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THE BIOLOGICAL ROLE OF SHEEP AND COW MILK PROTEINS

Sonia BEN FRAJ, Dănuț Nicolae ENEA, Monica MARIN, Livia VIDU

University of Agronomic Sciences and Veterinary Medicine of Bucharest,
59 Marasti Blvd, District 1, Bucharest, Romania

Corresponding author email: dan.enea26@yahoo.ro

Abstract

The study of milk proteins from different animal species is essential for understanding their impact on human health and their potential in the food industry. This article examines the biological role of proteins found in sheep and cow milk, highlighting their unique contributions to human nutrition and disease prevention. Through a comparative analysis, we explore the specific protein profiles of these two types of milk, including amino acid composition, biological activities, and digestibility. By employing a methodology that integrates in vitro studies, clinical trials, and systematic literature reviews, we assessed the impact of these proteins on bone health, muscle development, and immune system regulation. Our findings reveal that, although sharing some essential nutritional properties, sheep and cow milk proteins exhibit marked differences in terms of immunomodulatory capabilities and the prevention of chronic diseases. Specifically, certain sheep milk proteins have shown superior potential in promoting gastrointestinal health and preventing inflammation. This article concludes on the importance of diversifying protein sources in the diet to fully leverage their health benefits, highlighting the potentially superior role of sheep milk in certain nutritional and therapeutic contexts. Our discoveries open new avenues for exploiting the unique properties of sheep and cow milk proteins, both for nutritional science and industrial applications.

Key words*: milk production, protein, cow, sheep, biological role.*

INTRODUCTION

The protein in the Milk illustrates a significant source of nutrition because of the high biological values and the presence of amino acids essentials. Milk proteins are also the source of different dairy products because of the important techno-functional and biological properties of the proteins. With respect to cow milk, it is depicted as the heterogenous mixture of the proteins having different physio-chemical and structural properties (Petrova et al., 2022). Milks are obtained from the mammalian specie while cow milk protein is categorized in accordance t the solubility in two different fractions including caseins that are insoluble in acidic conditions and the whey proteins that are soluble proteins (Zenker et al., 2020). With respect to the biological value, HBM is approximately 9 gram of the protein per litre, thus, cow milk comprises of 32 gram of protein per litre (Antunes et al., 2022). In the cow milk, there is a ratio of casein fraction that is around 76 to 86% while the fraction of whey protein is around 14 to 24 percent in the total protein content of the cow milk. In addition, there are variations in the content and ratio of the protein subclass in the cow milk composition (Dhesi et al., 2020).

It has been denoted that the consumption of cow milk is by billions of people globally and has been recognized as the overall food. The ratio protein in the cow milk aims to provide both micro and macro nutrients that are important to the development and growth of the human body. The protein is depicted to be of high biological value that aims to represents all important amino acids and have high level of digestion (Giannetti et al., 2021). Despite the nutritional composition, the role of milk products in the human nutrition is high and depicts that it plays a protective and essential role to fight with the chronic disease (Zenker et al., 2020). Another study denoted in the background that cow milk biological protein has major health consequences including the allergy and lactose intolerance while, the choices of people lifestyle such as vegetarianism and veganism, the demand of cow milk alternative have increased and now people are using plant-based milk

