

Milk Nutritional Composition and Its Role in Human Health

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Abstract: Introduction: Milk is a nutritious, white or slightly yellowish liquid, which is a biological secretion of mammalian breasts, including the human species, intended for feeding their babies. Purpose: The purpose of this review is to examine the nutritional value of milk and its usefulness in human nutrition. Material and Methods: The study was conducted based on reviewing Greek and international scientific studies on the subject found in Greek and international databases such as "PubMed", "Scopus" and "Medline", through the search engine "Google Scholar" and the Hellenic Academic Libraries Association (HEAL-Link). The exclusion criterion for the articles was the language, except for Greek and English. Mostly, only articles and studies accessible to authors were used. Results: Cow's milk consumption is vital for children, because it is considered one of the most important factors in the structure and development of the skeleton and maintenance of Intestinal microbiota (intestinal flora) aiding digestive processes. Additionally, it promotes the absorption of calcium. As regards the milk consumption by older adults, it meets the needs of the body in the best way because its nutrients are in digestible form. One liter (1 L) of milk provides 700 calories and consuming 2 L of milk per day neutralizes the feeling of hunger from the body, while achieving a satisfactory weight loss diet. Conclusions: Milk, therefore, is an invaluable and irreplaceable liquid that offers considerable long-term benefits to both people of all ages and society.

Key words: Milk, nutrition and milk nutrients.

1. Introduction

Milk and its dairy products are among the most important foods in the human diet. Consumption began to increase to a greater extent when research showed that milk is rich in nutrients. Milk is a nutritious, white or slightly yellowish liquid, which is a biological secretion of mammalian breasts, including human species, intended for feeding their babies [1].

According to the Food Laws and Regulations, milk is the colostrum-free product of whole, uninterrupted milking of a healthy dairy animal, which lives and feeds under healthy conditions and is not in a state of overwork [2].

The chemical composition of milk is influenced by

various daily factors, such as the age of the animal, lactation (milking stages), reproduction, time of year, ambient temperature, diet, health status and gestation period of the animal [1-3]. Various species of animals are used to produce milk. Cow's milk has the highest consumption. Its share in world milk production is 90%. They are followed by buffalo milk with 5%, goat milk with 3% and sheep milk with 2% [3]. The inclusion of milk in the diet of a person and especially a child is directly related to a healthy life. Milk is directly related to maternal affection and care [2].

The purpose of this review is to examine the nutritional value of milk and its usefulness in human nutrition.

2. Materials and Methods

The study was conducted based on reviewing Greek

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and international scientific studies on the subject found in Greek and international databases such as “PubMed”, “Scopus” and “Medline”, through the search engine “Google Scholar” and the Hellenic Academic Libraries Association (HEAL-Link). The exclusion criterion for the articles was the language, except for Greek and English. Mostly, only articles and studies accessible to authors were used.

3. The Origin and Evolution of Milk during the Course of Time

Milk is the first food of a human being after birth, which is able to fully meet the needs of this tender period of life. Such an important natural good could not be without a long history [4]. Humans first learned to consume the milk of other mammals regularly after the domestication of animals during the Neolithic Revolution or the development of agriculture. This development took place independently in many world locations from 9000-7000 BC in Mesopotamia, until 3500-3000 BC in America [5, 6]. Humans first domesticated the most important dairy animals—cattle, sheep and goats—in Southwest Asia [7]. Domestic dairy animals spread to Europe from Southwest Asia, beginning around 7000 BC [8].

Camels that were also domesticated in central Arabia in the fourth millennium BC, were used as dairy animals in North Africa and the Arabian Peninsula [9]. While the first Egyptian records for burn treatments describe burn bandages containing milk from mothers of male babies [10]. From 1300 BC, milk and its products were the main food of the ancient Greeks [11]. During the Medieval period, milk was called virtuous white liquor because alcoholic beverages were safer to drink than water [12].

The production of milk and dairy products expanded commercially after 1863 and Pasteur’s discovery of the process of inactivating the bacteria that turn wine into vinegar. This method, in honor of Pasteur, now known as “pasteurization”, has found great practical application in the production,

distribution and standardization of dairy products, resulting in the use of dairy products soaring [13]. It should be noted that during the last century as well as nowadays, with the technological and scientific development that has taken place, the dairy industry has experienced rapid growth.

4. Milk

Milk is the normal secretion of the breast that is taken after one or two acts of removing milk from the mammary glands without adding or removing anything while it is intended for consumption in liquid form or for further processing [14]. According to the US Milk Code (USDEW, 1953), milk is the secretion of breast milk which is free of colostrum, obtained by milking one or more healthy cows and which contains at least 3.15% fat and 8.25% solid fat-free components.

