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Reconnoitering Milk Constituents of Different Species, Probing and Soliciting Factors to Its Soundness

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Abstract

Milk composition and production varies from species to species, reflecting its diversified benefits on health. Lipids from caprine and ovine milk are anti-obesity and anti-atherogenic while prebiotic in the case of caprine. Higher contents of selenium from caprine and iron from camel milk play a role in immune system and oxygen transport system, respectively, whereas enriched vitamins like riboflavin, folic acid, B6, vitamin A of bovine, and foliate of cattle are effective in the synthesis of hemoglobin, and high niacin content of caprine is anti-cancerous. Camel milk is found to have characteristics of anti-carcinogenic, antidiabetic, and autoimmune therapeutic. Various processing techniques like pasteurization, skim milk powder processing, and ultra-high temperature processing are necessary for safe provision of milk to meet consumers' demand. Change in flavor, loss of micronutrients, biofilm production, and spore-forming bacteria are prominent challenges during processing. Antimicrobial resistance and disease conditions are exaggerating factors of milk deterioration with respect to quality and quantity. Preclinical trials like somatic cell count, California mastitis test, proteomic analysis, Raman spectroscopy-based analysis, and X-ray fluorescence analysis are helpful in avoiding the spread of disease and controlling of economic losses. This chapter focuses differential functions of bioactive of milk, issues arising during processing techniques, and preclinical studies of milk for safer production and consumption of milk.

Keywords: milk composition, bovine, camel, caprine, ovine, mare, differential functions, processing techniques, preclinical milk tests

1. Introduction

Milk, according to USDA, is a sterile lacteal secretion from mammary glands by full milking of one or more animals and considered free of colostrum. Basically, milk is composed of significant components that may be categorized into macro and micro milk components. The former category is comprised of protein, lipids, and oligosaccharides mainly lactose, whereas the latter contains minerals and vitamins [1]. Utilization of milk from various species of animals depends upon likelihood of people and access to the dairy animals. In such situations, some of dairy animals are overlooked due to their limited population in specific regions of the world. Camel and caprine milk is specifically medicinal in nature that is limitedly utilized as

staple use. The production systems are fewer than needed which is a grave situation. It is a dire need to explore bioactive components of milk from various animals and to investigate alternative resources to feed the hungry and to be benefited by pharmacological aspects.

The likelihood of food consumption stresses it to be natural, free from chemical preservatives, and microbiologically safe with extended shelf life [2]. The rapid development of our society in the past few decades and the careless use of large amount of agricultural services are appearing to be a burden over human health. The hunger of the increasing population cannot be satisfied with fresh milk due to unequal production and utilization system. Previous 15 years have noticed dairy industry emerging as technology revolution in product processing [3]. But there are several harms to the soundness of milk associated with processing techniques in terms of quality and quantity losses. The current chapter encompasses bioactive components of milk from different milk-producing animals and their chances of being deteriorated by processing techniques.

2. Dairy milk bioactive components and their role on health and diseases

2.1 Bovine milk

Bovine milk as whole milk and its products are serving an easy way of achieving good nutrition. Bovine milk contains the nutrients needed for growth and development of the calf and is a resource of lipids, proteins, amino acids, vitamins, and minerals. The milk is also blessed with many substances like hormones, growth factors, immunoglobulins, peptides, cytokines, polyamines, bioactive peptides, and many enzymes that play different roles in our body [4]. Milk composition has dynamic properties and its composition varies depending on lactation, diet, age, breed, energy balance, and udder health. Colostrum is very different from milk, but the most important difference is the concentration of milk protein. It will be twice in colostrum compared with milk in late lactation. Lipids in bovine milk are suspended or emulsified in the form of fat globules covered with membranes. Lipids are mainly composed of different types of fatty acids having different fraction. Milk contains about 32 g of protein per liter. Milk protein is a good source of essential amino acids. In addition, milk contains various biologically active proteins, ranging from antimicrobial drugs and ending with nutritionally enriched proteins, as well as growth factors, hormones, enzymes, antibodies, and immune-stimulants. Nitrogen in milk is distributed in casein, serum, and nonprotein nitrogen. The content of casein in milk is about 80% of milk protein. Whey protein is a globular protein that is more soluble in water than casein. The main components are β -lactoglobulin, α -lactalbumin, bovine serum albumin, and immunoglobulin. Milk also contains many minerals, vitamins, and antioxidants. Antioxidants prevent the oxidation of milk and also provide protection to cells which involve in milk production and to udder also. The most important antioxidants in milk are mineral selenium and vitamins E and A [5]. However, cow milk (CM) differs from buffalo milk (BM) composition of different milk bioactive components. Buffalo milk has lower cholesterol but more calories and fat compared with cow's milk. Cow milk has higher cholesterol level than BM, but higher fat contents are present in BM with higher calorie percentage. Buffalo milk has a higher content of fat, lactose, casein, whey proteins, and minerals than cow milk. All of the casein in buffalo milk is present in the micellar form, while in the CM, only 90–95% of the casein is in the micellar state and the rest is present in serum phase. The calcium content is higher in BM

