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A resource about dairy-based nutrition
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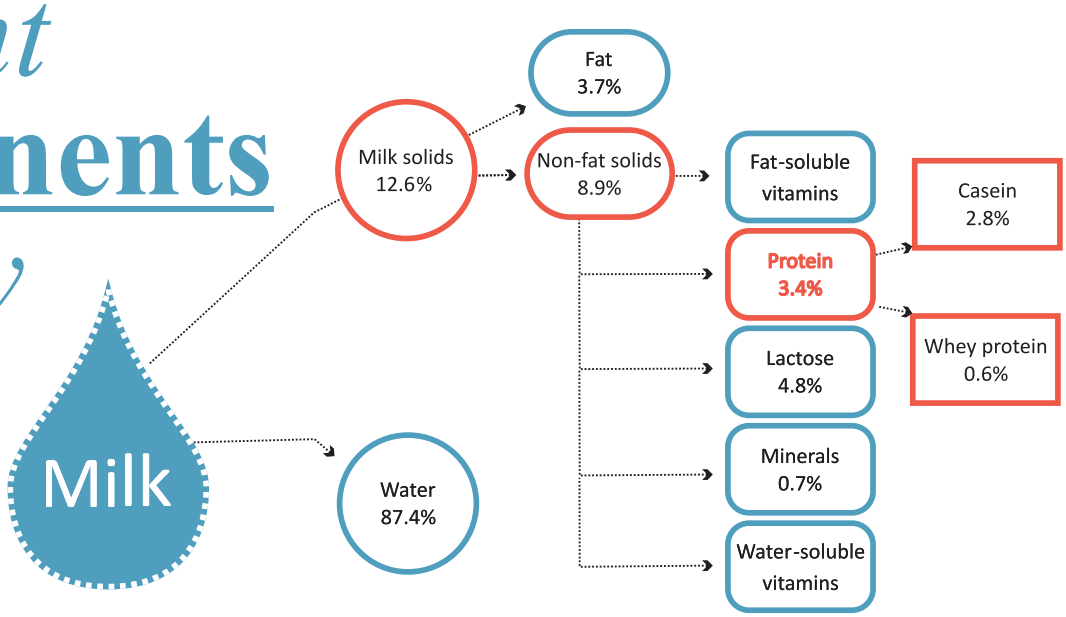
This review describes the nutritional composition of dairy and highlights the role of key nutrients for good health.

A publication for health professionals

Nutrient components *of dairy*



As one of the five core food groups, dairy foods have a key role in a balanced diet. Dairy foods are convenient and cost effective and naturally contain more than 10 essential nutrients, including calcium, vitamin A, vitamin B_{12}, riboflavin, carbohydrates, protein, potassium, phosphorus, magnesium and zinc.[1,2] As a result of new technologies in genetics, molecular biology and analytical chemistry, a number of milk constituents with physiological benefits beyond milk's traditional package of nutrients are being recognised.[3]

Milk is the primary ingredient of dairy products and consists of a complex mixture of components, with the major ones being lactose, lipids, proteins, minerals and water. Although fresh full-cream cow's milk is a liquid food (87% water), it contains on average 13% total solids, of which 9% are non-fats,[4] as shown in the diagram above.

Energy

The energy (kilojoule) content of milk and other dairy foods varies widely and depends mostly on the specific fat content. However, the addition of non-fat milk solids, sweeteners and other energy-yielding components to dairy foods contributes to the total energy provided by the selected food.[5] Milk is considered to be a nutrient-dense food that provides a meaningful amount of nutrients relative to its energy content.[6]

Proteins

Cow's milk protein is an important protein source in the diet owing to its high quality and biological value. It is a good source of essential (i.e. required for growth and which cannot be synthesised by the body) and branched-chain amino acids.[7,8] Cow's milk contains about 3.5% protein, of which 80% is casein and 20% is whey protein. Each of these proteins has unique amino acid profiles, characteristics and biological functions, including exerting antibacterial, antiviral, antifungal, opioid and immunomodulatory effects in addition to improving absorption of other nutrients.[7]

Carbohydrates

Lactose (β-D-galactopyranosyl-(1,4)-D-glucopyranose) is the principal carbohydrate in milk. It is more commonly known as 'milk sugar' and consists of a glucose and a galactose molecule bound together. Lactose varies slightly in concentration in milk (4.5–5.2 g/100 g) and exists as two forms (α and β), which differ in their solubility and sweetness (β-lactose is slightly sweeter than the α form). Lactose is also used as a fermentation substrate by lactic acid bacteria.[4,9]

Fats

Milk fat contributes unique characteristics to the appearance, texture, flavour and stability of dairy foods. It is the main source of energy in milk and provide essential vitamins and several other potential health-promoting components. The majority of the lipids in milk occur as fat globules, with 96–98% consisting of triglycerides. The rest is free fatty acids, cholesterol, diglycerides, monoglycerides and phospholipids.[9]

The composition of milk fat varies somewhat according to the animal origin, stage of lactation, presence of mastitis, ruminal fermentation or feed-related factors.

