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## Milk, Dairy Products, Nutrition and Health

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### Summary

Scientific progress in nutrition, medical and food sciences is having an increasingly profound impact on consumer's approach to nutrition. There is a growing awareness that many chronic diseases are caused by unbalanced diet. In addition to disease prevention, the role of food as an agent for improving health has been proposed and a new class of food, so called functional food, has come into being. This term is used to indicate a food that contains some health-promoting components and not only traditional nutrients. From this point of view we could argue that milk and many dairy products belong to the family of functional food replete with bioactive peptides, probiotic bacteria, antioxidants, highly absorbable calcium, conjugated linoleic acid and other biologically active components. Although evaluation of the benefits or risks of foods normally does not entail the same extensive examination as that required of drugs, this does not negate the need for sound scientific information before making conclusions and recommendations to the consumers. This paper reviews and discusses some of the latest findings regarding the role of milk and dairy products in nutrition and health.

*Key words:* milk, dairy products, functional food, nutrition, health

### Introduction

An increasing amount of scientific evidence confirms that many chronic diseases such as cancer, osteoporosis, coronary heart disease and hypertension are connected to an unbalanced diet. The diet-health message has reached consumers and the food industry. Consumers are beginning to believe that diet has a powerful influence on health and wellbeing and the food industry has taken advantage of new possibilities. Progress in food processing and biotechnology has enabled the food industry to create food with special characteristics and in addition to disease prevention, the role of food as an agent for improving health has been proposed. New terms such as probiotics, prebiotics, synbiotics and functional food have been created to describe food products with special characteristics.

Functional Food is a new chapter in nutrition science. There are many aspects of functional food and as a

consequence term has no exact definition. It is usually described as »food which promote health beyond providing basic nutrition«. Roberfroid (1) indicated that food is functional if it contains a food component that affects one or a limited number of functions in the body and Head *et al.* (2) stated that functional food could be naturally occurring food, not just enriched or modified food. In the light of such statements one may say that the best known examples of functional food are fermented milks containing probiotic bacteria. Milk itself is much more than the sum of its nutrients. The development of an infant's immature physiological functions is very dependent on milk and therefore is logical that milk is a natural source of a variety of beneficial nutrients and biologically-active compounds with a potential impact on human health. Besides, probiotic bacteria beneficially affect the host improving the properties of in-

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testinal microbial balance (3). Probiotic effects include alleviation of intestinal disorders such as lactose intolerance, acute gastroenteritis due to rotavirus and other enteric pathogens, adverse effects of pelvic radiotherapy, constipation, inflammatory bowel disease, and food allergy (4).

Besides functional food, on the market we also find a group of foods described as »lesser evil foods«, which include foods with the negative properties removed (foods free of or with reduced levels of fat, cholesterol, salt or sugar). Many products that might be considered functional already exist in nature, although their health benefits have not ever been emphasized (5,6).

### The Diet-Health Message and its Perception by Consumers

Consumers have got the message about the relationship between diet and health and believe that the three most important factors contributing to health are diet, exercise and genetic factors. In European research programme performed in 1993 it was found that diet was perceived to be the most important factor, cited by 70 % of respondents in Germany, 68 % of UK respondents and 55 % of French respondents, well ahead of exercise and genetic factors (6).

An increasing number of people believe that specific foodstuffs contain active substances which reduce the danger of illness and which generally contribute to the improvement of one's health. These foods are attractive to modern men and women who desire to reach old age in a healthy and vital state. But are modern individuals sufficiently, and especially, correctly informed?

An excessively simplistic interpretation of scientific findings regarding the link between diet and health can lead to entirely mistaken judgements or conclusions, based either on fear or on hope. It is interesting that in popular magazines the number of articles which discuss the harmful effects of foodstuffs or (even more often) their ingredients, and which therefore scare the reader, is much higher than the number of articles dealing with the healthy and beneficial effects of food, and which are aimed at raising public awareness. This most likely results from the fact that the area of education is the responsibility of experts, who usually find it difficult to present generally complex scientific findings in a simple and concise manner. This particularly applies to multi-disciplinary fields of interest such as food. On the other hand, articles which discuss the harmful effects of "toxicity" and the danger of consuming specific foodstuffs are frequently written by unqualified persons; this is reflected in the factual errors (the result of misconceptions, rather than misprints) which often pervade articles written by these authors and which point to their lack of knowledge.