than in milk from cow, and it contains more colloidal calcium and phosphorus. The BM is richer in fat than milk from cattle, and absence of b-carotene in BM, which is present in CM, is another notable characteristic [6].

2.2 Camel milk

Camel is a blessing from God as narrated in Muslim's Holy Quran [7]. The total population of camels in the world accounts 23.9 million. Among the countries, India has 1.9% population of camels over the total world camel population [8]. They are playing a crucial part in the lifestyle of numerous communities, especially those living in arid regions of the Middle East and the Arabian region since many centuries [9]. Total CM production is 1.3×10^6 tons [10], and the annual trade volume in the world is \$ 10 billion which is expected to be increased in the near future [11]. Among various types of camels such as Bactrian camel (two humped), dromedary camel (single humped), wild Bactrian (true camels), plus llama, alpaca, guanaco, and vicuna camels [12], the dromedary camel is a resident of desert and dry land environment and accounts 94% of the total world population [13]. Camel milk being a good source of fats occupies opaque white color having salty taste due to high vitamin C content and good odor [14]. The overall constituents of camel milk account 3.4% protein, 3.5% fat, 4.4% lactose, 0.79% ash, and 87% water [15]. Mineral contents are important enriching constituents of milk which in the case of camel accounts for 0.60–1.0% [16] vis-a-vis Ca, P, Mg, Fe, Na, Zn, K, and Cu [17]. Many vitamins like A, C, D, E, and B groups are present in dromedary species of camel. High amount of vitamin C, fatty acids, and fructose and lack of beta-lactoglobulin are the most significant health promoting properties [18].

2.3 Caprine milk

Goats were first domesticated by ancient peoples in the Middle East 10,000 years ago [19]. Goat farming has been increased from 751.63 million (year 2000) to 1006.79 million (year 2016) and is being ranked third after cattle and sheep in total population of animals in all over the world according to FAO [20]. However according to the Economic Survey of Pakistan, goat population has been also increased from 70.3 to 72.2 million in Pakistan [21]. The salient differential bioactive components account for total solids (13.20%), fat content (4.50%), oligo-saccharides especially lactose (4.3%), protein contents (3.60%), minerals (0.80%), and vitamins [22].

2.4 Equine milk

Horses can live in many different environments and develop in different ways. The first ancestor of Hyracotherium lived about 60 million years ago. They have four toes on the front paw and three toes on their hind legs [23]. Currently, there are hundreds of breeds of equine present all over the world. However, dairy breeds are predominately found in Mongolia and USSR. Among the dairy breeds, Haflinger horses are the most important milk breed of adults weighing 500 kg, known for their milk production capacities in European countries. [24]. The lactation of mare starts almost 7 days after birth and lasts almost up to 5–8 months of foal age [25]. Due to small mammary gland, mare requires multiple milking (5–7/day) with 2–3 hour intervals [26]. However, the gross milk composition of different breeds varies with an average of fat (1.25%), protein (2.15%), lactose (6.40%), and small amount of minerals 0.4% [25].

