



THE ROLE OF CHEESE IN HEALTHFUL DIETS

SUMMARY

Cheese, a concentrated form of many nutrients in milk with a prolonged shelf life, has great taste appeal, variety, and versatility. Moreover, cheese can be an integral part of a healthful diet that contributes to human health. The 2005 Dietary Guidelines for Americans, along with several health professional organizations, recommend three daily servings of low-fat or fat-free milk, cheese, or yogurt as part of a healthful diet.

Many cheeses are an excellent natural source of calcium (a "nutrient of concern" or limited in Americans' diets) and a good source of high quality protein and phosphorus. These three nutrients are particularly important for helping to attain and maintain healthy bones.

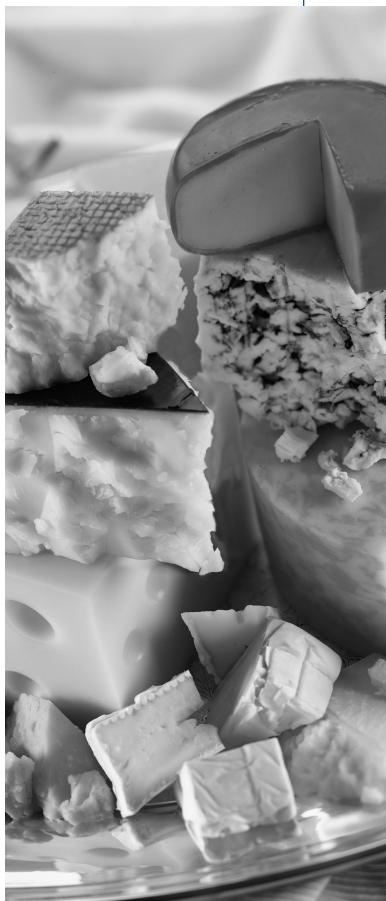
Most children do not consume recommended servings of "Food Groups to Encourage" (i.e., low-fat and fat-free dairy foods, fruits, vegetables, and whole grains) identified by the Dietary Guidelines as being limited in children's diets. Cheese, when offered as part of school meals or snacks, can help children meet their recommended servings of dairy foods. Also, the addition of cheese to fruit, vegetables, and whole grains may help increase their intake of these foods.

Many cheeses, particularly aged cheeses (e.g., Cheddar, Colby, Swiss, Parmesan) contain negligible amounts of lactose. As such, aged cheeses can be a well tolerated source of dairy nutrients, especially calcium, for people who are lactose maldigesters. Several health professional organizations recommend aged cheeses as a dairy option for lactose maldigesters.

Several varieties of cheese (e.g., Cheddar, Gouda, blue, Monterey Jack, mozzarella, Swiss, process) have been shown to reduce the development and progression of dental caries by stimulating the flow of saliva, clearing the mouth of food debris, and acting as a buffer to neutralize the acids that attack the teeth. Components in cheese such as protein, fat, calcium, and phosphorus may contribute to cheese's protective effect against dental caries. The American Academy of Pediatric Dentistry and the American Dental Association recommend cheese for dental health.

Cheese in moderation can be included in heart-healthy diets that meet total fat, saturated fat, and sodium recommendations. The Dietary Approaches to Stop Hypertension (DASH) dietary pattern, which is a low-fat diet containing two to three servings of dairy foods (including reduced-fat cheese) and eight to 10 servings of fruits and vegetables a day, has been shown to reduce high blood pressure and other risk factors for heart disease. Findings that cheese may be less cholesterolemic than suggested by its fat/saturated fat content is thought to involve other components in cheese such as calcium, protein, sphingolipids, and long-chain menaquinones (vitamin K₂). Recent scientific reviews of dairy foods and cardiovascular disease conclude that there is little evidence showing that cheese contributes to heart disease risk.

Cheese's popularity has continued to grow over the years. This may be attributed in part to the dairy industry's continual effort to develop cheeses tailored to meet specific consumer preferences for healthier cheeses with acceptable flavor, texture, and functionality.