Milk is created in the glandular epithelium of the mammary gland. It is a living and functional biological fluid [15]. The main constituents of milk are water, fat, proteins, lactose and salts which are its main constituents and determine its nutritional and commercial value. In addition to its main constituents, it contains hundreds of other constituents in lower concentrations such as vitamins, minerals, enzymes, dissolved gases and other lipids that determine its biological and technological properties [15]. The enzymes contained are catalase, phosphatase and lipase. Milk proteins are casein (α S1-Casein, α S2-Casein, β -Casein, κ -casein). Whey proteins are α -lactalbumin and β -lactoglobulin. Essentially, milk is a fat emulsion with proteins, lactose, minerals (calcium, magnesium, and potassium), vitamins (A, B1, B2, C, D) and other solids and minerals. Solids represent 13% of milk with fat at 4%, protein at 3.5% and lactose at 5% [16].

Milk is not homogeneous. Some of these ingredients, such as fat, can be separated from the rest of the milk mechanically [1].

Cow milk is a complete food, which covers almost all the needs of the human body. Precisely, it consists

of proteins, lactose, triglycerides, phosphorus, calcium and vitamins (B2, A and mainly D). It is rich in calcium and lysine, an amino acid that is often missing from plant proteins. Dominant in the minerals are calcium and phosphorus, which favor its absorption by the body (Table 1) [17].

Sheep milk compared to cow's and goat's milk is richer in fat (low molecular weight fatty acids), protein and salts, while its lactose content is low. Also, its fat shows not only quantitative but also qualitative differences from cow's milk.

Goat milk has a high content of low molecular weight saturated fatty acids and is poorer than sheep's milk and richer than cow's milk. The same goes for the rest of its solids. Sheep's and goat's milk contain significantly less vitamin B6 and B12 than cow's milk and twice as much as a woman's milk [3, 18].

Buffalo milk also contains less water, more total solids, fat and protein and slightly more lactose than cow's milk while it is richer in fat and protein. Its whiteness is often used to distinguish it from cow's milk because buffalo milk lacks beta-carotene (precursor to vitamin A) [19].

Another milk that has been used since ancient times is donkey milk. Donkey milk contains a rich variety of vitamins (A, B1, B2, B6, D, E), protein, essential fatty

acids, minerals and is a rich source of calcium, phosphorus, sodium, iron, zinc and immunoglobulins which makes it extremely beneficial for consumption and skin care [20].

As for breast milk or mother's milk, it differs significantly in composition and properties from cow's milk. It has a much higher content of lactose and significantly lower in albumin and salts. The differences in proteins are not only quantitative but mainly qualitative. In terms of fat, breast milk has a higher proportion of unsaturated fatty acids and does not contain the characteristic low-molecular-weight fatty acids, such as cow's and sheep's milk [17]. The vitamin content is highly dependent on food. Also, its calcium content is lower than that of cow milk and the calcium/phosphorus ratio is 2.2 times higher. It also contains various enzymes such as amylase, lipase, acidic and alkaline phosphatase and lacks xanthine oxidase, which is a criterion for distinguishing it from cow milk [21].

As for milk intended for consumption, it is called heat-treated milk, and by this term the types of milk are characterized that are suitable for human consumption and are made exclusively from raw milk. Heat-treated drinking types of milk include pasteurized and long-lasting milk (Table 2) [22].

Table 1 Average milk composition of different mammals (g/100 g).

Milk	Water	Fat	Protein	Lactose	Ash	Fat-free solid residue	Total solids
Goat	87.00	4.25	3.52	4.27	0.86	8.75	13.00
Cow	87.2	3.70	3.50	4.90	0.70	9.10	12.80
Sheep	80.71	7.90	5.23	4.81	0.9	11.939	19.29
Breast	87.43	3.75	1.63	6.98	0.21	8.82	12.57

Source: Mantis (2000).

Table 2 Composition of milk intended for consumption.

Type	Fat (%)	Min. Fat-free solid residue (%)
Whole milk	3.5 (min.)	8.5
Semi-skimmed milk	1.5-1.8	8.5
Partly (partially) skimmed milk	1.8-3.5	8.5
Skimmed milk	0.5 (max.)	8.5

Source: Food and Beverage Code (2009).

There are also types of milk in terms of consumption, and these are [23]:

(1) Fresh milk. It is a pasteurized type of milk which is processed through exposure to high temperature for a short period of at least 71.7 °C for 15 s. Fresh milk shelf life cannot exceed five days, including the pasteurization date [24].

(2) Pasteurized milk. It is the milk that has been pasteurized to destroy most of its pathogenic microorganisms. Pasteurization is recommended to heat the milk to a high temperature for a short time, 73 °C for 15 s (fast method) [25].

