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**Review Article**

# Characteristics of cow's milk proteins including allergenic properties and methods for its reduction

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**ABSTRACT**

**Introduction:** Composition and hygienic quality of milk determine its nutritional value and processing suitability. However, biological quality of milk depends on the content of bioactive components, which due to its health promoting properties have a positive effect on human health. Biologically active substances present in cow's milk include proteins, peptides, amino acids, sugars, vitamins, enzymes, sterols, phospholipids and fatty acids. Among these components, several proteins (lactoferrin,  $\beta$ -lactoglobulin, bovine serum albumin and casein) that inhibit cancer cell growth, deserve special attention. However, cow's milk contains also approximately 30 potentially allergenic proteins. The most common bovine milk allergens are casein fractions and  $\beta$ -lactoglobulin naturally not present in human breast milk.

**Aim:** The aim of this study was to analyze the available literature on the characteristics of cow's milk proteins as allergens that may cause food allergies and identify methods of reducing their immunogenicity.

**Material and methods:** On the basis of the available literature characteristics of cow's milk proteins and their effect on the occurrence of food allergy in human are presented. A review of the available methods of modification of animal proteins that may reduce its allergenicity was also conducted.

**Discussion:** It is possible to reduce cow's milk allergenicity in the production of dairy products by thermal, enzymatic and biotechnological techniques. The majority of subjects that demonstrate intolerance of bovine milk may safely consume fermented dairy products.

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Conclusions: Prevalence of food allergy is so high that it may be considered a disease of civilization. Therefore, attention should be paid to food technological processes that may eliminate or reduce allergenicity of cow's milk proteins.

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## 1. Introduction

### 1.1. Significance of human milk proteins

Due to its nutritional value, human milk is considered the best nourishment for infants.<sup>32</sup> Composition of breast milk varies over the course of lactation. In the period of early lactation colostrum, that contains a lot more proteins than mature milk, is being produced; content of proteins in milk decreases with each month of lactation. Colostrum and then mature milk are the most important and difficult to replace nourishment for infants, perfect source of nutrients, such as protein, fat, calcium, phosphorus, magnesium, fat soluble and water soluble vitamins. It provides infants with all components necessary for their growth and development. It is also a source of bioactive proteins, i.e. lactoferrin, lysozyme, secretory immunoglobulin (IgA), vitamin B<sub>12</sub>, lactalbumin, bile salt,  $\kappa$ -casein and  $\beta$ -casein, whose role is to increase the absorption of nutrients in gastrointestinal tract and stimulate immune system and defense mechanisms against pathogens. In gastrointestinal tract these proteins increase digestion and absorption of nutrients through inhibitors, such as trypsin inhibitor or other active enzymes. In addition, they are involved in stimulation of the immune response against pathogens. It is a complex set of defense mechanisms against bacteria and viruses through prebiotic effect that consists of creating an environment to promote growth of beneficial bacteria in the intestines, i.e. *Lactobacillus* or *Bifidobacteria*, and inhibiting growth of pathogenic intestinal flora, i.e. *Streptococcus mutans*, *S. pneumoniae*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Candida albicans*.<sup>21</sup>

Cellular immune factors found in breast milk include

- B cells, which increase concentration of antibodies against specific microorganisms,
- macrophages, which destroy microbes directly in child's intestines, produce lysozyme and activate other elements of the immune system,
- neutrophils, which may act as phagocytes by consuming bacteria in the gastrointestinal tract,

- T cells, which directly destroy infected cells or produce chemical transmitters that stimulate other elements of the immune system, proliferate in the presence of microorganisms that cause serious disease of a child, produce immune response-enhancing factors,
- secretory immunoglobulin A (SIgA), which binds to pathogens in the gastrointestinal tract and prevents its penetration through intestine to the tissues,
- vitamin B<sub>12</sub>-binding protein, which reduces the amount of this vitamin required for bacterial growth,
- bifidogenic factor, which stimulates growth of *Lactobacillus bifidus* in child's intestines, contributing to displacement of pathogenic bacteria,
- fatty acids, which damage membranes of some viruses and destroy them,
- fibronectin, which increases macrophage activity against bacteria, facilitates regeneration of tissues damaged by intestinal immune response,
- gamma interferon, which increases the activity of immune cells,
- hormones and growth factors, which accelerate maturation of the intestinal epithelium, making it "tight" and resistant to penetration of pathogens and allergens,
- lactoferrin, which binds iron – trace element required for bacterial growth; reduced availability of iron inhibits growth of pathogens,
- lysozyme, which kills bacteria by damaging its cell walls,
- mucous substances, which adhere to bacteria and viruses and prevent contact with mucous membranes, and
- oligosaccharides, which bind with microorganisms and prevent them from contact with mucous membrane.<sup>24</sup>

### 1.2. Characteristics of cow's milk proteins

Similar to human milk, the main component of bovine milk that determines its nutritional value is protein (Table 1). Cow's milk proteins are a heterogeneous mixture and can

Table 1 – Main cow's milk proteins given by Bernatowicz and Reklewska.<sup>3</sup>

Protein	Content in milk (g/L)	Functions
Casein	28	Precursor of bioactive peptides, carrier of Ca, PO <sub>4</sub> , Fe, Zn, Cu ions
$\beta$ -Lactoglobulin	6.30	Allergenic protein, carrier of retinol, fatty acids, antioxidant
$\alpha$ -Lactalbumin	3.20	Immunomodulatory, antineoplastic, carrier of Ca, Zn, Mn, Co ions; involved in the synthesis of lactose
Lactoferrin	0.10	Antibacterial, antioxidant, antineoplastic, immunomodulatory, Fe absorption
Lactoperoxidase	0.03	Antibacterial
Lysozyme	0.0004	Antibacterial
Glycomacropeptide	1.20	Antiviral

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