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INTRODUCTION

Cheese's popularity is attributed to its taste (e.g., sharp to mellow flavors, ethnic flavors), convenience, variety, and versatility of use. Moreover, cheese can be an integral part of a healthful diet. The proportion of milk products consumed as cheese increased from 30% in 1994-96 to 35% in 2001-02 to 38% in 2003-04 of the total Milk Group intake by the U.S. population (1). In the U.S., more than 300 varieties of cheese in various flavors, forms (e.g., chunks, slices, cubes, shredded, grated/crumbled, string/stick, spreads), and packaging are available to meet consumers' needs (2).

Cheese is an important dietary source of essential nutrients such as protein, vitamins, and minerals (3). Also, several health benefits are attributed to cheese (4). Government and health professional organizations support the inclusion of cheese in a healthful diet (5-8). The 2005 Dietary Guidelines for Americans recommends three cups per day of low-fat or fat-free milk or equivalent milk products such as cheese or yogurt for people aged nine years and older (5). For children aged two to eight years, two cups per day of low-fat or fat-free milk or equivalent milk products are recommended (5). One and one-half ounces of natural cheese (e.g., Cheddar, Swiss) or two ounces of process cheese is equivalent to the calcium content of one cup of milk (5). The U.S. Department of Agriculture (USDA)'s *MyPyramid* food guidance system (www.mypyramid.gov) provides similar recommendations. This *Digest* reviews the nutritional contribution of cheese and the beneficial role of cheese in bone health, gastrointestinal health, and dental health, as well as how cheese can fit into a heart-healthy diet.

CHEESE: A SOURCE OF ESSENTIAL NUTRIENTS

Cheese is a concentrated source of some of milk's nutrients (3,9). About 10 pounds of cow's milk are used to make one pound of whole milk cheese (2). The nutritional value of cheese varies with the type of cow's milk and dairy and non-dairy ingredients used (e.g., whole, reduced-fat, fat-free,

Cheese can be an integral part of a healthful diet due to its nutritional content and contribution to human health. Many cheeses are an excellent natural source of calcium and a good source of high-quality protein and phosphorus which support bone health.



buttermilk, whey, emulsifiers, fat-free milk solids, or a combination thereof) and the manufacturing process (e.g., manner of coagulation, length of ripening or aging) (10). The composition of numerous cheeses and related cheese products is governed by definitions and standards of identity in the Code of Federal Regulations established by the U.S. Food and Drug Administration (FDA) (11).

In 2005, cheese contributed only 3.4% of the energy (calories) available in the U.S. food supply (3). Yet, this food supplied about 9% of the protein, 27% of the calcium, 11% of the phosphorus, 7% of the zinc, and 9% of vitamin A activity available (3). For information on the nutrient content of specific cheeses, refer to USDA's Nutrient Database (12), or the Nutrition Facts panel on product labels for the nutrient content of individual brands.

Protein. A number of cheeses (e.g., Cheddar, Colby, Gouda, Monterey Jack, Swiss, ricotta) are a "good source" of protein (i.e., contain 10 to 19% of the Daily Value [DV] per reference amount customarily consumed [RACC]) and some are an "excellent source" of protein (e.g., cottage cheese, ricotta) (i.e., 20% or more of the DV per RACC on the Nutrition Facts Label) (12). The amino acid composition of cheese protein classifies it as a high quality protein. Protein in cheese is a "complete protein" containing all nine of the essential amino acids that cannot be synthesized to meet the body's needs and must be obtained from the diet (12,13). Protein in many cheeses is readily digestible because some of the proteins are broken down during ripening to peptides and amino acids (9). Because cheese is a good source of high quality, easily digestible protein, it is considered a meat/meat alternative by the USDA National School Lunch Program and can be served as an ounce-for-ounce substitute for meat (14).

