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Nutraceutical Functions of Milk Components

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Review Article

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ABSTRACT

In the present scenario the food consumption trends have changed from consuming any type of food to consuming a value added food product. The changing lifestyle and increasing extent of industrialization has resulted in several diseases and immunodeficiency. Emergence of new food categories like nutraceutical foods and functional foods have become more important as it delivers specific health benefits and improves human nutrition. The main focus of this review is to summarize the presence of specific bioactive components of milk which contribute to health enhancing nutraceutical properties when consumed.

Introduction

Nutraceuticals are the food products with high medicinal value which help to improve the health and regulate immunity to prevent and cure diseases. Bovine milk is an excellent source of bioactive components which are present naturally or formed due to the changes during several food processing operations. Milk contains derived peptides of protein, lactoferrin, immunoglobulin, enzymes, lipids, growth factors, cytokines, lactose and oligosaccharides. These bioactive components are the compounds having biological, physical and immunological properties when consumed [1]. And these are used for the treatment of bone health, dental health, heart health, immunodefense, digestive health, stress and diarrhea [2]. As these components in milk contribute to a number of health promoting effects, it is targeted as the potential ingredients for nutraceutical as well as functional foods.

Literature Review

In addition to the nutrients present naturally in milk, there are several bioactive components derived from milk, which were found in inactive form initially and released during the enzymatic hydrolysis or by fermentation or by gastrointestinal digestion and have multifunctional properties including applications to improve the human nutrition and health [3] .

Different Bioactive Proteins in Milk

Protein present in milk is 3.5% out of which 80% is casein and 20% is whey proteins. Other minor proteins which have multifunctional properties are also present in colostrum and milk [3]. Functions like antihypertensive [4], antimicrobial [1], antioxidative [5], opoid [6] and immunomodulation [7] are exhibited by whole casein .There are some products which are fortified with these bioactive components derived from β and k-casein. Sour milk and fermented milk enriched with hypotensive tripeptides Val-Pro–Pro and Ile-Pro–Pro under the brand names Calpis and Evolis have high demand in the market [2]. Many clinical studies proved that α lactalbumin of 20% present in whey proteins have favourable effect to reduce depression in humans. β lactoglobulin comprising 50% of whey protein has multifunctional properties such as anticarcinogenic, immunomodulatory, opioid, hypocholesterolemic, and other metabolic effects. β lactoglobulin causes milk allergy in children with 60% of oral challenges as it is absent in the human milk [2]. Reports by Schmidt and Poll (1991), proved that β lactoglobulin as the major allergen among whey protein. β–Lactoglobulin is a good trypsin substrate [8] Powerful allergens in whey proteins lost its sensitizing capacity when

hydrolyzed with trypsin. Trypsin has specificity of bonds associated with the hydrophobic side chains of the amino acids lysine and arginine. Asselin *et al* (1989) stated that allergenicity was reduced in hydrolysates than the untreated proteins. Hypoallergic formulas were made by subjecting whey proteins to tryptic digestion with less amino acid degradation [9]. The poor digestability of intact whey protein is also one reason for allergenicity and hydrolysis using a suitable enzyme or combination of enzymes can reduce allergenicity upto 70 % [10]. Lactoferrin and lactoperoxidase are the glycoproteins present naturally in colostrum milk. Lactoferrin helps to prevent microbial infections and plays an important role in host defence system and known to have excellent biological properties such as anti-inflammatory, anticancer, and immune regulatory properties [11]. Lactoperoxidase has the ability to inhibit the growth of spoilage causing microorganisms and this system is more importantly applied in the preservation of milk and other products [1]. Glycomacropeptide (GMP) is a hydrophilic peptide present in whey, released from k- casein during the manufacture of cheese by rennet action. . GMP contains low methionine and is rich in branched - chain amino acids which makes it a useful ingredient in the preparation of diets for patients suffering from hepatic diseases [1]. The phenylalanine is absent in the amino acid composition of GMP makes it suitable for nutrition in case of phenylketonuria [12] .This opens the opportunity to use cheese whey as a suitable keto diet [1].

Bioactive Peptides

Antimicrobial peptides, Immunomodulatory peptides, Anti-hypertensive peptides or angiotensin-converting enzyme (ACE) inhibitory peptides, Opioid peptides and Antioxidant peptides are the bioactive peptides having important role in the human health. Antimicrobial peptides are used for inhibiting gram negative and gram positive microorganisms [3] whereas immunomodulatory peptides help to improve the immunity in humans. Mainly casein derived cytomodulatory peptides help to improve the activities of immune competent cells thereby inhibiting the growth of cancer cells [13]. Glycomacropeptides and its derivatives produce IgG anitbodies that stimulate the immunity [3]. Antihypertensive peptides are able to control the hypertension which is commonly seen in the present population due to their lifestyle diseases and many medicines were used to decrease this hypertension but has concluded with adverse side effects. Antihypertensive peptides in milk inhibit the growth of Angiotensin-converting enzyme (ACE-which causes high blood pressure) to control increase in blood pressure. When antihypertensive peptides are used in food, diets will result in natural prevention of hypertension. Milk derived opoid peptides help in the growth and function of brain cell and also in the digestive system [3]. Antioxidant peptides are the bioactive peptides derived from milk and used to prevent the formation of free radicals which cause oxidation in the food products .Many artificial antioxidants were used to prevent oxidation and causes strong side effects in human physiology. This can be rectified by using natural antioxidant peptides from milk [3].