Bioactive name	Species name	General characters/ functions	General composition	Differential composition (%)	Differential functions
Lipids	Buffalo	Anti-cancer, antiviral, antibacterial, anti-plaque, anticaries, anti-inflammatory, anti-atherogenic, antihypertensive, prevent CHD [32, 35]	Triglycerides 98% (SFA, USFA, SCFA, MCFA, LCFA), CLA [5] Fat globule membrane 1–2% (diglycerides, monoglycerides, phospholipids, sterols, FFA), peptides [5]	Fat (8.30%) [28] >50% SFA	Increases HDL and cholesterol level due to high SFA
	Cow			Fat (4.88%) [28] CLA (15 mg/100 mL) [33] FG > 5 µm [33]	
	Caprine			Fat (3.84%) [28] High MCFA, SCFA, and CLA (35 mg/100 mL) [22] FG < 5 µm [33]	Reduce cholesterol and LDL, rapidly digested, anti-obesity, treatment of malabsorption patients [22]
	Ovine			7.1% [43]	Anti-atherogenic, decrease LDL cholesterol [39]
				High caproic, caprylic, and capric acids [37] and low butyric acid [38], high oleic acid [39] FG < 3 µm [34]	
	Camel			3.5% [36]	
Proteins	Mare	Iron carrier, lactose synthesis, retinol binding activity, immunomodulator, anticarcinogenic, antioxidant, antimicrobial, anti-inflammatory	Low triglycerides (80%) High phospholipids (5%) and FFA (9%) [25]	1.25% [25] FG = 2–3 µm [25] High level of MCFA, higher contents of LA and ALA [25]	
	Buffalo			4.48% [28]	
	Cow			3.49% [28]	
	Caprine			3.42% Low αs1 casein, high lactoferrin [33]	Low αs1 casein helps easily tolerated by Childs, treatment of CMA, increased iron absorption [33]
	Ovine			5.7% [43]	
	Camel			3.4% [15, 18] High whey proteins (high Ig, lactoferrin, lysozyme), no β-Lg, high PGRP [15, 18]	Anti-cancerous activity especially breast cancer, antidiabetic, treatment of autoimmune diseases [15, 18]
	Mare			Caseins 50% (αs1, αs2, β, k), whey proteins 39% (less β-Lg, more α-La & Ig) [25]	Rich source of essential AA and source of nutrition, easily digestible due to high whey proteins
				2.15% [25] High β-casein (50%), low kappa casein, αs1 and αs2 (40%), also high gamma casein (10%) [29] High lactoferrin (>10 times) [30]	

Bioactive name	Species name	General characters/ functions	General composition	Differential composition (%)	Differential functions
Carbohydrates	Buffalo	Probiotic, antioxidant, anti-inflammatory, Help in calcium	Lactose (lactulose, lactitol, lactobionic acid, galacto)	Lactose (4.86%) [28]	Prebiotic
	Cow			4.47% [28]	
	Caprine	Transport and absorption, beneficial bacteria growth promoter, source of fiber, treat constipation [31]	Oligosaccharides (galactose, glucose, NANA) [44]	Lactose (4.11%) [28] High amount of oligosaccharides (>10 times than cow)	
	Ovine			4.6% [43]	
	Camel			4.4% [15, 18] High lactose	
	Mare			6.40% [25]	
	Minerals	Buffalo	Strengthening bones, avoid osteoporosis, antioxidant, antihypertensive, DNA synthesis and repair, anti-cancerous, immunomodulatory, avoid	High Ca, P, K, and Na and trace Mg, Zn, Fe, Cu, and Se [45, 46]	
Cow		0.76% [28]			
Caprine		0.89% [28] High selenium [45, 46]			
Ovine		0.9% [43]			
Camel		asthma, maintain fluid integrity [45, 46]	0.79% [15, 18] High chloride, low citrate, high Zn, Cu, Fe, and Mn [47]	High iron helps in oxygen transport, component of ETC [47]	
Mare			0.4% [25]		
Vitamins		Buffalo	Source of nutrition, antioxidant, anti-cancerous, anti-inflammatory, protect from osteoporosis, atherosclerosis [47, 48]	Fat soluble (A, D, E, K), water soluble (B complex) [47, 48]	High riboflavin, folic acid, B6, vitamin A
	Cow	High folate and vitamin B12 [45, 46]			Help in synthesis of hemoglobin [45, 46]
	Caprine	High niacin, vitamin B3, vitamin A [49]			Anti-cancerous activity [49]
	Ovine				
	Camel		High vitamin C and niacin, low vitamin A, low vitamin E [47, 48]	Antidiabetic, antioxidant, wound healing [47, 48]	
	Mare		High vitamins A, D3, and K3 [25]		