Carbohydrate. Most cheeses, particularly aged cheeses, contain a negligible amount of lactose, the major carbohydrate in milk (4,12). For example, Cheddar cheese contains 0.10 g lactose per 1.5 oz serving and Swiss cheese contains 0.03 g lactose per 1.5 oz serving (12). In general, aged cheeses contain minimal

lactose because of its removal in the whey during cheese-making and the conversion of any remaining lactose entrapped in the curd to lactic acid and other acids during the aging (fermentation) process (4). Within 21 to 28 days, little lactose is present in aged cheeses (9). In fresh, unripened cheese (e.g., cottage cheese) or ripened (aged) cheese, 15 to 20% of the lactose is converted to lactic acid and other acids within a few hours after it has been made (15). The range of lactose in cottage and process cheeses may be explained by the legal addition of optional ingredients such as fat-free milk and cheese whey which may increase the lactose content of some of these products compared with natural aged cheeses (9,11,15). As discussed below, many cheeses, particularly aged cheeses (e.g., Cheddar, Colby, Swiss, Parmesan) because of their negligible lactose content, are well tolerated by individuals who have difficulty digesting lactose (i.e., lactose maldigesters).

Fat. The fat content of cheese is largely responsible for its flavor and texture, which contribute to consumers' preference for full fat cheeses. Cheeses vary widely in total fat, saturated fat, and cholesterol, in large part because of the type of milk (e.g., whole, reduced-fat, low-fat, fat-free) and milk product (e.g., cream) used to make cheese (9). A serving (1.5 oz) of Cheddar cheese contains 14 g total fat, 9 g saturated fat, and 45 mg cholesterol (12). In contrast, a serving (4 oz) of fat-free dry curd cottage cheese contains 0.3 g total fat, 0.2 g saturated fat, and 8 mg cholesterol (12).

A number of reduced-fat cheeses (e.g., reduced-fat Cheddar, Colby, process cheeses) are available to help consumers reduce their intake of total fat, saturated fat, and discretionary calories. For a cheese to qualify as a reduced-fat cheese, it must contain at least 25% less fat per FDA reference amount than its full-fat counterpart (16). Recognizing increased consumer demand for lower fat cheeses, yet limited acceptance of these products, researchers are developing low-fat natural (e.g., Cheddar, mozzarella) and process cheeses with consumer-acceptable flavor, texture, and functionality (17,18). Although cheese in general ranks first as a source of saturated fat in the U.S. diet (19), this food also contains potentially beneficial bioactive



Many aged cheeses such as Cheddar, Monterey Jack, and Swiss, which are naturally low in lactose (milk sugar), are a well tolerated source of dairy nutrients for individuals with lactose maldigestion.

lipids, conjugated linoleic acid, and sphingolipids (20-22). On-going research seeks to clarify the role of these milk fat components in health (20-22).

Vitamins. The vitamin content of cheeses varies according to the milk used and the manufacturing process (9). 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 (9). For example, Cheddar cheese made with whole milk contains 426 IU of vitamin A per 1.5 oz serving, whereas a serving (4 oz) of cottage cheese made with 1% milk fat contains 46 IU of vitamin A (12).

Cheese naturally contains little vitamin D. Cheddar cheese, for example, contains 5 IU of vitamin D per 1.5 oz serving (12). However, the FDA allows vitamin D₃ (cholecalciferol) to be added to certain cheese and cheese products at levels up to 81 IU per 30 g (~1 oz) of cheese (23). This rule permits processors to add vitamin D to a level slightly above 20% of the DV of 400 I.U. for vitamin D (i.e., an "excellent source"). Cheese is recognized as a good candidate for vitamin D fortification because most cheeses are "good" or "excellent" sources of calcium; aged cheeses have only traces of lactose which make it a viable source of vitamin D (if fortified) and calcium for lactose maldigesters or those who otherwise do not drink milk; the milk fat content of cheese might promote the stability and absorption of fat-soluble vitamin D; and cheese is widely consumed (24,25). Researchers have demonstrated that vitamin D is bioavailable from fortified regular fat and low-fat cheeses and process cheeses tested (24-26).

Emerging research suggests that vitamin K₂ (menaquinones), specifically long-chain menaquinones (27) found in some cheeses as a result of microbial activity may have beneficial roles in bone health (28) and cardiovascular health (29). Because water-soluble vitamins (e.g., thiamin, riboflavin, niacin, pantothenic acid, vitamin B₆, vitamin B₁₂, folate) are lost into the whey fraction, their content in cheese is low (12).