which have increased the varieties of the plant-based milk (Petrova et al., 2022). People usually considers the plant-based milk as the alternative to the cow milk. The biological role of milk proteins has now been illustrated as negative due to having high ratio of cholesterol and fatty acids and composition of lipid fraction (Auntunes et al., 2022) With regards to the sheep milk, it exerts a ratio of biological ratios which influence metabolic actions and resistance to disease (Nudda et al., 2020). The sheep milk comprises of high ratio of casein, conjugated linoleic acid isomers, whey protein that aims to stimulates the immune systems and comprise of the properties of antidiabetic, anti-obesity and anti-cancer. The sheep milk has been denoted as to have an excellent resource of group B vitamins and protein that assures the good functioning of the nervous system (Nudda et al., 2020). The milk of sheep holds major biological value as it contains proline rich polypeptide that partially reverse the neurodegenerative change and also have an immunoregulatory and properties of pro-cognition (Wang et al., 2022). The biological property of CLA isomers in the sheep milk helps in minimizing the oxidative level of stress and mitrochondrial dysfunction in the brain that helps in reducing neurodegenerative disease including the Alzheimer disease (Lajnaf et al., 2023). The milk of sheep has been denoted as the inhibitory activity that works to reduce the angiotensin and coverts the enzyme that is crucial in the prevention of any infection (Lajnaf et al., 2023). The biological role of sheep milk is significant in lowering down the inflammatory biomarker and also minimize the atherosclerosis development in the human body (Lajnaf et al., 2023) Presently, the lifestyle has become sedentary and there has been lack of physical activities with an insufficient contribution of diet which creates rapid disease development. In the contemporary era, the customer awareness of food depicts that people wants highly biologically active ingredients that could be able to enhance the health thus the functional food plays a significant role in the health of human (Flis & Molik, 2021). With respect to the sheep milk and the products, it is a major source of calcium, fatty acids, iron, magnesium and phosphorus. The study by Li et al. (2022) denoted that the sheep milk protein biological value represents that it is fermented and fermented quality always imprints a health promotional effect specifically on the civilization disease and hearts disease. The consumption of sheep kefir and yogurt minimize the obesity and the risk of metabolic syndrome which reduces the type 2 diabetes (Roy et al., 2021). The consumption of sheep milk comprises of biologically active ingredients, antioxidant ingredients and immunomodulatory substance. There is a high ratio of content of valuable substance in the milk proteins of sheep and has been prove to provide major benefits to human health (Roy et al., 2021).

MATERIALS AND METHODS

For this study, the researcher used qualitative design to review the findings and to conclude the final thoughts. The rationale behind using qualitative research design is that this kind of design helps in exploring the objectives and to provide a deep understanding on the insights of the real-world facts. For this study, the researcher has not used the numerical data or have intervened with the statistics but used qualitative research to obtain the hypotheses. The qualitative study design helps the researcher to obtain the experiences of the researchers, their behaviour and perception regarding the concerned topic while, it helped in responding the whys and hows instead of how much and how many (Tomaszewski et al., 2020).

In order to analyse the biological role of sheep and cow milk proteins, the literature analysis has been done. The analysis of literature comprises of two different forms that are within the study literature and between the study literature analysis (Paul & Criado, 2020). Both the analysis of literature is important. This study used within study literature evaluation that includes to analyse the contents from the past journal articles and researches. The study has analysed every component related to the research objectives from different past research papers including their section of literature review, theories, conceptual frameworks, discussion and results (Paul & Criado, 2020). By analyzing the literature and past research papers, the common data and information have been obtained from the empirical works to attain the findings and to sum up the conclusion.

Initially, the researcher started the preparation stage and prepared the review and research structure by evaluating about the specific research objectives and questions to be addressed. After searching all the relevant literature, the researcher analysed that there is a need to obtain the articles information that should be up to date and must be related to the topic. The recent articles have been assessed to obtain the biological significance of the sheep and cow milk protein and its effectiveness on human health.

The searching was done by using appropriate key words and articles and research were analysed from the scientific database. Some of the scientific databases that were used includes PubMed, Scopus, Science Direct and Web of Science. This analysis included proper inclusion for every publication used in the study thus, specific principles were being formed as the inclusion criteria in this study. In the data collection, the most up to date scientific articles were used from the year 2019-2023. Thus, major prominence was placed on the research papers which were published within the last five years which increases the viability of this study.

RESULTS AND DISCUSSIONS

The study denoted about the components of the sheep milk proteins signifying that the significant endogenous amino acid in the sheep milk protein is called as proline that plays a major role in the synthesizing of the polyamines and arginine and also activates the MTOR cells which signals to initiate the process of the synthesis of proteins, especially collagen. Both of them are found in the sheep milk.

Table 1. The composition of sheep milk proteins (Flis & Molik, 2021)

Amino acid	In g/100 g of sheep milk	In g/100 g of Casei
Tryptophan	0.084	1.3
Threonine	0.268	3.6
Isoleucine	0.338	5.1
Leucine	0.587	9
Lysine	0.513	7.3
Methionine	0.155	2.1
Cysteine	0.035	0.8
Phenylalanine	0.284	5.2
Tyrosine	0.281	5.6
Valine	0.448	6.7
Arginine	0.198	3.3
Histidine	0.167	3.3
Alanine	0.269	3.2
Aspartic acid	0.328	7.7
Glutamic acid	1.019	21.1
Glycine	0.041	1.7
Proline		10
Serine	0.492	5

With respect to importance of each amino acids for human health, here are following points of some of them.