It is also interesting that alarming statements such as those on the harmfulness of milk fat and proteins tend to stick in people's minds more than positive statements, as, for example, explanations of probiotic bacteria. I am firmly convinced that most people are familiar with the harmful effects of fats and cholesterol, and with the link between them and coronary heart disease. As a

result, even if it is not necessary, they resort to consuming low-fat products and preparations which reduce cholesterol. On the other hand, there are only a few people who know what probiotics are, not to mention functional food. The great majority of consumers opt for this food mainly because they read "bio" or "natural" on the label, and assume it is therefore likely to be healthier.

Unfortunately, at this point I would like to stress that we, the genuine experts, are partly to blame for this because we often tend to look only through our own eyes, forgetting that our discoveries are merely a small piece of the mosaic which will ultimately – and only when all the pieces are put together – explain the significance of a specific foodstuff in our diet. To take an example: consumers are familiar only with the harmful effects of milk fat, while it is much less known that scientists are currently discovering the important roles played by a number of ingredients in milk fat, such as conjugated linoleic acid, butyric acid, anti-oxidants, and vitamins soluble in fat. Additionally, it is possible that determinants of healthful effects of dairy product are multifactorial, for example due to live bacteria and other components of fermented milk such as highly absorbable calcium, conjugated linoleic acid and bioactive peptides. Isolation of a single component may not yield the positive benefits of a whole food. Important nutritional qualities of milk are the wide range of nutrients it contains and the good balance of its nutrients. I would like therefore to define the value of dairy foods in a healthy diet above all in the light of complex interactions between milk components and their combined effect on organism. Three common chronic diseases will be taken by way of example.

### Milk, Dairy Products and Cardiovascular Disease

Coronary heart disease (CHD), the most common and serious form of cardiovascular disease, is the leading cause of death in developed industrialized countries. Many risk factors, both genetic and environmental, contribute to the development of this disease. It is evident that diet is an important modifiable risk factor. Obesity, dietary fat quantity, saturated fatty acids and cholesterol are on a black list of risk factors and as a consequence milk and dairy products are also often listed, particularly those with increased fat content (7,8). However, there is little evidence from scientific studies that dairy foods contribute to an atherogenic blood profile when consumed in usual amounts. An interesting epidemiological study presented by Gurr (9) had shown that people who regularly consumed milk were much less likely to suffer a heart attack than those who did not. His interpretation of such results was that »the biological basis for this observation is unknown and it may be due to factors in the lifestyle of people who choose to drink milk regularly, rather than to a protective factor in milk as such«. In my opinion there are protective factors in milk and possible mechanisms which could explain such observations. I will try to find and present some of them.

Milk fat has often been characterized as containing a high proportion of saturated fatty acids but it needs to be added that only three of them, representing about one third of the milk fatty acids, are cholesterolemic. These are lauric (12:0), myristic (14:0) and palmitic (16:0) acid (10–12). Furthermore, milk and dairy products contain components with at least a protective if not hypocholesterolemic effect such as calcium, linoleic acid, conjugated linoleic acid (CLA), antioxidants and lactic acid bacteria or probiotic bacteria. Calcium plays an important role in mediating vascular contraction and vasodilatation, muscle contraction, nerve transmission and glandular secretion (13). There are more and more proof that linoleic acid is beneficial in reducing CHD risk in human subjects, and some evidence that CLA protects against the development of early arterial lipid accumulation and helps regulate body weight and fat distribution (14–16). It is well established that a raised level of serum cholesterol does not adequately explain the increased risk of CHD or the relationship between diet and CHD. Several lines of evidence indicate that the development of atherosclerosis is related to free radical processes, lipid peroxidation and oxidative modifications of low density lipoproteins (LDL). LDL is the principal carrier of cholesterol but its atherogenic potential arises from an increase in the number of LDL particles and not from its cholesterol content *per se*. The oxidation of LDL promotes the final deposition of cholesterol in the arterial wall. It has been shown that LDL particles are more susceptible to oxidative modification than larger and lighter ones (17). Fortunately, the cell possesses highly efficient protective mechanisms, including antioxidants such as  $\alpha$ -tocopherol, ascorbat,  $\beta$ -carotene, glutathione, and metal-binding proteins such as transferrin and enzymes such as superoxide dismutase and catalase (18). The majority of this substances could be found also in milk and milk products.