Minerals. Many cheeses are an excellent natural source of calcium, providing ≥20% of the DV of 1,000 mg calcium per RACC. Cheese ranks second as a source of calcium

and of phosphorus in U.S. diets, preceded only by fluid milk (19). Many cheeses qualify as a good source of phosphorus, providing at least 10% of the DV of 1,000 mg per RACC.

Salt/sodium in cheese helps to maintain this food's expected flavor, texture, and shelf-life by controlling the activities of enzymes and microorganisms (18). The sodium content of cheeses varies due to the different amounts of salt added during processing (9). In general, natural cheeses such as Swiss (54 mg sodium/oz) and Cheddar (176 mg sodium/oz) contain less sodium than many process cheeses, which may contain as much as 400 mg sodium/oz (12). Swiss cheese qualifies as a low-sodium food (16). For individuals who wish to lower their sodium intake, some manufacturers have introduced cheeses reduced in sodium (12). Researchers are in the process of developing more cheeses with reduced or low sodium content (17,18).

Cheese's Nutritional Value Nourishes Growing Children.

Cheese is a nutritious source of calcium and high-quality protein and can make other foods more appealing to children. Most children do not consume recommended servings of "Food Groups to Encourage" (FGTE) (i.e., fruits, vegetables, whole grains, and fat-free or low-fat milk) identified by the Dietary Guidelines for Americans as being limited in children's diets (5). Cheese is a popular menu item among children and, when offered as part of school meals or snacks, can help them meet daily recommended servings of dairy foods. Results from two studies of middle school children indicate that the addition of cheese to various menu offerings may help increase the consumption of some FGTE – fruit, vegetables, and whole grains – compared to when cheese was not offered (30). This result was observed both in a cafeteria setting with a wide variety of foods available, and in a controlled setting of side by side food components. Additionally, the taste or flavor, appearance, and portion sizes of the cheese and FGTE used in the studies were rated highly by the students (30).

The American Academy of Pediatric Dentistry and the American Dental Association recommend cheese for dental health. Research shows that cheese helps neutralize acids that attack teeth, and calcium and phosphorus in cheese support remineralization of tooth enamel.



HEALTH ASPECTS OF CHEESE: WHAT THE RESEARCH SHOWS

Bone Health. Many cheeses are an excellent source of calcium and a good source of protein and phosphorus, each of which have been demonstrated to support bone health (7,12). In addition, cheese is a dietary contributor of other nutrients (e.g., magnesium, zinc, vitamins A and K) which play a beneficial role in bone health (7). Calcium is the specific nutrient most important for supporting normal growth and development of the skeleton in the early years and helping maintain bone health in later life (7,31). Many government and health professional organizations recommend foods such as dairy foods, including cheese, as the preferred source of nutrients for bone health (5-8,31).

Gastrointestinal Health. Many aged cheeses, because of their negligible lactose content, are a well tolerated source of dairy nutrients for lactose maldigesters (31). Primary lactose maldigestion is a genetically determined condition in which the amount of lactose (milk sugar) consumed exceeds the amount of the enzyme lactase necessary to metabolize lactose. Lactose intolerance is defined as the occurrence of gastrointestinal symptoms which may result from the incomplete digestion of lactose. Studies demonstrate that many lactose maldigesters can consume cheese without developing symptoms of intolerance (32,33). Because many cheeses, particularly hard or aged cheeses (e.g., Cheddar, Swiss, mozzarella), are high in calcium yet naturally very low in lactose, several health professional organizations recommend cheese as a dairy option for people with lactose maldigestion (5,6,34). The interim final rule revising regulations governing the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) food packages recommends lactose-reduced or lactose-free dairy foods as an important first option before non-dairy choices for those with lactose intolerance and allows amounts of cheese that exceed the maximum substitution

amounts for those who obtain medical documentation (35).