SFA = saturated fatty acids; USFA = unsaturated fatty acids; SCFA = short-chain fatty acids; MCFA = medium-chain fatty acids; LCFA = long-chain fatty acids; FFA = free fatty acids; HDL = high-density lipids; LDL = low-density lipids; FG = fat globule; α -La = α lactalbumin; β -Lg = β -lactoglobulin; Ig = immunoglobulin; LF = lactoferrin; Lyz = lysozyme; A.A = amino acid; LA = linoleic acid; ALA = α linolenic acid; CLA = conjugated linoleic acid; ETC = electron transport chain; CMA = cow milk allergy; ACE = angiotensin-converting enzyme; CHD = congenital heart defect; PGRP = peptidoglycan recognition proteins; NANA = N-acetylneuraminic acid.

Table 1.
General and differential compositional-cum-functional physiology of bioactive components of milk from different animals.

2.5 Sheep milk

Unlike caprine and bovine milk, sheep milk is rich in total solids and major milk contents that supply energy. Ovine milk is highly enriched in bioactive components such as lipids, proteins, oligosaccharides, minerals, and vitamin contents (**Table 1**) [27].

3. Milk processing techniques and their harms to milk

Rapid development of our society in the past few decades and careless use of large amount of agricultural services are appearing to be a burden over human health [3]. The hunger of the increasing population cannot be satisfied with fresh milk due to unequal production and utilization system. In the past 15 years, the dairy industry has evolved with newer techniques of production, products, and processing [3]. But there are several harms to the soundness of milk associated with processing techniques in terms of quality and quantity losses.

3.1 Pasteurization

Diseases associated with the consumption of milk are common due to microbial contamination. To keep milk safe from such microbial contaminants, primarily large-scale techniques (like pasteurization) are adopted to every milk production system. For this purpose, collected milk from dairy farms is sent to a reservoir of processing units for processing, where a large amount of milk is stored [50]. Transportation of milk in such a way may cause a source of spreading viruses and bacteria. That milk is usually pasteurized and assuming that heat treatment has demolished appropriately [51]. However, some bacteria remain intact due to microbial biofilm within the distribution line and unhygienic behavior of employees [52]. While repeated or prolonged heat treatment causes protein denaturation and binding of denatured whey protein with casein micelles leads to migration of soluble calcium and phosphate to the colloidal stage and mollify of the enzymes. Research shows that the available amount of lysine, iodine, folate, and vitamins B12, C, B6, and B1 in milk decreases after pasteurization [53]. Heat treatment reduces α -la (α -lactalbumin) and PGRP (peptidoglycan recognition protein) in the case of camel milk [54]. Extreme pH, removal of bound Ca^{2+} , addition of denaturant agents, or cleavage of disulfide bridges can denature α -lactalbumin in several ways [55]. Among vitamins, vitamin C is the most important that can be quickly destroyed when milk is heated [56].

Treatment at elevated temperatures reduces the quality of milk supply, as many nutrients are thermally unstable [2]. The second most parameter is aroma of dairy products, which critically affects consumer acceptance, shelf life, and other attributes. When thermal treatment is employed to reduce or destroy the microbial load and enzyme activity to ensure safety and to increase shelf life, the aroma of the milk changes and differs from that of raw milk [57]. Ultra-pasteurization (UP) and ultra-high temperature (UHT), high temperature/short time (HTST), DSI-UP, or IND-UP are widely used thermal treatments for extended shelf life of milk. These processing techniques affect color due to various reactions during thermal processing or storage. These key changes in flavor during thermal processing of milk are associated with Maillard reactions [58].

