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## **Nutraceutical Properties of Milk and Milk Products: A Review**

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### **ABSTRACT**

Milk is recognised as complete food for human beings because it contains most of the essential nutrients. Besides, traditional components now it is proved that milk is also a good source of biopeptides and other bioactive components which are necessary for body maintenance and to fight against several disease conditions. Minerals present in milk are good source of bone health and body cells functioning. Various vitamins such as vitamin-A, D, B<sub>12</sub> and others are a vital source for the body coat and physiological functions of the human body. The conjugated linoleic acid naturally present in milk is a good fat for human health. Various components of milk are also necessary for thyroid function, protection against metabolic disorders, gout and other similar malfunctioning. Besides, several other components the prebiotics, probiotics, symbiotic, biopeptides and bioactive components along with unique source of protein (casein), carbohydrate (lactose) etc. may serves as live saving drugs in emergency cases of the human body.

**Key words:** Milk, biopeptides, casein, lactose, vitamins, minerals, conjugated linoleic acid

### **INTRODUCTION**

A nutraceutical is a food with a medical-health benefit, including the prevention and treatment of disease. The term was coined in the late 1980s by Stephen DeFelice, M.D., founder and chairman of the Foundation for Innovation in Medicine. Such foods also commonly are referred to as functional foods, signifying they and their components may provide a health benefit beyond basic nutrition. Examples include fruits and vegetables as well as fortified or enhanced foods. While all foods are functional in that they provide nutrients, nutraceuticals contain health-promoting ingredients or natural components that have a potential health benefit for the body. "Functional" attributes of many traditional foods are being discovered, while new food products are being developed with beneficial components.

Milk is an excellent source of well balanced nutrients and also exhibits a range of biological activities that influence digestion, metabolic responses to absorbed nutrients, growth and development of specific organs and resistance to disease. These biological activities are mainly due to the peptides and proteins in milk. However, some of the biological activity of milk protein components is latent and is released only upon proteolytic action. Bioactive peptides are produced during digestion of milk in the gastrointestinal tract and also during fermentation and food processing. The milk and milk products also provides coenzymes alongwith biopeptides which enhances the physiological functionality and biological significance of dairy products

(Dajanta *et al.*, 2008; Singh and Sachan, 2009; Mazza, 1998). Milk also promotes strong bones by being a very good source of vitamin D and calcium and a good source of vitamin K. In addition, milk is a very good source of iodine, a mineral essential for thyroid function and a very good source of riboflavin and good source of vitamin B12. These two vitamins are necessary for cardiovascular health and energy production. Cow's milk is a good source of vitamin-A (a critical nutrient for immune function) and potassium (a nutrient important for cardiovascular health). Milk produced by grass fed cows contains a beneficial fatty acid called Conjugated Linoleic Acid (CLA) (Midau *et al.*, 2010). Research studies show that this fatty acid inhibits several types of cancer like human skin cancer, colorectal cancer, breast-cancer and help to lower cholesterol and prevent atherosclerosis. The components of milk like Casein and whey proteins are the two main protein groups in milk, caseins comprises about 80 percent of the total protein content in bovine milk and are divided into  $\alpha$ -,  $\beta$ - and  $\kappa$ -caseins. Whey protein is composed of  $\beta$ -lactoglobulin,  $\alpha$ -lactalbumin, immunoglobulins (IgGs), glycomacropeptides, bovine serum albumin and minor proteins such as lactoperoxidase, lysozyme and lactoferrin. Each of the subfractions found in casein or whey has its own unique biological properties. Milk proteins can be degraded into numerous peptide fragments by enzymatic proteolysis and serve as source of bioactive peptides.

#### **Nutritive value:**

- Milk is a good source of calcium which is responsible for maintaining the strength and density of bones. Besides, its role in bone health it also provides aids for protection against colon cancer, breast cancer, bone loss during menopause, prevents migraine headaches, reduces PMS symptoms during the luteal phase of the menstrual cycle and childhood obesity
- The vitamin-D which is a fat soluble vitamin found in milk and milk products acts actually like a hormone than vitamin. Calcitriol, the most metabolically active form of vitamin D, works with Parathyroid Hormone (PTH) to maintain proper levels of calcium in the blood. In addition, calcitriol participates in the regulation of cell proliferation, differentiation and growth which suggests that vitamin-D may play a role in the prevention and treatment of various cancers. A cup of cow's milk supplies 24.4% of the daily value for this important vitamin
- Vitamin-K present in milk is important for maintaining strong bones. Among these vitamin K1 activates osteocalcin, the major non-collagen protein in bone which anchors calcium molecules inside of the bone. Therefore, without enough vitamin K1, osteocalcin levels are inadequate and bone mineralization is impaired. A cup of cow's milk provides 12.2% of the daily value for vitamin K
- Cow milk is a very good source of riboflavin and a good source of vitamin-B<sub>12</sub> which are important for energy production (Sachan and Singh, 2010). Vitamin B<sub>12</sub> plays a pivotal role as a methyl donor in the basic cellular process of methylation through which methyl groups are transferred from one molecule to another. It resulted into the formation of a wide variety of very important active molecules. Riboflavin (vitamin-B<sub>2</sub>) plays at least two important roles in the body's energy production. When active in energy production pathways, riboflavin takes the form of Flavin Adenine Dinucleotide (FAD) or Flavin Mononucleotide (FMN). In these forms riboflavin attaches to protein enzymes called flavoproteins that allow oxygen-based energy production to occur. Flavoproteins are found throughout the body particularly in locations where oxygen-based energy production is constantly needed such as the heart and other muscles. One cup of cow milk supplies 14.8% of daily needs for vitamin B<sub>12</sub> and 23.5% of the DV for riboflavin (Singh and Sachan, 2010b)

