V. NUTRIENT CONTENT OF CHEESE

Cheese provides many essential nutrients. As indicated in Table 29, in 1994, cheese contributed 8% of the protein available in the food supply, 23% of the calcium, and 5% of the riboflavin, as well as many other nutrients in significant amounts. Cheese contains, in a concentrated form, many of milk's nutrients. About 10 pounds (5 quarts) of whole milk are needed to make 1 pound of whole milk cheese and 9 pounds of whey.

The composition of milk used in cheese-making changes as a result of separation of the curd from the whey, and ripening or curing of cheese. Separation of the curd from the whey in cheese-making causes a significant partition of nutrients and a considerable change in the nutrient content of cheese compared to that of the original milk. Milk's water-insoluble components (e.g., fat, fat-soluble vitamins, casein), which are primarily retained in the curd, are concentrated in cheese. Most ripened cheeses contain about 10 times the amount of water-insoluble components as in milk. For example, in Cheddar cheese the 3.2% fat (in milk) is increased to 32% (in cheese) and the 2.3% protein is increased to 23%. Most of milk's water-soluble constituents (e.g., milk sugar or lactose, dissolved salts, other proteins such as lactalbumin and lactoglobulin) remain in the whey. These nutrients are therefore lower in cheese than in milk, with the amount in cheese depending on how much whey is entrapped in the curd. The proportions of the nonfat nutrients are about the same as in whole milk cheese.

A typical partition of nutrients between curd and whey in cheese-making is found in Table 30. The amount of various nutrients retained in the curd and whey largely depends on the type of cheese being manufactured, the type of milk (whole, reduced fat, nonfat) or whey used, and the manner of coagulation (enzyme or acid coagulated).

Ripening also influences the nutrient content of cheese, although to lesser extent than separation of the curd from the whey. Generally, nutrient changes during ripening or curing do not result in nutrient losses per se. Protein, carbohydrate, and fat are the nutrients mainly affected during ripening. The end products of alterations in these nutrients are responsible for the characteristic odor and flavor of the finished cheese. In certain varieties of cheese, the B complex vitamins may increase due to the synthesis of the vitamins, mainly on the outer layers of the cheese. However, on a moisture-corrected basis, little difference in the vitamin content may occur.

Cheese is an important source of high-quality protein, vitamins, and minerals, as indicated below. Because of its nutrient content, cheese is considered to be a nutrient-dense food, providing a high concentration of nutrients relative to its energy content. The nutrient content of select cheeses can be found in Table 13. For information on the nutrient content of many other cheeses, refer to USDA's Nutrient Database 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 food supply. Further, the proportion of protein from cheese has increased more than five-fold since the turn of the century. Cheese is a source of high-quality protein (i.e., protein that contains all of the essential amino acids in amounts proportional to the body's need for them). Casein is the main protein in cheese, although the water-soluble milk proteins lactalbumin and lactalglobulin may also be present, depending on the amount of whey entrapped in the cheese.

  Both the method of coagulation of milk and the degree of ripening influence the protein in cheese. In enzyme-coagulated cheese (e.g., Cheddar), protein is present as di- and mono-calcium paracasein. A portion of the calcium is removed by lactic acid produced during cheese-making, resulting in calcium lactate and free paracasein. During curing, the rigid insoluble paracasein is hydrolyzed into smaller molecular and soluble nitrogeneous forms, resulting in a softer, more pliable, partially digested food. The extent of protein hydrolysis and the resulting compounds determine the characteristics of the final cheese. In some varieties of soft cheeses (e.g., Camembert, Limburger), much of the protein is converted to water-soluble compounds, including peptides, amino acids, and ammonia. The softness of these types of cheese is due to the extensive solubilization of the proteins as well as to the high moisture content of the cheese. In hard cheeses (e.g., Cheddar, Swiss), less protein hydrolysis occurs than in soft cheeses.