Although probiotics, in the form of fermented milk products, have the reputation of cholesterol-lowering properties in humans, no conclusive evidence is available, with many studies giving conflicting results. The conflicting reports may be explained by factors such as differences in experimental design, species and strains of bacteria used as well as lifestyle and genetic or biochemical variability within and between human population (19–22).

Advances in genetics and molecular biology indicate that susceptibility to chronic diseases such as coronary artery disease, hypertension, diabetes, osteoporosis and cancer is to a great extent genetically determined. Studies in the United States have shown that 50 % of the variance in plasma cholesterol concentration is genetically determined (23).

### Milk, Dairy Products and Hypertension

Hypertension is another modern day problem and again both genetic and environmental factors influence blood pressure. People with high blood pressure are at increased risk of coronary heart disease, stroke, and kidney failure. Because of the high cost of the medicines and potential adverse side effects associated with phar-

macological therapy for these diseases, people are encouraged to change their lifestyle from »harmful to healthy«. This means weight reduction if overweight, increased physical activity, limited alcohol and sodium intake and adequate consumption of calcium, potassium, and magnesium. Current scientific evidence indicates that it is not only an excess of one electrolyte (sodium) in our diets but rather inadequate levels of several, that produce hypertension. An adequate intake of calcium, potassium, and magnesium have now been documented to reduce blood pressure. Therefore, there is nothing surprising in the results found in several clinical trials that the effect of milk on blood pressure was greater and more rapid than that of calcium alone (7,24). Milk and dairy products are meaningful sources of all three nutrients along with bioactive peptides termed casokinins or ACE – I peptides with a potential to reduce blood pressure due to their ability to inhibit angiotensin-I-converting enzyme (ACE) and block conversion of angiotensin I to angiotensin II, a potent vasoconstrictor (25–27).

### Milk, Dairy Products and Colon Cancer

Colorectal cancer is one of the leading causes of cancer morbidity and mortality in the Western countries and it is thought to be caused by an interaction between dietary factors and genetic predisposition. Diet is estimated to be responsible for 30 to 60 percent of all cancers but the role of diet in cancer etiology is difficult to elucidate because food contains components that may either cause or prevent cancer. Epidemiological studies indicate that increased consumption of fat, meat, and total calories and low intake of foliate, fiber, and calcium enhance the risk of colon cancer but there are also several scientific proofs supporting the protective role of milk products (7,28,29). The components in dairy foods which may protect against colon cancer are above all calcium and vitamin D, probiotic lactic acid bacteria, a class of fatty acids known as conjugated derivatives of linoleic acid (LCA) and bioactive peptides derived from milk proteins (28,30–35).

A potential mechanism for the protective effect of calcium against colon cancer was suggested from animal studies. Dietary fat increases levels of bile acids and free fatty acids in the colonic lumen which damage the colonic epithelium and promote epithelial proliferation. Calcium binds and precipitates unconjugated bile acids and free fatty acids and thus its cytotoxicity is diminished (36,37). However, Bostick *et al.* (38) reported the results of a randomized, double-blind, placebo-controlled clinical study which did not support this thesis. 193 subjects with a history of sporadic adenomatous polyps were treated with placebo (n = 66) or 1.0 g calcium (n = 64) or 2.0 g calcium (n = 63) daily for 6 months. Rectal biopsies were obtained at the beginning of the trial and at 1, 2 and 6 months. They did not find any significant difference in the rate of cell proliferation between the calcium groups and the placebo group. On the other hand, when the daily calcium intake was increased *via* dairy foods the results were positive (28). These observations indicated the need for the studies that used dietary calcium for a longer period of time. On the basis

of numerous animal and human studies Van der Meer *et al.* (39) concluded that milk products may improve intestinal health by means of the intestinal cytoprotective effects of their high calcium phosphate content. They proposed the following mechanism: the high amounts of colloidal calcium phosphate in milk products cause intestinal formation of insoluble, amorphous calcium phosphate (CaPi), which precipitates bile acids, fatty acids, and other unknown cytotoxic factors and thus inhibits colonic epithelial proliferation. Likewise, Glinghamer *et al.* (40) found that a shift from a dairy product-free diet to a dairy product-rich diet, with a concomitant intake of milk protein and fat, did not change the genotoxicity of the colonic content but significantly reduced the cytotoxic compounds in the colon by precipitation. It was also observed that these cytoprotective effects occurred throughout the intestine and therefore the mucosal damage was diminished and the resistance to an infection improved (39).