(3) Condensed milk. It is characterized as the product of condensing raw milk up to one third of the original volume and must contain at least 8% fat [25].

(4) Evaporated or partially condensed milk. It is the product obtained from raw milk after condensation, i.e. removal of water, up to half of the original volume, which must contain (%) fat twice as much as the corresponding raw milk [26].

(5) Sugar milk. It is dehydrated or concentrated or dry milk to which cane sugar or dextrose has been added or both [25].

(6) Long lasting milk. The types of long-lasting milk follow:

(a) UHT milk: Produced by continuous heating of raw milk, which involves the short-term application of high temperature (at least 135 °C for 1 s) in order to destroy all residual microorganisms and their spores, as well as the packaging of the product under aseptic conditions in opaque containers [27].

(b) Sterilized milk: Sterilization is done by heating the milk to temperatures higher than 100 °C for a short time (rapid method, 135-150 °C for 2-10 s) [27].

The procedures above seek to destroy all microorganisms, so that the milk can be stored for a long time even out of the refrigerator.

(7) Powdered milk. They are raw milk condensates (milk powder or milk tablets or dry milk) until dry, and, they should not have a moisture content of more than 5% by weight. Low heat powder is used in dairy

products such as cheese and baby food. High heat powder is used in the bakery and chocolate industry and medium heat powder in the production of concentrated dairy products [26].

5. Nutritional Value of Milk

Milk is the only food created by nature specifically for animal and human nutrition. The fact that the diet of newborns depends exclusively on milk shows that milk contains all the necessary nutrients.

By the term “milk” it is exclusively regarded as the milk which [27]:

- comes from cows;
- is fresh;
- is complete;
- is not dehydrated or concentrated;
- does not contain additives (e.g. sugar, vitamins, etc.).

Cow's milk consumption is vital for children, because it is considered one of the most important factors in the structure and development of the skeleton and maintenance of intestinal microbiota (intestinal flora) aiding digestive processes. Additionally, it promotes the absorption of calcium [28].

As regards the milk consumption by older adults, it meets the needs of the body in the best way because its nutrients are in digestible form. One liter (1 L) of milk provides 700 calories and consuming 2 L of milk per day neutralizes the feeling of hunger from the body, while achieving a satisfactory weight loss diet [29].

However, lactose intolerance has been reported several times due to a lack of the enzyme lactase in adults. Unlike cow milk, goat milk has a low content of casein, which is attributed to its hypoallergenic properties that have been observed in many cases of allergies. It contains a large amount of essential fatty acids that are recommended in the treatment of diseases such as coronary heart disease, intestinal disorders and cystic fibrosis. Moreover, these fatty acids have the special metabolic advantage to provide

energy while at the same time reducing the amount of cholesterol [3].

Goat milk is a good source of low cost but a source of a high quality protein, providing 8.7 g protein/250 mL cup covering 17.4% of the RDA (Recommended Dietary Allowance) for protein. Respectively, cow's milk provides 8.1 g/ 250 mL cup or 16.3% of RDA in protein [30].

Sheep milk is used either as it is or mixed with goat's or cow's milk. Characteristic of sheep milk is that its fat and protein content are increased at the beginning and end of the lactation period and decreased in the middle, while its salt content is increased towards the end of the lactation period [26].

Buffalo milk has beneficial effects on the human body, especially in those people who have problems with allergies, psoriasis, and eczema or lactose intolerance. Fresh milk is especially recommended as a type of food for thin and sick people [27].

Donkey milk proteins offer remarkable moisturizing properties due to their excellent absorption by the skin, as well as their ability to bind water. The mineral salts of donkey milk allow the skin to be cleansed, while also improving the healing process. At the same time, it detoxifies the liver, regulates the intestinal microfauna thanks to the action of lysozyme and lactose, has a positive effect in the treatment of high cholesterol, osteogenesis, and the treatment of atherosclerosis while it prevents cardiovascular diseases [28].

Milk also produces a variety of products, such as frothed milk or cream, butter, yogurt and cheese, as well as products that have low or local consumption such as Doogh (or yogurt milk), acidophilus milk, kefir and Kumys (or kumiss or koumiss) various types of cheese, ice cream and condensed milk [28].

6. Conclusions

Human beings are the only mammals that continue to consume milk after the period of breastfeeding, and this is because milk provides calcium and vitamins to

the body. Milk is an excellent combination of all macronutrients, such as carbohydrates, proteins and fat together, in excellent proportion to each other, but it also offers several vitamins and minerals important for the body. Milk, therefore, is an invaluable and irreplaceable liquid that offers considerable long-term benefits to both people of all ages and society.

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