- Vitamin-A is critically importance for the health of epithelial and mucosal tissues and acts as a body's first line of defence against invading organisms and toxins. A cup of cow milk gives 10.0% of the daily value for vitamin-A

**Protective value:**

- Milk is a good source of low-cost high-quality protein, providing 8.1 grams of protein (16.3% of the daily value for protein) in one cup. The structure of humans and animals is built on protein. We rely on animal and vegetable protein for supply of amino acids and then our bodies rearrange the nitrogen to create the pattern of amino acids we require. Approximately 20% of total milk protein fraction consists of a heterogenous group called whey protein which is consist of several dissimilar proteins with their specific physiological functionality. The most abundant whey protein,  $\alpha$ -lactoglobulin acts as co-enzyme in lactose synthesis while lactoferrin, lactoperoxidase or various immunoglobulins have specific roles in protection of neonates and adults against micro-organisms. Some of whey proteins contain bioactive peptides with weak opioid or other biological activities (Singh and Sachan, 2010b). Seraphin and albutensin are the examples which come from serum albumen fraction while lactoferroxin comes from lactoferrin and lactotensin from  $\beta$ -lactoglobulin components. Whey proteins are currently considered as most desirable components in the diets of body-builders and athletes seeking to increase their muscle mass (Singh *et al.*, 2009). These are now commercially available by the names of dried sweet whey, WPC (low/medium/high protein), ion exchange treated, hydrolysed WPC, precision tailored whey peptides etc
- Gout is a common type of arthritis whose onset typically involves the big toe. It has been linked to eating of high purine foods. Purine is one of the nucleic acid building blocks of DNA and RNA which contributes to gout since they are metabolized to form uric acid. If it produced in excess then it can deposit in joints causing pain, redness and swelling. The risk of contracting gout decreased with increasing intake of dairy products. Men consuming the most dairy products cut their risk of gout by almost 50%. Although, some vegetables like beans, peas, lentils, asparagus, cauliflower, spinach and mushrooms are also high in purines
- The organic milk is a good source of omega-3 fats as compared to conventional milk. And it contains up to 71% more omega-3, have a better ratio of anti-inflammatory omega-3 and pro-inflammatory omega-6 fatty acids. Drinking just 10 ounces a day of organic milk provides approximately 10% of the UK's DRI for the omega-3 fat and alpha-linolenic acid. Organic cheese is an even better source and a matchbox sized piece of organic cheese provides 88% of the RDI of this omega-3 fat
- Milk is a very good source of iodine which as a component of the thyroid hormones thyroxine (T4) and triiodothyronine (T3) which is essential to human life. The thyroid gland adds iodine to the amino acid tyrosine to create these hormones. Without sufficient iodine body cannot synthesize them. These thyroid hormones regulate the metabolism in every cell of the body and play a role in virtually all physiological functions. An iodine deficiency can have a devastating impact on health and well-being. A common sign of thyroid deficiency is an enlarged thyroid gland commonly called a goiter. Goiters are estimated to affect 200 million people worldwide and in all but 4% of these cases, the cause is iodine deficiency. One cup of cow milk provides 39% of the daily value for iodine

- Potassium is an important electrolyte involved in nerve transmission and the contraction of all muscles including the heart. It is also essential for maintaining normal blood pressure and heart function. A one cup of cow milk provides 10.8% of the daily value for potassium
- Melatonin is a hormone produced within the brain and which occurs naturally in milk which helps to regulate our body clock (the circadian rhythm). The levels in our bodies vary over the course of a 24 h cycle and over the course of our lives. It's when your body can't produce enough melatonin that you can't get off to sleep at night. Sleepless Americans can take melatonin in dietary supplements but in the EU, Australia and elsewhere synthetic melatonin which is the basis for almost all dietary supplements, is classified as a drug and it cannot be added to any foodstuff. Milk naturally contains some melatonin and many companies have looked at the possibility of marketing this intrinsic health benefit but as so often in the business of food and health, it was the Finns who were first with an innovative dairy product to address the sleep issue

**Role of dairy products as probiotics, prebiotics and symbiotic:** Probiotics are "live micro-organisms which when administered in adequate amount confer a health benefit on the host". The use of fermented dairy products like yogurt, kefir and kumis is a long back practice but the probiotic role of these products was setup by Metchnikoff (1908). The organism responsible for the fermentation of dairy products varies according to the dairy product and their utility like acidophilus milk is produced by Lactobacilli, yogurt by Lactobacilli and Streptococci and bifidus milk by Bifidobacteria. The role of fermented dairy products as a probiotics in the health benefits includes growth promotion, increase in absorption of minerals, increase in immune response through increased production of secretory immunoglobulins, decrease in population of pathogens through the production of acetic and lactic acid as well as other bacteriocins, reduction in lactose intolerance through consumption of *Lactobacillus acidophilus* containing food, suppression of potentially harmful microbial enzymes associated with colon cancer, stabilization of intestinal microflora in gastrointestinal disturbances case and use of antibiotics, relief of constipation, reduction of serum cholesterol and inhibitory effect against mutagenicity (Table 1).

