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Exploring Milk's Nutritional Composition and Its Health Benefits: A Comprehensive Review

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Abstract:

Milk is a highly nutritious liquid that serves as a staple in the diets of many populations worldwide. It is rich in essential nutrients such as proteins, vitamins, and minerals, contributing to various health benefits. This paper reviews the composition of milk, its nutritional value, and its impact on human health. Ensuring that the milk given to the consumer is safe to consume and of high quality is the aim of quality control. The product's nature and modification, the hygienic conditions on the farm and in the industry, the process it undergoes, and the storage conditions all have an impact on the properties of raw milk. The government, industry, and farmers are among the many entities that keep an eye on milk quality. The farmer must have control over the raw milk to improve and maintain the quality of the product delivered to the evolving sector. The review also discusses sustainable dairy farming practices and the future of milk production in the context of global nutrition and environmental concerns.

Introduction:

Starting with high quality raw materials, the best way to do this is to produce the highest quality milk. Therefore, testing is required to ensure the safety and purity of raw milk. The presence of macroscopic abnormalities, addition of water, microbiological quality, presence of remains, presence of milk from dairy cows, and composition of raw milk are examined. Microbial contamination is a serious problem as rotten bacteria can reduce durability and disease can affect food safety. Contamination of raw milk on farms can be attributed to several factors, such as inadequate cleaning agents, incorrect milk cooling systems, inadequate breast preparation or milking status, or the presence of milk from mastic cows. Another concern is the presence of residual mycotoxins, pesticides, or veterinary medicines. An important aspect of raw milk quality is its composition. Dry matter, fat, and protein for payment are determined by the farmer and processor. The industry can handle other milk parts and improve quality, labeling and processing [1]. Milk consumption is at the highest. The global milk production rate is 90%. It follows 5% buffalo milk, 3% goat milk, and 2% sheep milk [3]. Including milk in the diet of people, especially children, is directly related to healthy living. Milk is directly related to mothers' love and care [2]. The purpose of this review is to examine the nutritional value of milk and its utility in human nutrition.

Materials and Methods:

The study was carried out using the search engine "Google Scholar" and the Hellenic Academic Libraries Association (HEAL-Link) to review Greek and worldwide scientific studies on the topic that were located in Greek and international databases like "PubMed," "Scopus," and

"Medline." With the exception of Greek and English, the items were excluded based on their language. The majority of the time, only research and papers that were available to authors were used.

The Origin and Evolution of Milk during the Course of Time:

A human being's initial food after birth is milk, which can completely satisfy their demands at this delicate stage of life. It would be impossible for such a significant natural good to exist without a lengthy history [4]. Following the domestication of animals during the Neolithic Revolution or the advancement of agriculture, humans initially discovered how to regularly ingest the milk of other mammals. From 9000–7000 BC in Mesopotamia to 3500–3000 BC in America, this development occurred independently in numerous places throughout the planet [5, 6]. Cattle, sheep, and goats are the most important dairy animals that humans initially domesticated in Southwest Asia [7].

Around 7000 BC, domestic dairy cows made their way from Southwest Asia to Europe [8]. North Africa and the Arabian Peninsula employed camels as dairy animals after they were domesticated in central Arabia in the fourth millennium BC [9]. On the other hand, burn bandages containing milk from mothers of male infants are described in the earliest Egyptian records for burn treatments [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. The manufacturing, distribution, and standardization of dairy products have greatly benefited from this process, which is now called "pasteurization" in honor of Pasteur and has led to an increase in the consumption of dairy products [13]. It should be mentioned that the dairy business has grown rapidly during the past century and in the present due to scientific and technological advancements.

Milk:

Milk, which is meant to be consumed in liquid form or processed further, is the normal secretion of the breast that is obtained after one or two acts of extracting milk from the mammary glands without adding or subtracting anything [14]. Milk is defined as the production of breast milk that is free of colostrum, obtained by milking one or more healthy cows, and that includes at least 3.15% fat and 8.25% solid fat-free components, as per the US Milk Code (USDEW, 1953). The mammary gland's glandular epithelium produces milk. It is a biological fluid that is alive and active [15].

Water, fat, proteins, lactose, and salts are the primary components of milk that define its nutritional and economic worth. Its biological and technological qualities are determined by hundreds of other ingredients, including vitamins, minerals, enzymes, dissolved gasses, and other lipids, in lower concentrations than its primary constituents [15].

It contains the enzymes lipase, phosphatase, and catalase. Casein (αS1-Casein, αS2-Casein, β-Casein, κ-casein) is a protein found in milk. α-lactalbumin and β-lactoglobulin are whey proteins. Proteins, lactose, minerals (calcium, magnesium, and potassium), vitamins A, B1, B2, C, and D, and other substances and minerals make up milk, which is essentially a fat emulsion. With fat at 4%, protein at 3.5%, and lactose at 5%, solids make up 13% of milk [16].

Milk is not uniform. It is possible to mechanically remove some of these

components, like fat, from the remaining milk [1]. ‘

Cow milk is a complete diet that meets nearly every requirement of the human body. It is specifically made up of proteins, lactose, lipids, calcium, phosphorus, and vitamins B2, A, and mostly D. It is high in lysine, an amino acid that is frequently absent from plant proteins, and calcium. Calcium and phosphorus make up the majority of the minerals, which promotes the body's absorption of them (Table 1) [17].

Sheep milk has a lower lactose level than cow's or goat's milk, but it is higher in fat (low molecular weight fatty acids), protein, and salts. Additionally, its fat differs from cow's milk in both quantitative and qualitative ways.

