**NUTRITIVE AND HEALTH PROPERTIES OF HUMAN MILK**

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**ABSTRACT**

Human milk is considered to be the most suitable food source for feeding newborns and infants. The World Health Organization suggests breastfeeding for the first six months. Human milk meets almost all the nutritional requirements that support healthy growth and development. It contains the essential nutrients and other components like immunoglobulins, cytokines, immune cells, lactoferrin, growth factors, oligosaccharides, long-chain fatty acids, and metabolic hormones. These immune and biologically active components not only contribute to the maturation of the infant immune system but also act as a protective barrier against pathogens. It protects against many diseases such as diarrhea, respiratory tract infections, and necrotizing enterocolitis. Also, it enhances neurodevelopment and gastrointestinal function. For this reason, human milk and breastfeeding should be the first choice for infant feeding. Remarkably, human milk offers numerous short- and long-term benefits not only on the infant but also on the mother through breastfeeding. However, breastfeeding and/or ingestion of human milk is not always possible and/or sufficient. In this case, it may be necessary to rely on donor human milk obtained from Human Milk Banks or infant formula that is not equivalent in terms of composition to human milk. The aim of this study is to provide descriptive and important information to reveal the nutritional and health properties of human milk.

**Keywords**: breast milk, casein, human milk, necrotizing enterocolitis.

**1. INTRODUCTION**

The best source of nutrition for the growth and development of infants is human milk (breast milk) (Li et al., 2021). The reason for this can be summarized as follows:

1. Human milk contains essential nutrients such as proteins, carbohydrates, lipids, and minerals.
2. It contains bioactive factors such as immunological factors in its structure to preserve infants from invading microorganisms.
3. It supports the development of the infant microbiome and thereby the immune system of the newborn.
4. Since some components in its structure affect gene expression in newborns, human milk closely influences health (Meng et al., 2021).

Breastfeeding decreases postpartum hemorrhage and the incidence of breast cancer in mothers. The World Health Organization and the United Nations Children's Fund recommend that infants should be fed only with human milk for the first 6 months after birth, and then breast milk should be given along with appropriate complementary foods until the age of 2 to ensure the ideal growth of infants and the sustainability of their health (Zhang et al., 2022a). The source of the health benefits associated with breastfeeding is the cumulative effect of the nutritional and bioactive components in human milk. Many of these identified biological effects are directly related to the duration of breastfeeding (Mosca & Giannì, 2017).

Though human milk from the mother is thought the best choice for infants, when it is unavailable, donor human milk obtained from Human Milk Banks is the second-best option for feeding preterm infants. Low-Temperature Long-Time pasteurization (62.5 ◦C for 30 min) as heat treatment is normally applied to donor human milk to ensure microbiological safety and extend shelf-life. Nevertheless, Low-Temperature Long-Time pasteurization can reduce the concentration of some vitamins such as vitamin B1 and C and cause denaturation of some proteins. It can create structural modifications in important bioactive proteins including lysozyme, lactoferrin, and IgA, and thereby eliminate their beneficial bioactivities (Leite et al., 2022).

Unfortunately, not all infants can be fed with human milk or donor milk. They are fed with infant formula that does not contain fully or partially human milk oligosaccharides. The demand and sales of infant formula appear to be booming in the global market. The Compound Annual Growth Rate (CAGR) of infant formula exceeded 4.43%, as its consumption ascended from 2.23 million tons in 2012 to 2.66 million tons in 2016, according to the latest research reports. The global market size of infant formula was valued at USD68.6 billion in 2021 and is expected to reach a value of USD 93.3 billion in 2025, indicating an 8% CAGR in 2021-2025. Despite this increase in the market size of infant formula, it should be forgotten that infant formula can never replace human milk (Li et al., 2021).