Histidine amino acid is important for the repair and growth od tissues, protection of nerves and helps in the histamine production that is essential for boosting human immune system

The valine, leucine and Isoleucine provides strength to muscle and provides energy production during the exercise by regulating the sugar levels in blood.

Lysine is helpful to provide protein, formation of collagen, absorption of calcium and carnitine production that is included in energy production and metabolism of fats

Methionine supports in the detoxification process and contains compounds of sulphur that is important for human health (Lopez & Mohiuddin, 2023).

Table 2. Essential amino acids in cow milk (Kyselov et al., 2022)

Essential amino acids	Cow milk
Tryptophan	0.046
Threonine	0.149
Isoleucine	0.199
Leucine	0.322
Lysine	0.261
Methionine	0.083
Cystine	0.03
Tyrosine	0.159
Valine	0.22

The table indicates that cow milk is a rich source of essential amino acids, which are the building blocks of proteins necessary for numerous bodily functions. Tryptophan, although present in the smallest amount, plays a key role in the synthesis of serotonin, contributing to mood and sleep regulation. Threonine supports protein synthesis and immune function, while isoleucine, leucine, and valine - all branched-chain amino acids - are abundant and critical for muscle repair and energy. Leucine, in particular, stands out for its role in muscle protein synthesis. Lysine is vital for tissue repair and metabolism, methionine for detoxification

processes, cystine for structural protein formation, and tyrosine for neurotransmitter production. The presence of these amino acids in adequate amounts confirms the nutritional value of cow milk, especially as a source of complete protein in the diet.

Table 3. The nutritional composition of cow and sheep milk (Zgheib & Zara, n.d)

Parameter g/100 g	Cow milk	Sheep milk
Moisture	87.9	82.9
Fat	3.7	6.1
Ash	0.7	0.9
Lactose	4.7	4.8
Protein	3.4	5.5
Casein	3	4.7

This table compares the compositional differences between cow milk and sheep milk based on various nutritional parameters per 100 grams:
Moisture: Sheep milk has less moisture content (82.9 g/100 g) compared to cow milk (87.9 g/100 g), which implies that sheep milk is denser and potentially more concentrated in other constituents.
Fat: The fat content in sheep milk (6.1 g/100 g) is significantly higher than in cow milk (3.7 g/100 g). This higher fat content can contribute to a creamier texture and richer flavor in sheep milk and its derived dairy products. It can also mean higher energy content per unit volume.
Ash: The ash content, which is a proxy for total mineral content, is slightly higher in sheep milk (0.9 g/100 g) compared to cow milk (0.7 g/100 g). This suggests that sheep milk may offer more minerals, which are essential for various body functions.
Lactose: Both types of milk have nearly the same lactose content, with sheep milk having a marginally higher amount (4.8 g/100 g) than cow milk (4.7 g/100 g). Lactose is the sugar found in milk and is an important carbohydrate source.
Protein: Sheep milk has a considerably higher protein content (5.5 g/100 g) than cow milk (3.4 g/100 g). Proteins are crucial for body repair and growth, and sheep milk's higher protein content could make it a more nutritious option.
Casein: Casein is the main group of proteins in milk and forms the basis of cheese. Sheep milk contains more casein (4.7 g/100 g) than cow milk (3 g/100 g). Higher casein content can lead to increased cheese yield from sheep milk and might affect the texture and flavor of the cheese. In summary, sheep milk appears to be richer in several key nutrients compared to cow milk. This can make it a valuable food source, especially in regions where sheep are more prevalent than cows. The higher fat and protein contents also suggest that sheep milk may have a more pronounced taste and could be more satiating. However, these differences also mean that sheep milk might not be as suitable for individuals with specific dietary restrictions, such as those requiring lower fat intake. The nutritional richness of sheep milk, especially in terms of proteins and minerals, highlights its potential benefits and uses in various culinary and food processing applications.