The prebiotic term is generally applied for oligosaccharides which promotes the growth of beneficial organisms. The example of some dairy origin oligosaccharides are lactulose, lactosucrose, lactitol, fructo-oligosaccharides, malto and isomalto-oligosaccharides, raffinose and stachyose. Whereas, symbiotic contains the characteristics of both prebiotic and Probiotics such as Symbalance yoghurt produced from *Lactobacillus reuteri*, *L. acidophilus*, *L. casei*, biofidobacteria and inulin (Mirhosaini *et al.*, 2010).

The main role of casein is to provide amino acids required for the growth of neonates. Holt (1997) suggested the importance of casein micelle system in prevention of pathological calcification of the mammary gland. The peptides hidden in the casein amino acid sequence has a specific activities such as casomorphins contains opioid-like activity, immunopeptides provides immunostimulating activity, peptides with antihypertensive activity, phosphopeptides having the ability to sequester calcium and other minerals. Though the bioactive peptides are under trial for various uses but some of them are commercially available for various uses and some of them are given in Table 2.

Traditional dairy processing techniques were largely based on the nutritional quality and productivity (Foda *et al.*, 2009). But the need of health conscious consumers can be fulfilled only by the enhancement of physiological functionality of milk and milk products (Singh and Sachan, 2010a). The processing techniques based on membrane technology can be utilized for the

Table 1: Different types of function foods, their origin and role in human body (aboutbioscience.org)

Nutraceutical	Sources	Role in human body
$\alpha$ -carotene	Carrots, various fruits	Neutralizes free radicals which may damage cells; bolsters cellular antioxidant defenses
Lycopene	Tomatoes and processed tomato products	Contribute to maintenance of prostate health
Insoluble fiber	Wheat bran	May contribute to maintenance of a healthy digestive tract
Monosaturated fatty acids	Tree nuts	May reduce risk of coronary heart disease
Flavonols	Onions, apples, tea, broccoli	Neutralize free radicals which may damage cells; bolster cellular antioxidant defenses
Sulforaphane	Cauliflower, broccoli, cabbage, kale, horseradish	May enhance detoxification of undesirable compounds and bolster cellular antioxidant defenses
Caffeic acid, ferulic acid	Apples, pears, citrus fruits, some vegetables	May bolster cellular antioxidant defenses; may contribute to maintenance of vision and heart health
Stanol/sterol esters	Fortified table spreads, stanol ester dietary supplements	May reduce risk of coronary heart disease
Sugar alcohols (xylitol, sorbitol, mannitol, lactitol)	Some chewing gums and other food applications	May reduce risk of dental caries (cavities)
Lactobacilli, bifidobacteria	Yogurt, other dairy and nondairy applications	May improve gastrointestinal health and systematic immunity
Isoflavones (daidzein, genistein)	Soybeans and soy-based foods	May contribute to maintenance of bone health, healthy brain and immune functions; for women, maintenance of menopausal health
Soy protein	Soybeans and soy-based foods	May reduce risk of coronary heart disease
Dithiolethiones	Cruciferous vegetables	May contribute to maintenance of healthy immune function

Table 2: Bioactive components of milk and milk products (Mazza, 1998)

Class	Product	Properties claimed
Bioactive peptides	Glutamine peptides	Maintain immune system
		Regulate protein turnover
		Glycogen replenishment
	Peptide FM	Inhibit dietary fat deposition
		Alter fat metabolism
	Casein phosphopeptides	Enhance calcium absorption
		Enhance iron absorption
		Prevention of dental caries
Bioactive proteins	Lacto peroxidase	Promote beneficial intestinal flora
		Probiotic effect
	Lactoferrin	Regulate iron transport and absorption
		Promote beneficial intestinal flora
	Lactoal (natural milk calcium/mineral complex)	Enhance calcium absorption

production of modified dairy products. In this technique we can fractionate the liquid system such as milk or whey into the streams containing components of varying molecular size or charge (Lopes *et al.*, 2009). This process can be utilized for extraction of certain components of desired biological activity from the rest of the stream without altering its overall technological functionality. The technology called genetic engineering may also be exploited in enhancement of functionality of milk and its ingredients. For this purpose technique such as transgenesis, intramammary gene insertion and immuno-induction may lead to the production of natural milk with increased contents of specific functionality.

## CONCLUSION

In the view of above citation we can conclude that instead of using traditional techniques and components of milk and milk products we can exploit the functionality of these products for health benefits. Improvement in this field is also important to withstand of our dairy industry at international level because 'nutri-marketing' is becoming a major driving force in the international dairy industry.

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