3.2 Ultra-high temperature (UHT)

The contents of flavored milk are sweeteners such as natural sugar, sucrose, fructose, glucose syrup, or a sweetener without calories depending upon the

manufacturer and the consumer demand [59]. As a result of heat treatment, the basic constituents like proteins, carbohydrates, and vitamins of flavored milk undergo chemical and biochemical modifications [60]. Some of these modifications include lactulose and acid formation through lactose degradation. It promotes dehydroalanine development by side chains of amino acids through β -elimination. It is a compound that reacts readily with lysine yielding lysinoalanine and the denaturing of whey proteins [61].

3.3 Skim milk

A multistage processing technique (like skim milk development) involves wide use of heat treatment for milk preservation [62]. The formation of Maillard intermediates and glycation products during manufacture of dairy products has been studied [63]; the focus of these studies was the reduction in nutritional values, e.g., lysin [64].

3.3.1 Biofilm resistance of the bacteria in a milk powder processing factory

In the dairy industry, it is known to use a closed production system without removing or opening equipment using the CIP process. In terms of economic benefits, short cleaning procedures and long-term use of equipment in processing lines are common [65]. As a result, bacteria remain on the surface of the device and can accumulate in hard-to-reach places, such as dead ends, cracks, seals, and valves, where the complexity of cleaning and disinfection is difficult [66]. Undesirable biofilms on the surfaces of food processing have certain properties, such as increased tolerance to antimicrobial agents, increased secondary metabolites, etc. These are the potential cause of bacterial contamination [67]. In dairy industry, the presence of such biofilms leads to contamination after processing, shortens the shelf life, and promotes the transmission of diseases [68].

3.3.2 Presence of spore-forming bacteria in skim milk

The existence of spore-forming bacteria in milk is a critically important issue in the dairy industry. Bacterial endospores can survive in harsh environmental conditions such as high heat, low pH, desiccation, or cleaning and sanitizing chemicals [69]. Compared with vegetative cells, spores have also been found to attach more readily to stainless steel, leading to the formation of biofilms that can promote bacterial contamination within dairy processing plants. Spores present in final products can germinate and produce enzymes that decrease the quality and shelf life of dairy product; it causes the significant economic losses [70]. Additionally, some spore formers such as *Bacillus cereus* and *Bacillus subtilis* can produce toxins that are responsible for food poisoning [71]. *Thermophilic geobacillus* spp. and *Anoxybacillus* spp. are other spore formers of importance to the dairy industry, as they are commonly present in dairy powders and evaporated milk [70].

4. Factors affecting milk production and composition

The milk quality is influenced by many factors acting together and influences each other [72]. One of the most important factors is disease that adversely affects livestock systems that leads to decrease in yield, income, and survival of livelihood. The impact of livestock diseases is complicated and often exceeds the impact on the respective producers [73]. Selection of dairy animals, nutritional

management, advances in milking technology, and mammary gland of the dairy animals are the other factors that are also associated with milk yield as well as its composition [74].

4.1 Antimicrobial effects on quality of milk production and processing

Unadulterated high-quality milk that is free of antimicrobial residues is the most appropriate choice to farmers, consumers, and milk processing companies. Such milk enables the farmers to get a fair price [75]. Antibiotics are widely used in livestock production for therapeutics, growth promoters, and prophylactics since many years [76]. Such antimicrobial drugs affect the antibiotic-sensitive bacteria that involves in many fermentation processes. So, the presence of these antimicrobial drugs may affect the dairy products. This results in damage to the sensory properties and coagulation or ripening of the dairy products [77]. If the sale of raw milk is considered “unsuitable for consumption,” due to the presence of antibiotics, transmission of milk may lead to ban by competent authorities. Costs of storage and subsequent disposal are the duties of farmers. So, farmers must incur large economic losses [78].