Components in the cow milk

The past study by Lajnaf et al (2022) denoted the components in the cow milk proteins signifying Caseins as the important component that are the phosphoproteins that illustrates the sufficient fraction of protein in the milk and represents 80 percent of the total protein in the milk. It usually comprises of four proteins which differs with respect to the content of concentration, amino acids, phosphorus and molecular weight. In the protein, α and β caseins are denoted as the most sensitive caseins and involves in the precipitation of the concentration of calcium (Lajnaf et al., 2022).

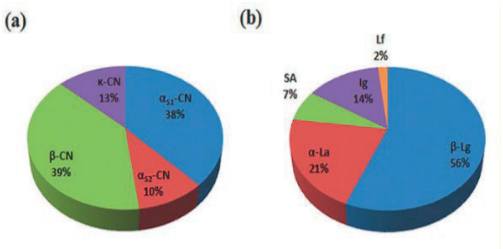

Figure 1. Proportions of the different caseins (a) and whey proteins (b) in cow's milk (abbreviations: β-CN: β-casein; αs1-CN: αs1-casein; αs2-CN: αs2-casein; κ-CN: κ-casein, β-Lg: β-lactoglobulin; α-La: α-lactalbumin; SA: serum albumin; Ig: immunoglobulins; Lf: lactoferrin (Lajnaf et al., 2022)

The Figure 1 denotes that the cow milk also contains the soluble protein fraction and the whey proteins that are the most significant component and are in the high fraction in the milk having the percentage of 20% to 25%. The

composition of the whey protein in the cow milk relies on the species of mammalian. Thus, the table denotes that the ratio of lactoglobulin is 56 while, α lactalbumin is 21 percent and bovine serum albumin is 7 percent (Lajnaf et al., 2022)

Table 4. Characterization and Allergenic Profile of Milk Proteins in Cow's Milk (Lajnaf et al., 2022)

Specification	Proteins	Allergen name	Molecular mass	PI	Relative amount	Amino acid residus	Allergenic activity of
Caseins 80% of total protein	Casein	Bosd9	22.9	4.46	38%	199	57%
	Casein	Bosd10	22.4	4.78	10%	207	
	Casein	Bosd11	23.5	4.49	39%	209	
	Casein	Bosd12	18.9	3.97	13%	169	
Whey proteins (20-25%)	Lg	Bosd5	18.28	5.2	56%	162	66%
	La	Bosd4	14.18	4.65	21%	123	18%
	BSA	Bosd6	66.4	4.7	7%	583	
	Lf	Bosd lactoferrin	76.1	8.18	2%	689	
	Ig	Bosd7	15.-800	5.5-7.5	14%	240-250	

The table presents an insightful breakdown of the main protein allergens found in cow's milk, detailing caseins and whey proteins. Caseins, which make up approximately 80% of total milk protein, are divided into four subtypes: Bosd9, Bosd10, Bosd11, and Bosd12, with molecular masses ranging from 18.9 to 24.4 kDa and pI values between 3.97 and 4.78. The relative amounts of these caseins vary, with Bosd11 constituting the largest proportion at 39%, while Bosd12 is the least at 13%. The allergenic activity, where noted, shows that 57% of patients exhibit a reaction to Bosd9, a significant figure suggesting its high allergenic potential.

Whey proteins, which account for 20-25% of milk proteins, include β-lactoglobulin (Bosd5), α-lactalbumin (Bosd4), bovine serum albumin (BSA, Bosd6), lactoferrin (Bosd lactoferrin), and immunoglobulins (Ig, Bosd7). These proteins have molecular masses that range broadly from 14.18 to 800 kDa and show varied allergenic activity, with β-lactoglobulin affecting 66% of patients, highlighting its prominence as a milk allergen.

Notably, α-lactalbumin has a lower incidence of allergenic activity (18%), suggesting it might be less problematic for people with milk allergies. However, lactoferrin and immunoglobulins, despite their lower relative amounts in milk, have significant molecular sizes and varying pI values, which could influence their allergenicity.

This table is a valuable resource for understanding the allergenic components of cow's milk. It also emphasizes the complexity of milk allergies, as various proteins contribute differently to allergenic responses. The data could be pivotal for developing hypoallergenic milk variants and for healthcare professionals managing patients with milk allergies.