Typically, about 70% of the fat is in the form of saturated fatty acids (SFAs) and 30% exists as unsaturated fatty acids. Palmitic, myristic and stearic acid constitute 30%, 11% and 12% of the SFAs, respectively. Short-chain fatty acids make up 11% of SFAs. Oleic acid is the main monounsaturated fatty acid in milk (25–35%), with polyunsaturated fatty acids constituting only approximately 2% of the total fatty acid content.[7]

Current dietary recommendations advise moderation in total fat intake (20–35% of total energy value), with less than 10% of energy to be contributed by SFAs. Intake of *trans* fatty acids should be kept to a minimum. When selecting milk or milk products, low-fat or fat-free choices are recommended.

Vitamins

Almost all of the vitamins known to be essential to humans are found in milk, including the fat-soluble vitamins A, D and E, as well as the water-soluble B-complex vitamins and vitamin C. The fat content of milk determines the concentration of fat-soluble vitamins and therefore low-fat and skim milk varieties have lower amounts of these vitamins.[7]

Vitamin A has an important role in vision, gene expression, cellular differentiation, embryonic development, growth, reproduction and immunocompetence.[2] Milk and milk products are an important dietary source of vitamin A.

Three servings of full-cream dairy, consisting of 250 ml milk, 200 ml yoghurt and 40 g cheese, will provide 29% and 36% of the RDA for vitamin A in adult men and women, respectively.[10,11]

Vitamin D, a fat-soluble vitamin that enhances the intestinal absorption of calcium and phosphorus, is essential for the maintenance of a healthy skeleton throughout life.[2] As milk is not fortified in South Africa, vitamin D is present in low concentrations. However, exposure to sunlight should provide adequate vitamin D for most people living in South Africa.

Vitamin E is an antioxidant that protects cell membranes and lipoproteins from oxidative damage by free radicals. This vitamin helps to maintain cell membrane integrity and stimulates the immune response.[2] Vitamin E is present in low concentrations in milk (109 µg/100 g).[10]

In addition to the essential fat-soluble vitamins, milk and other dairy foods contain all of the water-soluble vitamins required by humans in varying amounts. Significant amounts of **thiamine** (vitamin B_1), which acts as a coenzyme for many reactions in carbohydrate metabolism, are found in milk.

Three servings of dairy provide about 8% and 10% of the thiamine recommended for adult men and women, respectively.

Milk is also an excellent source of **riboflavin** (vitamin B_2). This vitamin functions as a precursor for some of the essential coenzymes in the oxidation of glucose, fatty acids, amino acids and purines. The average riboflavin content of fluid full-cream milk is 0.158 mg/100 g.[2,10,11]

Niacin functions as part of a coenzyme involved in fat synthesis, tissue respiration and utilisation of carbohydrates. This vitamin promotes a healthy digestive tract, skin and nerves, as well as aiding in digestion and fostering a normal appetite. The niacin content of milk is 0.107 mg/100 g.[2,10,11]

Milk is also a good source of **pantothenic acid**, a component of coenzyme A, which is involved in fatty acid metabolism.

Folate as found in milk is a growth factor and functions as a coenzyme in the transfer of nucleotides necessary for DNA synthesis. Cow's milk contains a high-affinity folate-binding protein, which is a minor whey protein that promotes retention and increases the bioavailabilty of folate by slowing the rate of its absorption. Adequate folate nutrition is especially important for women of childbearing age to reduce the risk of neural tube defects in infants.

Three servings of dairy will supply approximately 9% of the 400 µg folate recommended for adults per day.[10,11]

Vitamin B_{12} is necessary for growth, maintenance of nerve tissue and normal blood formation. Milk provides 0.44 µg vitamin B_{12} per 100 g.[2,10]

Minerals

Milk and other dairy products are excellent sources of readily bioavailable calcium, providing approximately 300 mg per serving. Dairy is also an important source of minerals such as phosphorus, magnesium, potassium and zinc.[5,7,10]

Phosphorus is an essential mineral that has a central role in metabolism and is a component of lipids, proteins and carbohydrates.

Magnesium, a required cofactor for over 300 enzyme systems in the body, is related to the function of calcium and phosphorus. This mineral activates many of the body's enzymes, participates in protein synthesis and has a role in the metabolism of carbohydrates and fat. Because magnesium is widely distributed in foods, particularly those of vegetable origin, a deficiency of this nutrient is rare.[2]

Potassium contributes to the transmission of nerve impulses and helps to control skeletal muscle contraction. Accumulating scientific evidence supports the beneficial role of potassium in blood pressure control. Milk contains about 157 mg potassium per 100 g and is ranked as the top food source of potassium.[5,10]

Milk and other dairy foods contain many trace elements or nutrients needed by the body, such as **zinc**, **selenium** and **iodine**. Zinc is essential for growth and development, wound healing, immunity and a number of other physiological processes. Zinc is also a regulator of gene expression and helps to maintain the integrity of cell membranes. Dairy foods such as milk, cheese and yoghurt are good sources of zinc.[2] Iodine, which occurs naturally in milk, is an essential component of the thyroid hormones, which regulate growth and metabolism. The iodine content of cow's milk varies widely, depending on the geographical area and iodine intake of the cow.[2,5]

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