4.1.1 Assessment of antimicrobial coatings for packaged fresh milk

Packaging is an integrated technology that includes protection, ease of use, and communication. To protect the product, it is important to select and design the appropriate packaging materials [79]. Antimicrobial coatings are increasingly being used as a means of prolonging the shelf life of dairy products. This expansion helps consumers to reduce the amount of household waste milk [80]. The quality of the packaged milk depends on the internal properties of milk (oxidation-reduction potential, respiration rate, water activity, chemical structure, etc.) and the external factors (ambient composition, withholding temperature, relative humidity, etc.) [81]. Use of polymeric coating for maintaining the quality of milk is not possible due to many factors' involvement like design and development. Moreover, coating contributes to thermal and gas related mechanical properties due to its unique chemical structure [82]. But, due to the high cost of this process, small industries are unable to adopt it [83].

4.1.2 Diseases and disease conditions

Disease has a lot of impact, including a decline in productivity in livestock [84]. High infectious animal diseases, such as foot-and-mouth disease (FMD), hemorrhagic septicemia (HS), mastitis, peste des petits ruminant (PPR), and surra, cause irreparable economic losses for agricultural communities [85]. Ketosis is one of the diseases that causes lower milk production and an increased risk for developing other metabolic and infectious diseases which further affect milk properties [86]. There are many other factors especially environmental which affects production and properties of milk [87]. Mastitis is considered the most frequent health disorder in dairy farms. Decrease in milk components is one of the major origins of these economic losses both for clinical and subclinical infections [88]. These milk components are used as indicators of the metabolic status of cattle. The most relevant parameters of milk explain the balance of energy, protein, mineral, and acid-base balance and their standard concentrations and trends associated with various types of metabolic disorders. A comprehensive result of changes in the composition of milk can be used to identify early health problems. These changes in composition may help in protective cure of diseases [73].

5. Role of preclinical studies in safeguarding milk production and its properties

Dairy products are an important part of the human diet for more than 8000 years and are one of the official dietary recommendations for many countries in the world [89]. Daily intake of milk and dairy products has been identified as an important part of a balanced diet [90], because milk serves as a whole range nutrient consumed by humans (**Figure 1**).

5.1 Preclinical tests for milk analysis

5.1.1 X-ray fluorescence analysis

Recently, this technology has become widespread. The XRF method makes it possible to carry out analyses without sample separation. It helps in the quantification of minerals, trace elements, and volatiles which are difficult to determine in other analytical methods [92]. X-ray fluorescence spectroscopy (XRF) is an extension of the milk component analysis domain. Various configurations of XRF spectrometers are commercially available and are designed to provide economical and rapid analysis of milk. XRF is an excellent tool for daily analysis of the milk in dairy industries and research institutes. The results of the analysis can be used to assess nutritional value and evaluate the milk and dairy products [93].

5.1.2 Raman spectroscopy-based analysis

In this method, different types of milk quantity samples are used to classify several classes using reduction techniques in combination with random forest classifiers (RF). Quantitative and experimental analyses are based on locally collected milk samples from various species, including cow, buffalo, goat, and human milk samples. This classification is based on changes in the intensity of Raman peaks in a milk sample. The analysis of principal components (PCA) was used as a reduction technology in combination with RF to emphasize changes in Raman spectra that can differentiate milk samples from different species. The proposed method shows a sufficient opportunity to distinguish samples of cow milk from different species due to an average accuracy of about 94%, a specificity of about 97%, and a sensitivity of about 93% [94].

5.1.3 Somatic cell count (SCC) test

Mastitis is mostly caused by bacterial pathogens invading the mammary gland. Typical pathogens, namely, *Escherichia coli*, a gram-negative bacterium usually associated with acute, clinical mastitis, and *Staphylococcus aureus*, a gram-positive bacterium often associated with chronic mastitis, can cause differential activation of the immune system [95]. Somatic cell count (SCC) is used as key indicator in mastitis screening programs typically applied in the frame of dairy herd improvement (DHI) testing programs [96]. Direct microscopic somatic cell count (DMSCC) is one of the approved methods by FDA (Foss, Hillerød, Denmark). Flow cytometry and Ekomilk Scan® are also used to check the somatic cell count (**Figures 2 and 3**) [97].

