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HEALTH BENEFITS OF CHEESE

SUMMARY

Americans are consuming more cheese than ever before. Between 1990 and 2000, per capita consumption of cheese increased by more than 21%. The demand for cheese is attributed to its great taste, versatility, convenience, and nutrient content. To meet consumers' ever-changing demands, American cheese makers have introduced numerous new varieties of cheese in various flavors and forms.

Cheese contains a high concentration of essential nutrients, in particular high quality protein and calcium, as well as other nutrients such as phosphorus, zinc, vitamin A, riboflavin, and vitamin B_{12}. In 1999, cheese provided 25% of the calcium available in the U.S. food supply, a six-fold increase from 4% in 1909. The composition of milk used and the manufacturing process (e.g., manner of coagulation, length of aging) influence the nutrient content of specific cheeses. For individuals monitoring or reducing fat in their diet, many reduced fat varieties of cheeses are available. Also, individuals can include cheese in a fat reduced diet by making dietary trade-offs, for example, by balancing higher fat foods with lower fat foods.

In addition to its nutritional contribution to the diet, cheese has several health attributes. Certain cheeses such as Cheddar, Swiss, blue, Monterey Jack, and process American cheese, among others, have been demonstrated to reduce the risk of dental caries. Although the anticariogenic effects of cheese are not completely understood, several potential mechanisms are proposed. Consuming cheese may stimulate the flow of saliva, which has caries reducing properties (e.g., increases buffering capacity and promotes food clearance). Milk proteins in cheese have been demonstrated to neutralize plaque acids through their buffering capacity. Cheese appears to prevent acid demineralization and enhance remineralization of tooth enamel. To help reduce tooth decay, health professionals recommend eating cheese immediately after meals, or as a between-meal snack.

Many cheeses, particularly aged cheeses such as Cheddar and Swiss, contain little or no lactose. For this reason, cheese is an important source of calcium and many other nutrients found in milk for lactose maldigesters or persons who have difficulty digesting lactose or milk's sugar.

Because cheese is a calcium-rich food, its inclusion in the diet may help reduce the risk for osteoporosis. In addition, cheese, in moderation, is included in the DASH (Dietary Approaches to Stop Hypertension) diet designed to reduce the risk of hypertension. This diet, which includes 3 servings/day of dairy foods (e.g., lowfat and fat free milk and yogurt, regular and lowfat cheeses) and 8 to 10 servings/day of fruits and vegetables, has also been shown to reduce other risk factors for heart disease, specifically blood levels of total and low density lipoprotein (LDL) cholesterol and homocysteine.

Cheese's high nutritional value and its beneficial roles in health make this food an important dairy food to include in a healthful diet. D

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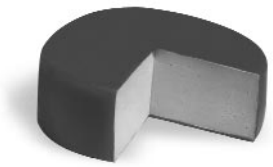
INTRODUCTION

Since the first cheese factory opened in the U.S. in the early 1850s, the amount and variety of cheese and cheese products manufactured and consumed in this country have continued to grow (1,2). Cheese available for consumption increased from 4 pounds per capita in 1909, to 9 pounds in 1945, to 19 pounds in 1975, and to 32 pounds in 1999, with continued growth expected (2,3). According to one survey, the percent of U.S. consumers eating cheese every day increased from 18% in 1992 to 24% in 2000 (4).

Cheese's popularity is attributed to its great taste, the availability of new and different varieties, its convenience and versatility of use, and nutritional value (2,4-6). Taste is a primary factor contributing to consumers' demand for cheese (4,6). More than 300 varieties (e.g., American, Cheddar, Mozzarella, Colby) of cheese are available in various flavors, forms (e.g., chunks, slices, cubes, shredded, grated/crumbled, string/stick, spreads), and packaging to meet consumers' needs (5,6). Cheese's nutritional value, especially its calcium and protein content, is identified as an important factor driving consumers' desire to consume cheese (3,4). This *Digest* reviews cheese's nutritional contribution to the diet. Also discussed are the health benefits of cheese, such as its ability to reduce the risk of dental caries and its role in the diet of lactose maldigesters. Growing evidence indicates that cheese can be part of dietary patterns to help reduce the risk of major chronic diseases such as osteoporosis and hypertension.