There is considerable interest in the metabolic activities of the intestinal microflora in relation to the etiology of colon cancer. The human colon is intensively colonized with bacteria and as such an extremely complex microbial ecosystem. The majority of these residents are in fact benign and may even offer some health-promoting effect. The lactic acid bacteria termed probiotics are the most prominent representatives of the latter category. Oral administration of certain probiotic bacteria is associated with a number of anticarcinogenic actions, including reduction of colonic pH, immunostimulation, anti-mutagenicity and reduction in the activity of enzymes responsible for the conversion of procarcinogens to carcinogens such as  $\beta$ -glucuronidase, nitroreductase and azoreductase. Epidemiological studies have shown that consumption of fermented milk products, specially those containing probiotic bacteria, may help reduce the risk of cancer at a number of sites (41,42).

Milk proteins, especially those associated with whey, are most likely another milk components with anti-carcinogenic properties. Whey proteins are sulphur amino acids rich proteins and may therefore retard the development of colon tumors and tumor precursors through provision of biologically available methionine and cysteine. Both amino acids have a positive influence on a cellular methylation status and therefore a stabilizing effect on DNA. In addition, serum albumin,  $\alpha$ -lactalbumin and lactoferrin are rich sources of the dipeptide  $\gamma$ -glutamylcystein which is an excellent source of dietary cysteine for cellular synthesis of glutathione an important actor in defense mechanisms that protect against cancer. Whey also contains different high-affinity binding proteins that bind iron, folic acid, vitamin B<sub>12</sub>, riboflavin, retinol and vitamin D. Their bioactivity is very important for keeping an organism in good healthy condition. Lactoferrin binds iron which is potentially pro-carcinogen and thus prevents intestinal damage, whereas the vitamin binding proteins protect vitamins from intestinal microflora as well as make them more bioavailable (29,35,43).

## Conclusions

Milk and dairy products have long been recognized as an important component of a balanced diet. However we can not state that they are essential to the diet although it is quite difficult to sustain an appropriate balance of nutrients if they are removed from the diet. Regardless of the fact that many questions remain concerning optimal nutrition, nutrient-nutrient interactions, genetic variations and gene-nutrient interactions, milk and dairy products provide a wide range of important nutrients. In addition, evidence of health benefits associated with the presence of specific components or bacteria is progressively gaining established scientific credibility. It is therefore understandable that among the best known examples of functional foods are fermented milks and yogurts containing probiotic bacteria. Finally I would like to stress once more that milk and dairy products are much more than the sum of their nutrients. There is a need to shift from the concept of studying the health benefit or harmfulness of a single nutrient and to recognize the importance of the whole food approach.

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## Mlijeko, mliječni proizvodi, prehrana i zdravlje

### Sažetak

Znanstveni napredak u prehrani, medicinskim znanostima i znanostima o hrani pobuđuje sve veće zanimanje potrošača za prehranu. Sve je više spoznaja o tome da su mnoge kronične bolesti uzrokovane neusklađenom prehranom. Osim zaštite od bolesti, predlaže se da hrana bude činitelj poboljšanja zdravlja, pa se takva vrsta hrane svrstava u skupinu nazvanu funkcionalnom hranom. Taj se pojam koristi kako bi se označila vrsta hrane koja sadržava neke tvari što poboljšavaju zdravlje, a ne samo tradicionalne hranjive sastojke. Stoga predlažemo da se mlijeko i mliječni proizvodi ubroje u skupinu funkcionalne hrane bogate bioaktivnim peptidima, probiotičkim bakterijama, antioksidansima, kalcijem koji se izvrsno apsorbira, konjugiranom linolenskom kiselinom i drugim biološki aktivnim sastojcima. Iako procjena prednosti ili rizika unosa određene vrste hrane normalno ne podliježe istim iscrpnim ispitivanjima, kao što se to zahtijeva kod lijekova, to ne umanjuje potrebu bitnih znanstvenih rezultata prije nego se donesu zaključci i preporuke potrošačima. U radu je dan pregled i rasprava o najnovijim dostignućima o utjecaju mlijeka i mliječnih proizvoda na prehranu i zdravlje.