Danthine *et al.* 2000). The major polar lipid present in MFGM comprises of phosphatidylcholine (PC, 36%), phosphatidylethanolamine (PE, 27%), sphingomyelin (SM, 22%), phosphatidylinositol (PI, 11%), and phosphatidylserine (PS, 4%) which accounts for 15-43% of total lipids in the MFGM.

Health benefits

Consuming buttermilk on regular basis offers manly health benefits. It is used in treatment of diseases as well as to maintain health. Sonali *et al.* (2017) reported that during storage of cultured buttermilk prepared by blending dahi and fermented whey in 60:40 using *L. helveticus* MTCC 5463, the proteolytic activity increased throughout storage period up to 5 days at 7±2°C. Many research workers have confirmed that various strains of *L. helveticus* have remarkable proteolytic activity and they present a potential system to liberate dormant bioactive peptides from milk proteins through proteolytic hydrolysis during fermentation of milk (Virtanen *et al.* 2007).

Anticancer Effects

In vitro study revealed that selenium carrier protein, FABP present in MFGM controls the growth of some breast cancer cell lines (Spitsberg and Gorewit, 2002). Inhibitors of beta-glucuronidase (produced by intestinal bacteria) present in the MFGM could prevent colon cancer (Spitsberg, 2005). Metabolites of sphingolipids are involved in differentiation and apoptosis of cells (Duan *et al.* 2009). SM is main component of skin cells and gives protecting effect against the ultraviolet radiation (Russell *et al.* 2010).

Influence on gut health

Studies on rat by Sprong *et al.* (1998) revealed that when the experimental animals were fed with lactase treated sweet butter milk powder it protected them from gastrointestinal infections by preventing colonization of *L. monocytogenes*. Also MFGM and peptide hydrolysates, generated by proteolysis with immobilized digestive enzymes, gave antibacterial activity against *Salmonella enterica* and *Pseudomonas fluorescens* (Clare *et al.* 2008).

Wang *et al.* (2001) reported that protein component of MFGM reduced gastric mucosa infection in mice caused by *H. pylori* on oral administration of MFGM. Periodic acid–Schiff VI/VII, one of the protein present in MFGM promoted mucosal healing (Bu *et al.* 2007). MFGM-enriched milk offered protection to young children against gastrointestinal infections as revealed by some researchers (Veereman-Wauters *et al.* 2012). XDH/XO fulfills protective, antibacterial functions in the alimentary tract(Harrison, 2006) and reduced inflammation in human with help of neutrophils (Fong *et al.* 2007). Sonali *et al.* (2017) reported that cultured buttermilk prepared by blending dahi and fermented whey in 60:40 ratio by employing *L. helveticus* MTCC 5463 showed antimicrobial activity against *S. aureus*, *S. typhi* and *E. coli.*

Heart health

Conway *et al.* (2014) suggested that buttermilk may represent a new safe food modality to manage blood cholesterol and blood pressure as part of healthy eating. Feeding of processed cheese spread containing buttermilk concentrate (30%) to rats significantly decreased the total and LDL cholesterol contents (El Sayed *et al.* 2006). Sonali *et al.* (2017) reported that *in vitro studies* of cultured buttermilk prepared by incorporation of fermented whey into *dahi* exhibited ACE-inhibitory activity.

Neurological Development

The consumption of milk phospholipids or milk products may reduce the risk of some neurodegenerative diseases as they offer protective

effect on stress induced neuronal cell death (Nagai, 2012). Cultured buttermilk is a good source of phospholipids.

Antioxidant activity

Conway *et al.* (2012) reported that buttermilk protein concentrates and their enzymatic hydrolysates exhibited superior antioxidant activity (especially due to the presence of butyrophilin in MFGM) compared to skim milk proteins. Sonali *et al.* (2017) reported that *in vitro studies* of cultured buttermilk prepared by incorporation of fermented whey into dahi using *L. helveticus* MTCC 5463 strain showed antioxidant activity as assayed by ABTS method.

Therapeutic Properties of Buttermilk described by Ayurveda

In Ayurveda buttermilk is advised for treatment of intestinal bowel syndrome (IBS), for improving digestion (*Pachana*), edema (*Shotha*), diarrhea (*Atisara*), hemorrhoids (*Arshas*), abdominal tumors (*Gulma*), Parasitic infection (*Krimi*), Diabetes (*Meha*), ascites (*Uadar Roga*), anemia (*Pandu Roga*), vomiting (*Chardi*) etc. (Laxmi, 2015).

CONCLUSION

On basis of the estimated availability of buttermilk and the scope for the development of health-based value added foods, it can be concluded that buttermilk, as a byproduct, needs proper attention for its judicious utilization. The MFGM components could be used safely for pharmaceutical preparation. Buttermilk is truly a nutritious drink available in the kitchen of each home whose nutritional qualities remains untapped. It is a promising ingredient for development of functional foods and more research on therapeutic properties of buttermilk need to be carried out.

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