Today, more than one-third of all cow's milk produced in the U.S. is used to make cheese.

CHEESE'S NUTRITIONAL CONTRIBUTION

Effect of cheese-making on cheese's nutrient content. About 10 pounds of milk are used to make one pound of cheese (1). Cheese is therefore a concentrated source of many of milk's nutrients (7,8). However, the type of milk/milk product used (e.g., whole, reduced fat, nonfat, buttermilk, cream, whey, nonfat dry milk solids, or a combination thereof) and the manufacturing process (e.g., manner of coagulation, length of ripening) influence the nutrient content of specific cheeses.

Natural cheeses are made by curdling milk (i.e., coagulating casein, milk's protein, to form curd), stirring and heating the curd, draining off the whey, and collecting or pressing the curd (6,7). Cheese can be unripened (e.g., cottage and cream cheeses) or ripened, cured, or aged (e.g., Cheddar, Colby, Brie). Separation of milk curds from the whey in cheese-making results in significant partitioning of nutrients and largely explains the differences in the nutrient content of cheese compared to milk (7). Water-insoluble nutrients of milk (e.g., protein, colloidal minerals such as calcium, fat, fat-soluble vitamins), which are primarily retained in the curd, are concentrated in cheese. In contrast, cheese contains fewer water-soluble constituents of milk (e.g., lactose, soluble minerals, water-soluble vitamins) because of their removal with the whey. Ripening may influence cheese's nutrient content, although to a lesser extent than separation of the curds from the whey. The composition of numerous cheeses and related cheese products is governed by definitions and standards of identity established by the U.S. Food and Drug Administration (9).

Nutrient Density. Cheese is a nutrient dense food providing a high concentration of nutrients relative to its energy content (8). In 1999, cheese contributed only 3% of the energy (calories) available in the U.S. food supply (10). Yet, this food provided 8% of the protein, 25% of the calcium, 10% of the phosphorus, 7% of the zinc, and 5% of vitamin A activity, in addition to other essential nutrients (10). For information on the nutrient content of specific cheeses, refer to USDA's Nutrient Database (8) or the Nutrition Facts panel on product labels.

Protein. Among dairy foods, cheese is the largest contributor to the amount of protein available in the U.S. food supply (i.e., 8.4% in 1999) (10). Moreover, the proportion of protein from cheese has increased more than five-fold since the turn of the century (10). Protein in cheese is of high quality, containing all of the essential amino acids in the amounts proportional to the body's need. Casein is the main protein in cheese,

although water-soluble milk proteins (e.g., lactalbumin and lactalglobulin) also may be present depending on the amount of whey entrapped in the cheese (7). Protein in many cheeses is readily digestible because some of the proteins are broken down during ripening to peptides and amino acids (7).

Carbohydrate. Cheese, particularly aged cheeses (e.g., Cheddar cheese), contains a negligible amount of lactose, the major carbohydrate in milk (7). Most aged cheeses contain minimal (1-3 g/100 g) or no lactose because of its removal in whey and the conversion of any remaining lactose (approximately 2%) entrapped in the curd to lactic acid and other acids during ripening. Within 21 to 28 days, no lactose is present in ripened cheeses (7). In fresh unripened cheeses (e.g., cottage cheese), 15 to 20% of the lactose is converted to lactic acid and other acids within a few hours. Because of their low lactose content, most cheeses, particularly aged cheeses, are well tolerated by individuals who have difficulty digesting lactose (i.e., lactose maldigesters), as discussed below (11). The wide range of lactose in process and cottage cheeses may be explained by the legal addition of optional ingredients such as nonfat milk and cheese whey to the creaming mixture (7,9).