  Protein in acid-coagulated cheese (e.g., cottage cheese made with a starter culture alone) is isoelectric casein. This protein is not greatly hydrolyzed or digested before use. Acid-coagulated cheeses treated with a high temperature (e.g., ricotta, queso blanco) contain all three milk proteins — casein, lactoglobulin, and lactalbumin — in appreciable amounts.

The protein and amino acid content of cheeses can be found in Tables 13 and 16 as well as in USDA's Nutrient Database.

- **Carbohydrate.** In ripened cheeses, the carbohydrate content, mainly lactose, is not nutritionally significant. Lactose is largely removed in the whey during cheese-making. The small amount of lactose entrapped in the curd is transformed to lactic and other acids by bacterial action during curing. Most varieties of cheese contain an insignificant amount of lactose (refer to Table 10 for the lactose content of selected cheeses). The legal addition of optional ingredients such as nonfat milk and cheese whey during the manufacture of process cheese products may increase their carbohydrate (lactose) content compared to natural cheeses. The wide range of lactose in process and cottage cheeses may be explained by the addition of lactose as an optional ingredient to the creaming mixture.
- **Fat.** The fat content of cheeses varies widely, mainly because of the type of milk (e.g., whole, reduced fat, nonfat) and milk product (e.g., cream) used to make cheese. Nonfat cottage cheese contains less than 0.5 g per 4-ounce serving, whereas a serving of Cheddar cheese (1.5 oz.) contains 14 g of fat. A high-fat cheese, such as cream cheese, is always enriched with cream and as such contains a greater proportion of fat than protein. Cheeses such as Cheddar, Brie, blue, Limburger, Muenster, Gouda, and Swiss are generally made from whole milk and have about the same amount of fat and protein. A lowfat cheese has a higher protein-to-fat ratio. The fat content of cheeses can be found in Table 13 and in USDA's Nutrient Database.

The minimum milk fat and maximum moisture content of most cheeses is governed by federal and state regulations. Recently, federal standards of identity for lowfat and nonfat cottage cheeses have been removed. These types of cottage cheese are now subject to the requirements of FDA's "general standard," which permits foods to be named by a defined nutrient content claim (e.g., lowfat) and a standardized term (e.g., "cottage cheese"). Lowfat cottage cheese (2% milk fat, 1% milk fat, or .5% milk fat) must contain no more than 3 g total fat per serving (about 4 oz.). Nonfat cottage cheese must contain less than 0.5 g total fat per serving.

The content of cholesterol, like that of fat, varies widely in cheese. Cheddar cheese contains 105 mg cholesterol per 100 g, whereas nonfat cottage cheese dry curd contains about 7 mg cholesterol per 100 g. The fat and cholesterol content of cheeses can be found by referring to the Nutrition Facts panel on product labels.

Cheese is a good source of the essential fatty acids linoleic and linolenic acids and is low in trans fatty acids. Fatty acids are precursors of prostaglandins, which have unique physiological roles in the body. During cheese ripening, a small amount of the fat is hydrolyzed to volatile fatty acids, butyric, caproic, caprylic, and capric acids and higher carbon chain fatty acids, which contribute to the flavor of cheese. Cheese is a significant source of conjugated linoleic acid (CLA) (refer to Table 19). Recent scientific research supports potential roles for CLA isomers in reducing the risk of certain cancers and heart disease, enhancing the immune function, and regulating body weight/body fat distribution. Cheese is also a good source of sphingolipids (Table 20). Preliminary scientific findings indicate that this milk fat component may help reduce the risk of heart disease and colon cancer.

- **Vitamins.** The vitamin content of specific cheeses varies widely as a result of the vitamins in the milk used, the manufacture of cheese, the cultures or microorganisms used, and the conditions and length of the curing period. As most of the fat in milk is retained in the curd, cheese contains the fat-soluble vitamins of the milk used in cheese-making. Cheddar cheese, which is made with whole milk, contains 1,059 International Units (IU) or 278 ug Retinol Equivalents (RE) of vitamin A per 100 g, whereas cottage cheese dry curd, made with nonfat milk, contains a comparatively smaller amount of this vitamin (30 IU or 8 ug RE per 100 g). Ripening results in little, if any, change in the vitamin A content of cheese.