**2. THE CHEMICAL COMPOSITION AND HEALTH EFFECTS OF HUMAN MILK**

Human milk is also known as "white blood" because of the nutrients in milk that are essential for the growth and development of the newborn (Zhang et al., 2022b). It is a personalized biofluid whose composition varies in nutritional content and bioactive components. The composition of human milk has evolved in evolutionary development to provide the infant with a balanced diet and protection against potential infectious pathogens while complementing the development of the newborn's immune system (Mosca & Giannì, 2017). Human milk contains bioactive molecules such as carbohydrates, lipids, proteins, vitamins and minerals, cytokines, growth factors, and oligosaccharides. Many of the components of human milk, such as casein, lactose, and oligosaccharides, are synthesized and secreted from specialized mammary epithelial cells in the mothers' mammary gland. But not all human milk components are synthesized in specialized mammary epithelial cells. Immunoglobulins (Ig), immune cells, and some micronutrients can come from the maternal circulation (Meng et al., 2021). Table 1 provides the average results of energy and nutritional value of mature human milk.

**Table 1.** The energy and nutritional value of mature human milk (Samur, 2008).

|  |  |
| --- | --- |
| Energy and Nutritional Value | Amount in Human Milk (100 mL) |
| Energy (kcal) | 69 |
| Protein (g) | 1.3 |
| Lactose (g) | 7.0 |
| Fat (g) | 4.1 |
| Protein (%) | 7.0 |
| Lactose (%) | 42.0 |
| Vitamins |  |
| Retinol (μg) | 60 |
| β carotene (μg) | 27 |
| D (IU) | 0.42 |
| E (mg) | 0.34 |
| K (μg) | 0.21 |
| Thiamine (mg) | 0.02 |
| Riboflavin (mg) | 0.03 |

Maternal diseases, time of lactation, length of gestation, genotype, and maternal’s diet are among the causes of compositional differences in human milk. The protein content of human milk gradually reduces from the second to the sixth-seventh months of lactation and remains stable thereafter. It is noteworthy that during early lactation preterm milk content is higher than term milk content. The content of lactose is especially high between the fourth and seventh months of lactation and then decreases. However, it is known that the fat content increases during lactation. While the fat fraction is most sensitive to the maternal diet, the protein and carbohydrate fractions are unaffected. Individual fatty acids in human milk which are taken from maternal plasma or synthesized endogenously in the mammary gland, indicate changes in maternal dietary fat within two or three days. Maternal body mass index affects the amount and type of fatty acids in human milk. The amount of saturated fatty acids and the ratio of n-6 to n-3 fatty acids are higher in the human milk of overweight women compared to the human milk of normal-weight women (Mosca & Giannì, 2017).

Significant differences in long-term health, intelligence, and incidence of mortality have been reported between breast-fed and formula-fed infants. It has been determined that diseases such as necrotizing enterocolitis, respiratory tract disease, and some chronic diseases are seen with a lower frequency and shorter duration in breast-fed infants (Li et al., 2021). Human milk can be also reduced the risk of obesity later in life (Meng et al., 2021).

Recent studies have provided much evidence regarding the importance of hormones in human milk on the health of newborns and the development of infants. The results of experimental and clinical studies show that human milk hormones can act directly on the newborn intestine or be absorbed and transferred into the newborn's bloodstream to reach other organs. Studies in rodents have proven that leptin in human milk could be absorbed into the blood of newborns through the small intestine and controls the establishment of hypothalamic neural networks related to food intake. In addition, insulin in human milk reaches the hypothalamus of the newborn. It has been observed to modulate neural connections and play a role in gut maturation and gut barrier strengthening. To date, more than thirty peptidic and steroid hormones have been identified in human milk. In the light of this information, it is thought that the hormones found in human milk may also control energy homeostasis and gut maturation in newborns (Marousez et al., 2022).

**3. CONCLUSION**

International health organizations and scientific societies like World Health Organization declare human milk to be the normative nutritional standard for newborns. Human milk plays an important role in supporting the healthy growth and development of infants. Breastfeeding improves the long-term neurocognitive development of infants by reducing the occurrence of infections such as sepsis, and necrotizing enterocolitis, and serious retinopathy. Human milk contains anti-inflammatory factors (IL-10, cytokine TGF-β2), adaptive immune compounds (immunoglobulins sIgA, IgG, IgM, IgE, IgD), antioxidant factors (vitamin C, tocopherols), antimicrobial factors (lactoferrin LF and lysozyme LZ), and digestive enzymes. As a result, new studies on the biochemical properties and health effects of human milk should be brought to the literature, and studies on this subject should reach more people.

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