Fat. The fat content of cheese is mainly responsible for its flavor and texture, which contribute to consumers' preference for full fat cheeses (12). Cheeses vary widely in fat, saturated fat, and cholesterol, in large part because of the type of milk (e.g., whole, reduced fat, nonfat) and milk product (e.g., cream) used to make cheese (7). A serving (1 oz) of Cheddar cheese contains 9 g fat, 6 g saturated fat, and 30 g cholesterol (8). In contrast, a serving (4 oz) of nonfat dry curd cottage cheese contains 0.5 g fat, 0.3 g saturated fat, and 8 g cholesterol (8).

In addition to cheeses naturally lower in fat (e.g., cottage, ricotta, part skim mozzarella), manufacturers have developed a variety of cheeses reduced in fat (e.g., 0 to 6 g fat /oz) (7,13). Researchers are using new technologies, processes, and ingredients to improve the quality of cheeses reduced in fat (5,14). The U.S. Food and Drug Administration has established definitions for foods, including cheese, labeled as low fat, reduced fat, light, less fat, nonfat and fat free (1,15). Under these definitions, for a cheese to qualify as low fat, it must contain no more than 3 g fat per serving.

Dietary guidelines recommend a diet moderate in total fat (i.e., no more than 30% of calories), and low in saturated fat (i.e., less than 10% of calories) and cholesterol (i.e., less than 300 mg/day) (16,17). Given the availability of cheeses of varied fat content and the ability to make trade-offs in the amount and sources of fat in the total diet, consumers can readily include cheese in a diet meeting fat recommendations. Children participating in the Bogalusa Heart Study have experienced a decline in recent decades in their percentage of energy from total and saturated fat, despite an increase in their cheese consumption (18).

According to the American Dietetic Association, all foods can fit into a healthful diet "if consumed in moderation with appropriate portion size and combined with regular physical activity" (19). Cheese provides high quality protein, calcium, and other essential nutrients. Also, cheese is a rich source of conjugated linoleic acid (CLA) and sphingolipids, which are milk fat components that may potentially help reduce the risk of chronic diseases such as certain cancers and heart disease (20-27).

Cheese, a source of high quality protein, calcium, and many other essential nutrients, makes a valuable contribution to the nutrient content of the diet.

Vitamins and Minerals. The vitamin content of cheeses varies due to the milk used and the manufacturing process (7). Because most of the fat in milk is retained in the curd, cheese contains the fat-soluble vitamins of the milk used in cheese-making (7). Cheddar cheese made with whole milk contains 1,059 IU of vitamin A per 100 g, whereas dry curd cottage cheese made with nonfat dry milk, contains comparatively less vitamin A (30 IU per 100 g) (8). Because water-soluble vitamins (e.g., thiamin, riboflavin, niacin, pantothenic acid, vitamin B_6, and folate) remain in the whey, their content in cheese is influenced by the amount of whey retained in the cheese.

Cheeses are a good source of several minerals, although the amounts of specific minerals in different cheeses vary according to manufacturing procedures. Cheese is the major delivery food for calcium (2). The share of calcium provided by cheese was

more than six times higher in 1999 at 25% than in 1909 at 4% (2). The increase in per capita levels of calcium in the U.S. food supply in recent decades is attributed in large part to the increase in cheese consumption (2). The calcium content of cheese is influenced by the acidity at coagulation and the amount of expulsion of whey from the curd. In ripened whole milk cheese made with a coagulating enzyme (e.g., Cheddar, Swiss, brick), the calcium and phosphorus largely remain in the curd. However, in cheeses coagulated by acid alone (e.g., cottage cheese), less calcium is retained because the calcium salts are removed from the casein. Cheddar cheese contains 721 mg calcium per 100 g (204 mg per 1 oz serving), whereas dry curd cottage cheese contains 32 mg calcium per 100 g (36 mg per 4 oz serving) (8). Because of the addition of creaming mixtures, regular cottage cheese contains more calcium (60 mg per 100 g) than dry curd cottage cheese (8). In general, cheeses that are high in calcium contain other minerals such as phosphorus and magnesium in appreciable amounts (8).