5.1.4 California mastitis test (CMT)

The technique, invented in 1957 by Schalm and Noorlander, is used to detect intramammary infection caused by a major mastitis pathogen in early lactation cows

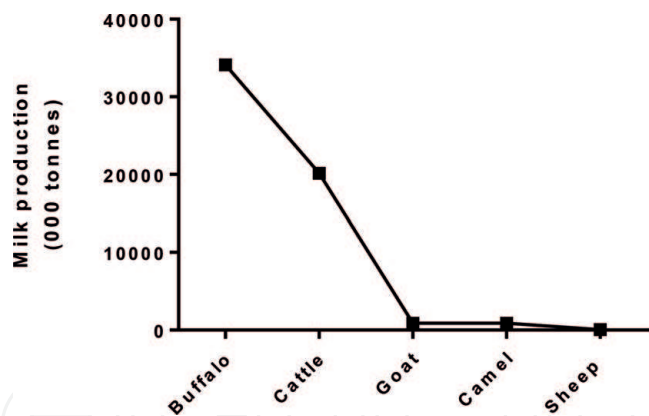


Figure 1.
Gross milk production of different milk-producing species [21].

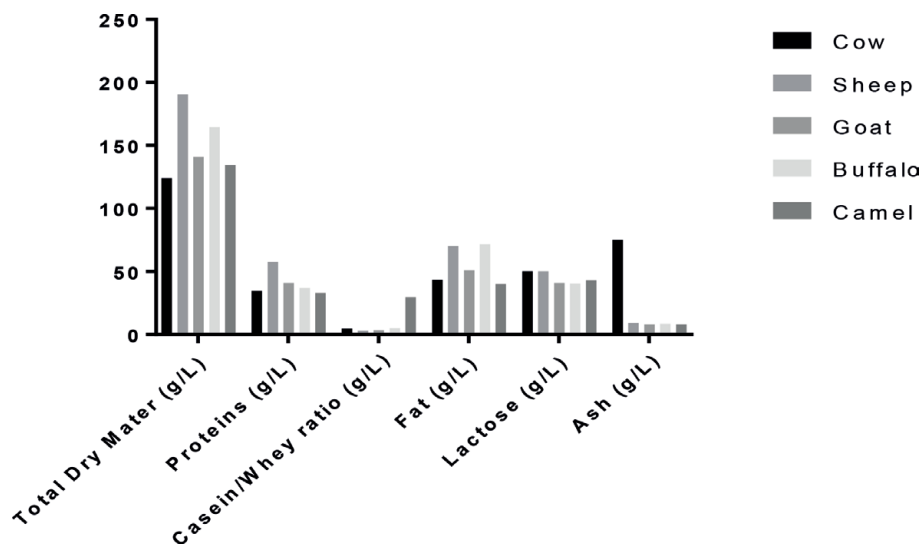


Figure 2.
General composition of milk from different dairy animals [91].

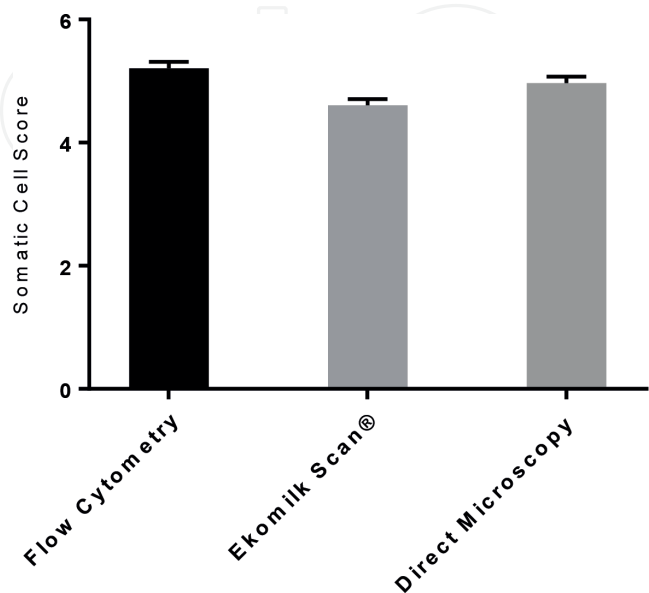


Figure 3.
Comparison of the somatic cell score (SCS) using different methods.