Biological role of cow milk proteins in functioning the human body

It has been denoted in the literature that the cow milk proteins are highly efficient in the functioning of human body as the milk is rich source of different proteins and each component in the milk proteins plays an effective biological role in the human body (Ribes-Koninckx et al., 2023). One of the past studies identifying the efficiency of cow milk proteins signifies that the primary proteins in the cow milk are whey proteins and the casein. With respect to the biological role of Casein, the past literature emphasizes that Casein helps in making up around 80 percent of the total content of protein in the cow milk and exists in the form of micelles that are the tiny and little particles (Cronin et al., 2023). The cow milk contains Casein hence it is digested slowly by the human beings and provides a sustain releasing of the amino acids in the bloodstream of the humans and keeps the human body full for long period of time (Cronin et al., 2023). The study also emphasized that Casein plays an important role in the transport of the phosphorus and calcium in the body that helps in strengthening the metabolism of the human (Cronin et al., 2023). In the cow milk, there are also whey proteins included that are depicted as the high-quality proteins and are important for the human body functioning (Lajnaf et al., 2023). The whey proteins in the cow milk also supports in the fast digestion in the human body and leads to increase the amino acid levels in the bloodstream which makes it a good source of protein for the recovery of any disease (Balivo et al., 2023). The study denoted that the wo milk proteins comprise of immunoglobulins which significantly contributes in the function of the

immune system to safeguard the body from germs (Lajnaf et al., 2023). The lactoglobulins and lactalbumin are also denoted as the proteins that plays an essential role in the transportation of the important nutrients such as minerals and vitamins in the human body while the component of lactoferrin helps to bind with iron and transports absorption that contributes in defending the body from all kind of infections (Lajnaf et al., 2023)

Biological role of sheep milk proteins in functioning the human body

The literature from the past study Yang et al (2023) denoted that the sheep milk protein is highly efficient in the functioning of the human body as it contains anti-cancer, antioxidant and anti-inflammatory impact on the body. The research has proved that the sheep milk proteins have the capability to reduce the oxidative stress level in the body and also regenerates the antivirus to fight with the HIV and hepatitis C (Cunha et al., 2023). The sheep milk proteins are also important in binding the irons and blocks the growth of infection and microorganism in the body. It has the capability to inhibit the cancer cell proliferation and also have the capability to fight with the blood brain barricades (Pan et al., 2023).

Comparison between protein content of cow and sheep milk

The sheep and cow milk differs with respect to their protein content that could have effect on the dietary preference and needs of human. In the cow milk, the typical protein content is around 3.2% to 3.5% while, sheep milk contains high ratio of protein that ranges from 4.5% to 6%. With respect to Casein and whey ratio, cow milk holds high ratio of casein and whey proteins that helps to increase immune system in human while, sheep milk has a balanced proportion of casein and whey protein in comparison to cow milk (Landi et al., 2021). Sheep milk is easy to digest and absorb due to balanced proportion. Both the sheep and cow milk comprise of important amino acids but sheep milk have high concentration of amino acids in comparison to cow milk. In a nutshell, the protein content in sheep milk is high than the cow milk and sheep milk is more beneficial for the people who urged to take proteins more hence, cow milk is preferable for people who looks for moderate protein intake (Landi et al., 2021).

CONCLUSIONS

The study aims to evaluate the biological role of cow and sheep milk proteins for the functioning of human body however, the findings obtained from various literature search depicted that sheep milk is more nutritious in proteins in comparison to the cow milk as sheep milk is different from the cow milk holding more proteins in milk per glass. In addition, sheep milk has high ratio of fats, vitamins, proteins and fats and adds the double level of zinc and calcium in comparison to the milk of cow. The components studied in the findings and discussion part also concluded that the protein in the milk of sheep is more digestive in comparison to the milk of cow as the milk of sheep aims to deliver high ratio of amino acids, leucine, isoleucine and valine and helps in building the blocks of protein in the human body. The study also concludes that the biological role of sheep milk proteins comprises of high ratio of saturated fatty acids and increase the lactose absorption that is also beneficial for those who are intolerant to lactose. The nutritional value of the sheep milk protein is high than the cow milk proteins as it supports the human body to strengthen the immune system and to fight with the disease of heart, epilepsy, gall stones and cystic fibrosis. In a nutshell, the study summarizes that the value and biological role of sheep milk protein is highly effective for the human body functioning.

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