The sodium content of cheeses varies due to the different amounts of salt added during cheese-making (7). In general, natural cheeses such as Swiss (74 mg sodium/oz) and Cheddar (176 mg sodium/oz) contain less sodium than many process cheeses, which may contain about 400 mg sodium/oz (8). For individuals wishing to lower their sodium intake, manufacturers have introduced cheeses reduced in sodium (7). The recommendation for sodium intake is 2,400 mg per day (16). However, individuals vary in their blood pressure response to changes in dietary sodium intake. Despite extensive research the relationship between sodium intake and hypertension (high blood pressure) continues to be debated (28-30).

CHEESE'S ROLE IN HEALTH

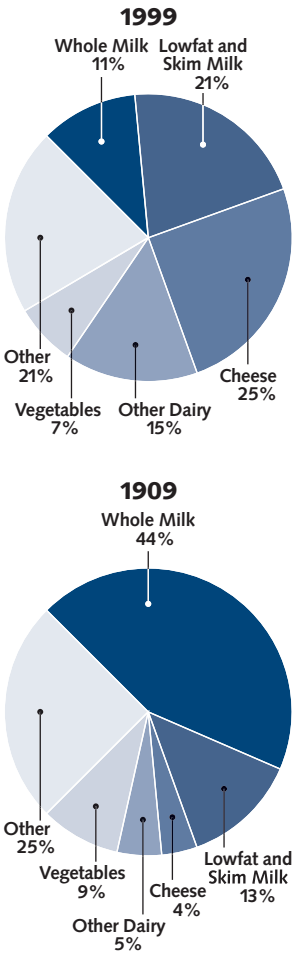
Dental Health. Cheese not only is noncariogenic (i.e., does not promote dental caries), but may also protect against dental caries (11,31). Dental caries results from the breakdown of tooth enamel (i.e., demineralization) by acids produced during the fermentation of sugars and starches by plaque bacteria (11,32). The critical pH for demineralization is in the range of 5.2 to 5.7 (11,33). The recent, first-ever report of the U.S. Surgeon General on the oral health of the American public describes dental caries as a "silent epidemic" (34). Prevention of this disease is therefore a public health priority.

Laboratory animal, human, and *in vitro* studies support a beneficial effect of cheese on dental caries and suggest several mechanisms for this effect (11,31). In laboratory animals fed diets high in fermentable carbohydrates, intake of cheese has been shown to reduce the development of dental caries (35-37). Intake of cheeses such as Cheddar and Swiss fed between cariogenic meals protects against root caries in desalivated animals (i.e., at high risk of caries because of lack of saliva) (37). This observation suggests that consumption of cheeses may be especially important for older adults, many of whom are at high risk for root caries and for whom loss of saliva gland function may occur due to certain medications (32).

Human dental plaque acidity studies, which measure a food's cariogenic potential, demonstrate that cheeses such as aged Cheddar, Swiss, blue, Monterey Jack, mozzarella, Brie, Gouda, and American process cheese prevent plaque pH from falling to a level conducive to the development of caries (11,31,32). Demineralization/remineralization studies as well as human epidemiological investigations also support a beneficial effect of cheese on dental health (11,31,32,38-40).

Several mechanisms have been proposed to explain cheese's anticariogenic effect (11,31,32). Cheese may buffer or neutralize plaque acids; stimulate saliva flow which has caries-reducing properties; and reduce demineralization and/or promote remineralization by protein, calcium, and phosphorus. The buffering effect of protein in cheese (e.g., casein phosphopeptides) on acid formation in dental plaque and the promotion of food clearance by

Sources of calcium in the U.S. food supply



Several varieties of cheese (e.g., Cheddar, Swiss, American process) have been shown to reduce the risk for dental caries, a disease recently described by the U.S. Surgeon General as a "silent epidemic."