The water-soluble vitamins in cheeses vary widely. Thiamin, riboflavin, niacin, vitamin B_6, pantothenic acid, biotin, and folate remain in the whey. The more whey retained in the cheese, the greater the content of these water-soluble vitamins in the cheese. The bacterial surface-ripened and mold-ripened cheeses (e.g., Limburger, Camembert, blue, Roquefort) may contain a higher concentration of the B-complex vitamins than the hard and semi-hard types of cheese (e.g., Cheddar, Swiss, mozzarella). In the bacterial surface-ripened varieties of cheese, the B-complex vitamins can be synthesized by the surface-ripening microorganisms during curing. In soft-ripened cheeses (e.g., Brie, Camembert), an increase in several of the B-complex vitamins occurs on the outer layers with little vitamin change in the center portion. In general, cheeses in which proteolysis is extensive (e.g., soft-ripened and semi-soft types) have a higher content of the B-complex vitamins than hard and soft-unripened types.

- **Minerals.** Cheeses are a good source of several minerals, although the amounts of specific minerals in different cheese types vary according to manufacturing procedures. Cheese's mineral content is influenced by the addition of salt and optional ingredients, the method of coagulation, treatment of the curd, and the resulting acidity. Refer to Table 13 and USDA's Nutrient Database for the calcium, iron, magnesium, phosphorus, zinc, copper, manganese, and selenium content of specific cheeses.

Cheese is a good source of calcium. The calcium content of cheese is largely influenced by the acidity at coagulation and the degree of expulsion of whey from the curd. In ripened whole milk cheeses made with a coagulating enzyme (e.g., Cheddar, Swiss, brick), the calcium and phosphorus largely remain in the curd. Cheese coagulated by lactic acid alone (e.g., cottage cheese) retains less calcium and phosphorus because the calcium salts are removed from the casein as casein is precipitated at its isoelectric point. Cheddar cheese contains 721 mg calcium per 100 g, whereas dry curd cottage cheese contains 32 mg calcium per 100 g. Regular cottage cheese contains more calcium (60 mg calcium per 100 g), indicating that the creaming mixture or other additives contribute calcium to the product.

Generally, cheeses that are high in calcium contain other minerals such as magnesium in appreciable amounts. Cheddar cheese, for example, contains about 28 mg magnesium per 100 g, whereas nonfat cottage cheese dry curd contains about 4 mg magnesium per 100 g. Manufacturing procedures can affect the content of several minerals. For example, if a high acidity is developed during the manufacture of a specific variety of cheese (e.g., nonfat cottage cheese dry curd), calcium and magnesium salts become more soluble and are removed with the whey. Likewise, frequent washings tend to lower the mineral content of the curd.

The sodium content of cheese is variable due to the addition of sodium chloride (salt) as an optional ingredient. One ounce of Cheddar cheese contributes only 7.3% of the recommended 2,400 mg daily sodium limit and 1 ounce of Swiss cheese contributes only 3.1%. Standards of identity are established for two low-sodium cheeses: low-sodium Cheddar and low-sodium Colby. These cheeses must contain no more than 96 mg sodium per pound. An ounce of either of these low sodium cheeses would supply no more than 0.25% of the recommended limit of 2,400 mg sodium per day. Other low-sodium cheeses are available. Low-sodium cheeses are defined as those containing 140 mg or less sodium per serving; very-low-sodium cheeses contain 35 mg or less sodium per serving; and sodium-free cheeses contain 5 mg or less sodium per serving (Table 9).

Trace elements such as zinc, copper, manganese, and selenium are found in negligible amounts in cheese.

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