Moreover, bioactive peptide component present in A2 milk also seeks attention. Milk are of 2 types classified due to variations in genes of β casein present in bovine milk. They are A1 milk mainly produced from crossbred breeds of cattle and A2 milk from indigenous cattles. The main difference is in the 67th amino acid position. A1 milk contains histidine and A2 milk contain proline in the 67th position. During the digestion of A1 β casein milk, it releases bioactive peptides called β casomorphins -7 (BCM-7) and causes many human disorders like heart disease, Type 1 diabetes, autism and schizophrenia but A2 β casein milk produces peptides called BCM-9 which does not cause such type of illnesses. This suggests that consumption of A2 milk is good for health and is associated with neutraceutical properties [14].

Bioactive Properties of Lipids

There are 400 different types of Fatty acids present in milk fat which have important nutritional value in the human diet [15]. Most of the fatty acids are esterified with glycerol and are present in form of triacylglyceride [16] which accounts for about 95% in the milk fat [17] and rest of 2% is diacylglycerol, 1% of phospholipids, 0.5% of cholesterol and 0.5% free fatty acids. Many of the studies reveal that different fatty acids have different health benefits and most of the fatty acids contain saturated fatty acid [17]. It is reported that cancer is prevented upto a limit by butyric acid (4:0) and it is a well-known gene modulator [18]. Antiviral and antibacterial functions are lead by Lauric acid (12:0) and also act as an anti caries and antiplaque agent [19]. It is also reported that the tumour growth can also be delayed by the caprylic acid (8:0) and this also plays an important role in antiviral activities [20]. Oleic acid which is a monounsaturated fatty acid present in milk has got favourable human health benefits [21]. Other important fatty acid is the conjugated linoleic acid (CLA) which is in the form of different positional and geometrical isomers and has become the major interesting area for the researchers. The most important isomer is cis-9, trans-11 which is formed by the bioconversion of polyunsaturated fatty acid by anaerobic bacteria in the rumen therefore it is known as rumenic acid [22]. The studies show that the CLA concentration is found increased in the grazing or pasture feeding animals. CLA is known to have many therapeutical values such as anti-carcinogenic, improvement of immune system, antidiabetic, antihypertensive, antiatherogenic, antiobesity and promotes reduction of body weight [23]. The consumption of butter milk is found to be more important because it contains bioactive lipids such as polar lipids which are found in milk fat globule membrane and shows numerous health promoting effects such digestion and many research studies proved that fractions of phospholipids and sphingolipids act as antiproliferative agents against human ovary and colon cancer cells [2].

Minerals and Vitamins

We know that milk is rich in nutrients due to the presence of minerals and vitamins. Minerals such as calcium, magnesium,

zinc and selenium are rich in its therapeutic value. Calcium rich milk not only strengthens the bones but also helps to reduce the chances of colon cancer or breast cancer and kidney stone development. It helps to prevent hypertension and facilitates in weight controlling [17]. Many reports on magnesium proved that it can be used for the treatment of asthma. Zinc which has an important role in human body mainly for the cell growth, metabolism of protein and lipids, gene expression, DNA repair and replication is found most abundantly in the milk itself [17]. Selenium which is present in minute concentration takes part in reduction of asthma and their deficiency tends to cause adverse mood states [24].

Milk is also rich in vitamins such as Vitamin A, vitamin B2, vitamin B12 and vitamin E. Although milk contains low concentration of vitamin A, it plays an important role in vision differentiation, reproduction, proper growth of cells and also in the health of epithelial and mucosal tissues [17]. Vitamin B_2 is a water soluble vitamin naturally occuring the form of riboflavin. It acts as antioxidant and also helps in the DNA repair [17]. Vitamin B_{12} is an essential nutrient in synthesis of DNA, the genetic materials of all cells. It also helps to keep the nerves and blood cells healthy. Vitamin B_{12} helps to prevent megaloblastic anemia a condition that makes people tired and weak [25]. Vitamin E is an antioxidant which protects the cells from damaging effect of Reactive oxygen species (ROS). The molecules containing free radicals are highly energetic and react with oxygen to form ROS which helps in the development of cardiovascular diseases and cancer. These ROS are released inside the body during the conversion of food to energy [26].

Discussion

Milk components are very important from nutritional point of view. In future, products with the bioactive component as the main ingredient will definitely help the infants, adults and aged population to be healthy and to prevent disease. Many human clinical studies have proved that better digestibility, immuno regulatory functions and anticarcinogenic functions of milk components enhance the status of milk as a healthy food choice. Milk being a dietary food nourishes the human body in many ways. Techniques for utilizing the neutraceutcal components in milk should be developed and thereby the components can be fully utilized. Components in milk show a wide range of properties in the development of human body such as increase in immunity, prevention from diseases and provide all the minerals and vitamins essential for the well-being of human.

Conclusion

By the isolation of these derived bioactive peptides and their continuous production it is possible to formulate several potential ingredients for drugs and food with neutraceutical properties. Health promoting functional foods and other pharmaceutical products enhance biological functions of human body thereby promoting positive effect on human health. Research and development activities should be done in this area to increase the scope and utilization of these components.

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