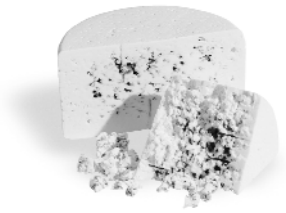
cheese-induced saliva flow are the most popularly held explanations for cheese's beneficial effect on dental caries (31). Both experimental animal and human epidemiological studies demonstrate that calcium and phosphate in cheese may be partly responsible for this food's ability to remineralize tooth enamel (11,31,32). When dental plaque samples were obtained from British adults before and 5 minutes after intake of cheese cubes or cheese-containing meals (e.g., pasta with cheese sauce), plaque calcium concentrations were significantly higher in subjects consuming cheese than in those who did not consume this food (41). This finding led the researchers to suggest that consuming cheese either alone or as part of a meal increases plaque calcium, which helps to reduce or prevent decreases in plaque pH levels and promote remineralization of tooth enamel (41).

The American Academy of Pediatric Dentistry advises parents to choose cheese along with other nutritious foods (e.g., vegetables, yogurt, chocolate milk) as caries-protective snacks for their children (42). A recent review of dietary determinants of dental caries recommends nutrition education aimed to help parents change their own and their children's dietary behaviors so that they choose diets with low or non-cariogenic snacks such as cheese (33).

Lactose Intolerance. Cheese is an important source of calcium and many other nutrients in milk for individuals with lactose maldigestion (also called lactase non-persistence) (11). Lactose maldigesters may have difficulty digesting lactose, the principle carbohydrate in milk, due to a deficiency of lactase, the enzyme necessary to metabolize lactose. Lactose intolerance is the occurrence of gastrointestinal symptoms resulting from incomplete digestion of lactose (11).

As mentioned above, cheeses, particularly aged cheeses, contain negligible amounts of lactose. Studies demonstrate that lactose maldigesters can enjoy dairy foods, including cheese, without developing symptoms of intolerance (43,44). For example, women with lactose maldigestion were able to consume 1,500 mg calcium/day from a diet containing 2 oz of cheese, 2 cups of milk, and 1 cup of yogurt throughout the day without developing symptoms (43).

Cheeses, particularly aged cheeses, contain little, if any lactose. For this reason, most cheeses are well tolerated by lactose maldigesters.



Because cheeses, particularly hard cheeses (e.g., Cheddar, Swiss), are high in calcium yet naturally low in lactose, the American Academy of Pediatrics recommends that children with lactose intolerance include cheese in their diet (45). Likewise for adults with lactose intolerance, cheese is recommended as a calcium-rich, well-tolerated food (11,46,47).

Other Health Benefits. Overwhelming scientific evidence indicates that consuming adequate amounts of calcium or calcium-rich foods may help delay or minimize age-related bone loss and thereby decrease the risk for osteoporosis (11,45,48,48-50). Foods, including cheese, are the preferred source of calcium and other nutrients important for bone health (51).

Research indicates that cheese can be included in dietary patterns that help reduce the risk of hypertension and heart disease. The well-publicized DASH (Dietary Approaches to Stop Hypertension) and DASH-low sodium diets – which have been shown to lower blood pressure – included cheese (52-54). The DASH diet contained three servings/day of dairy foods and 8 to 10 servings/day of fruits and vegetables (52,53). Although most of the dairy foods were in the form of lowfat milk and fat free yogurt, regular and lowfat cheeses were also included (53). In addition to reducing blood pressure, the DASH diet has been shown to significantly reduce total and low density lipoprotein blood cholesterol levels and lower blood levels of homocysteine, an amino acid linked to increased risk of cardiovascular disease (55,56).

CONCLUSION

Because of cheese's nutritional and health benefits, health professionals can be comfortable in advising their clients to consume cheese as part of a healthful diet balanced with physical activity. D

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Coming Next Issue:

CREATING A HEALTHY SCHOOL ENVIRONMENT FOR CHILDREN

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