Goat milk is richer than cow's milk and poorer than sheep's milk, and it contains a lot of low molecular weight saturated fatty acids. Its other solids are no different. Goat and sheep milk has twice as much vitamin B6 and B12 as cow milk, but considerably less than cow's milk [3, 18].

In addition to being higher in fat and protein than cow's milk, buffalo milk has a little higher lactose content, more total solids, fat, and protein, and less water. Since beta-carotene, a precursor to vitamin A, is absent from buffalo milk, its whiteness is frequently used to differentiate it from cow's milk [19].

Donkey milk is another type of milk that has been consumed since ancient times. A wealth of vitamins (A, B1, B2, B6, D, E), protein, vital fatty acids, minerals, and calcium, phosphorus, sodium, iron, zinc, and immunoglobulins make donkey milk a highly advantageous food and skin care product [20].

The content and characteristics of mother's milk, often known as breast milk, are very different from those of cow's milk. It has substantially less albumin and salts and a lot more lactose. Protein variations are primarily qualitative rather than quantitative. Compared to cow's and sheep's milk, breast milk lacks the distinctive low-molecular-weight fatty acids and has a greater percentage of unsaturated fatty acids [17]. Food has a significant impact on vitamin content. Additionally, its calcium/phosphorus ratio is 2.2 times higher and its calcium content is lower than that of cow's milk.

In addition, it has a number of enzymes, including lipase, amylase, acidic and alkaline phosphatase, and it does not have xanthine oxidase, which is a requirement to differentiate it from cow's milk [21].

When referring to milk that is meant for human consumption, the term "heat-treated milk" refers to milk that is manufactured solely from raw milk and is deemed suitable for human consumption. Pasteurized and long-lasting milk are examples of heat-treated drinking 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	88.00	5.15	4.42	5.22	0.89	9.54	14.17
Cow	88.2	4.81	4.35	5.89	0.68	9.87	13.90
Sheep	82.61	7.69	6.00	5.75	0.91	12.73	20.26
Breast	86.12	4.02	1.83	7.62	0.23	9.18	13.53

Table 2 Composition of milk intended for consumption.

Types	Fat	Min. Fat-free solid Residue (%)
Whole Milk	3.6 (min)	8.5
Semi skimmed Milk	1.6 - 1.9	8.5
Partly (partially) skimmed Milk	1.9 – 3.7	8.5
Skimmed Milk	0.5 (max)	8.5

Milk Nutritional Composition and Its Role in Human Health:

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

(1) Fresh milk. It is a pasteurized milk that has been prepared by briefly exposing it to high temperatures—at least 71.7 °C for 15 seconds. The shelf life of fresh milk, including the date of pasteurization, cannot be more than five days [24].

(2) Pasteurized milk. It is milk that has been pasteurized in order to eliminate the majority of its harmful germs. It is advised to pasteurize the milk by heating it to a high temperature for a brief period of time—73 °C for 15 seconds, if using the rapid method] [25].

(3) Milk that has been condensed. It must have at least 8% fat and is defined as the result of condensing raw milk to one-third of its original volume [25].

(4) Milk that has partially condensed or evaporated. After condensation, or the removal of water up to half of the original volume, it is the product made from raw milk that must have twice as much fat (%) as the corresponding raw milk [26].

(5) Milk with added sugar. It is dry, concentrated, or dehydrated milk that has had either dextrose, cane sugar, or both added [25].

(6) Milk that lasts. The following are the varieties of milk that last: (a) Milk with UHT: produced by heating raw milk continuously, which includes packing the product in opaque containers under aseptic conditions and applying a high temperature for a brief period of time (at least 135 °C for 1 second) to eliminate any remaining microbes and their spores [27]. (b) Sterilized milk: The fast procedure, which involves heating the milk to temperatures above 100 °C for 2–10 seconds, is used to sterilize milk [27]. The aforementioned methods aim to eradicate all bacteria, allowing the milk to be kept for an extended period of time, even when not in the refrigerator.

(7) Milk powder. They are raw milk condensates (dry milk, milk powder, or milk tablets) that have been dried until they are completely dry; their moisture content shouldn't be higher than 5% by weight. Dairy goods like cheese and baby food contain low heat powder. Medium heat powder is used to make concentrated dairy products, whereas high heat powder is utilized in the chocolate and pastry industries [26].

Nutritional Value of Milk:

The sole food that nature has made especially for the nutrition of both humans and animals is milk. Newborns' sole source of nutrition is milk, demonstrating that it includes all the nutrients they need. The phrase "milk" refers only to the milk that [27]:

- comes from cows;
- is fresh; is entire;
- is neither concentrated nor dehydrated;
- does not contain additives (e.g. sugar, vitamins, etc.).

Consuming cow's milk is essential for youngsters since it is thought to be one of the most crucial elements in the skeleton's growth and structure as well as the preservation of intestinal microbiota, or intestinal flora, which supports digestive functions. Moreover, it facilitates calcium absorption [28]. Because milk contains nutrients that are easily digested, it is the ideal option for older persons to achieve their nutritional demands. 700 calories are found in one liter (1 L) of milk, and two L of milk per day counteracts the body's hunger while still allowing for a healthy weight loss diet [29].

Conclusions:

Since milk gives the body calcium and vitamins, humans are the only creatures that continue to drink it after they have finished nursing. In addition to providing the body with a number of vital vitamins and minerals, milk is a great source of all the macronutrients—carbohydrates, proteins, and fat—in the right amounts. Therefore, milk is a priceless and irreplaceable drink that has significant long-term advantages for society as a whole as well as for individuals of all ages.

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