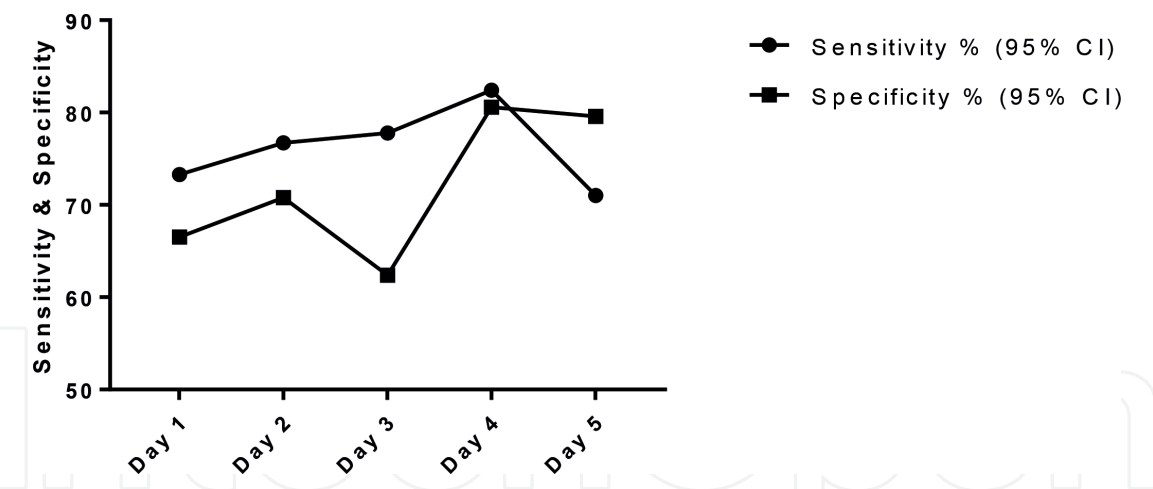


Figure 4.
Sensitivity and specificity within first week of calving through CMT [100].

[98]. They indicated that the degree of precipitation and gel formed by a mixture of the reagent and milk reflected the somatic cell count of the milk (**Figure 4**) [99].

5.1.5 Proteomics techniques for mastitis control

Early detection of mastitis and related pathogenic factors improves animal health status through timely and effective treatment. With the development of related technologies of proteomics, such as 2D-gel electrophoresis (2D-GE) and mass spectrometry (MS), several new proteins associated with mastitis have been identified [101]. The evolution of proteomic profiles of pathogens can help to identify the existing information on enzymes, toxins, and metabolites. However, the successful use of these new biomarkers for detection devices remains a challenge [102].

6. Conclusions

Fat is higher in bovine specie as compared to others and it is the main source of HDL and cholesterol enhancement in blood. Protein of ovine is higher than other milk-producing animals. Protein from camel milk (lactoferrin, immunoglobulin, lysozyme) is very useful in diabetes, cancer, and autoimmune diseases. High selenium found in caprine milk fortifies immune system, while higher contents of zinc, iron, and manganese in camel milk speak of greater oxygen carrying capacity by helping ion transport exchange. Higher riboflavin, folic acid, B6, and vitamin A in buffalo milk are blessings to enhance immunity and decrease of megaloblastic anemia. Antidiabetic, antioxidant, high vitamin C and niacin, low vitamin A and E are more defined properties that refer as wound healer agent. Heat treatment protocols result in denaturation of lysine, iodine, folate, and vitamins B12, B6, B1, and C, inactivation of enzymes, and change in flavor. Skim milk production often favors increase in biofilm resistance and spread of presence of spore-forming bacteria. Adding to this are the diseases or disease conditions exacerbating compromised soundness of milk. Preclinical studies are effective approaches to avoid deterioration of milk. X-ray fluorescence analysis is effective in evaluation of nutritive values of milk and milk products without decomposition of milk. Raman spectroscopy-based analysis successfully differentiate between milk of different species with higher sensitivity and specificity. Somatic cell count and California mastitis tests are

fruitful in estimation of intramammary infection. Latest techniques like proteomic protocols are explorable approaches as an effective preclinical study of milk.

Conflict of interest

Authors declare no conflict of interest.

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