Dental Health. Multiple factors, including diet, dental plaque bacteria, saliva flow and composition, and a susceptible tooth, influence dental caries, an oral health disease affecting nearly 42% of U.S. children and adolescents and 90% of adults (36). Findings from experimental animal studies and human investigations suggest that several varieties of cheese (e.g., Cheddar, Gouda, blue, Monterey Jack, mozzarella, Swiss, process) do not contribute to dental caries and that they may even help reduce the risk of caries (4,31,37,38). Also, certain cheese components such as protein (e.g., casein, bioactive peptides), fat, calcium, and phosphorus may contribute to this food's caries protective effect. Potential mechanisms by which cheese may play a protective role in dental caries include its ability to stimulate saliva flow, inhibit plaque bacteria, and provide calcium and inorganic phosphate, which reduce demineralization and enhance remineralization of tooth enamel (31,37,38).

While evidence to date suggests a protective effect of cheese against dental caries, additional research is needed to determine whether all cheeses deliver a similar degree of benefit and to determine the precise mechanism(s) responsible. However, the general public (39) and dental health professional organizations such as the American Academy of Pediatric Dentistry (AAPD) (40) and the American Dental Association (41) recognize that cheese supports dental health. The AAPD (40) states that:

- "Certain cheeses have been shown to have characteristics that disrupt the development of cavities when eaten alone as a snack or at the end of a meal."
- "Cheeses such as aged cheddar, Swiss, mozzarella, and monterey jack stimulate the flow of saliva, clearing the mouth of food debris and acting as a buffer to neutralize the acids that attack teeth."
- "The calcium and phosphorus found in cheese also reduce or

Studies have shown that moderate consumption of cheese is not associated with increased risk of coronary heart disease and that cheese can be included in a heart-healthy diet such as the DASH dietary pattern.



prevent decreases in pH levels of saliva and promote remineralization of tooth enamel."

Cardiovascular Health.

Cheese in moderation can be included in heart-healthy diets that meet total fat, saturated fat, and sodium recommendations (42-45). The Dietary Approaches to Stop Hypertension (DASH) dietary pattern, which is a low-fat diet including two to three servings of dairy foods and eight to 10 servings of fruits and vegetables a day, has been shown to reduce risk factors for heart disease. These include high blood pressure (hypertension) (46), total and low-density lipoprotein (LDL) cholesterol (47), and homocysteine (an amino acid thought to be an independent risk factor for heart disease) (48), as well as obesity (49). A week of sample menus of the DASH eating plan based on 2,000 calories a day includes reduced-fat cheeses five of the seven days (50). The American Heart Association (AHA)'s 2006 *Diet and Lifestyle Recommendations* to reduce the risk of cardiovascular disease offers the DASH diet and Therapeutic Lifestyle Changes as examples of healthy eating patterns that meet AHA guidelines (51). Both dietary patterns include two to three daily servings of low-fat and fat-free milk and milk products, including cheese (51).

Small human intervention studies have demonstrated that cheese intake has a relatively minor LDL cholesterol-raising effect compared to a similar quantity of fat from butter (42,52,53). Also, cheese intake has been shown to be positively associated with serum HDL cholesterol in a large cross-sectional study (54). Although further research is needed to confirm these findings and to identify the mechanism(s) involved, recent observational studies support the addition of moderate amounts of cheese in a heart-healthy diet (44,55,56). Findings that cheese may be less cholesterolemic than suggested by its fat/saturated fat content may involve other components in cheese such as calcium, protein (bioactive peptides), sphingolipids, and long-chain

menaquinones (vitamin K₂) (29,31, 43,45,55,56).

A review of a conference convened to examine dairy fat in relation to cardiovascular disease led the researchers to conclude, "There is no clear evidence that dairy food consumption is consistently associated with a higher risk of CVD [cardiovascular disease]. Of the major types of dairy foods, limited evidence to date indicates that cheese appears most likely to be associated with reduced CVD risk" (57).

CONCLUSION

Dietary recommendations acknowledging dairy foods' contribution to a healthful diet recognize cheese as an important component of the Milk Group (5-8). Because of cheese's nutritional and health benefits and the fact that cheese is a popular food, the dairy industry continually strives to develop cheeses to meet consumers' taste and health desires. D

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- Low-Fat Cheese Research (under Product Research, Cheese)

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