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# Goat's Milk (GM), a Booster to Human Immune System against Diseases

*Rajendra Panta, Vinod Kumar Paswan, Pankaj Kumar Gupta  
and Dhruba Narayan Kohar*

## Abstract

Milk is clean lacteal secretion from mammals shortly after parturition. GM is taken as a complete meal in human diet. GM is the only milk from milching species that possess possibility of substituting human milk. Availability of A2 casein in GM make it comparable to human milk in terms of protein. The most vulnerable ones are infants, aged people and pregnant women as their immune system could answer at any time if extra supplement is not administered. In this case, GM is only option that is highly compatible and nutritious nourishing food naturally. It has been used in curing respiratory problems, diarrhoea, colic, gastrointestinal disturbances etc. Feeding GM enhances production of immunoglobulin, beneficial gut microbiota, phagocytosis activities. Presence of inherent antibodies suits GM for using it in curing Tuberculosis. It contains every needed nutrient in higher amount as compared to milk from other animals. Per servings it has 13% more Calcium, 47% more vitamin A than Cow's milk. It is filled with most of the trace minerals. Selenium, an immune system enhancer provides anti-oxidative and anti-inflammatory protection via inhibition of bacterial growth. Chlorine and Fluorine acts as natural germicides. GM contain good source of Potassium which is crucial for maintainance of blood pressure and functioning of heart, it protects against arteriosclerosis. GM not only reduces the level of total cholesterol due to presence of Medium Chain Triglycerides but also improve mineralisation of skeleton and haemoglobin level. GM consists huge source of biorganic sodium, the absence of which results in arthritis. People who are lactose intolerant even can consume GM as it has low lactose content and for those who finds its smell and taste unusual, there is option of fortification. Because of easily digestible and readily bioavailable nature its consumption has been increased.

**Keywords:** arteriosclerosis, bioavailable, capra milk, fortification, immunity, substitute

## 1. Introduction

Goats are small ruminants that were among first domesticated farm animals which are into herding from about 10,000 years ago [1]. The acclimatising capacity of goat is peculiar as they can be economically reared in areas ranging from tropics, deserts, temperate to harsh climate of mountains without fluctuation in

productivity [2]. Goat is a major supplier of dairy and meat products for rural people and regarded as a “Poor man’s cow” [3].

The world’s goat population has increased by around 55% from 1991 to 2011 whereas cattle population grew only by 9% and sheep population decreased by about 7%. In between these years Goat’s milk (GM) production increased by around 70% [4] which can however be greater because of unreported home consumption of GM in large amount in case of developed countries [5]. The production of GM in world showed an increase of 62% from 1993 to 2013 from 11 to 18 million tons [6]. Except in Antarctic, GM consumption by human is found in all over the world [6]. The contribution of developing countries in goat rearing is noteworthy. Out of total goat population more than 90% alone is maintained by countries in Asia and Africa [7]. Majority of goats including dairy ones in Asia are in the hands of small-scale farmers, among which many of them are poor and landless [8]. The production and consumption pattern of GM and its products has increased in recent decades. Growth in consumption of such milk products is due to their known beneficial effects on human health which are already recognised by the scientific community (**Table 1**).

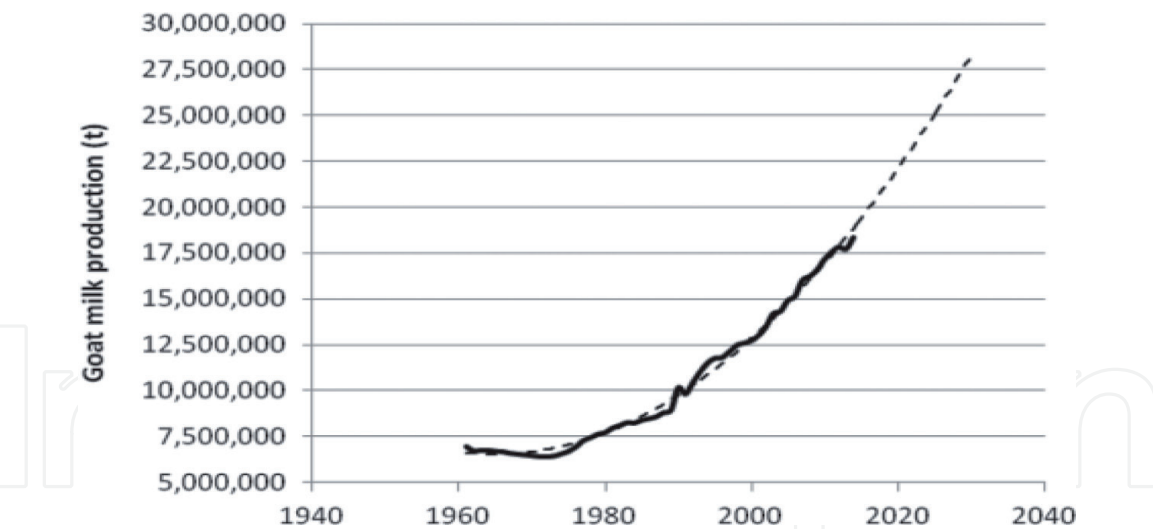
Total annual milk supply of goat is about 3.4%, sheep milk is 1.4%, camel milk is 0.2%, cow milk is 85% while buffalo contribute 11% [9]. About 80% of total GM supply is only from Asia [3] of which main countries include India, China, Bangladesh, Iran, Pakistan and Turkey [10]. 36.7% of world dairy goats are reared in Indian subcontinent producing 40.7% of the world’s goat milk, with India (60.6%, 129 L/doe), Bangladesh (16.9%, 37 L/doe) and Pakistan (13.3%, 100 L/ doe) [11]. Out of 500 breeds of goat only half dozen is raised for milking purpose and about 600–700 million dairy goats are present in the world (**Figure 1**) [12].

The major species of milching dairy goat includes Sannen, Anglo-nubian, Toggenburg, British alpine. They produce good quantity of milk. For an instance Toggenburg can produce 7.57 litres of milk per day [13]. Factors like breed, season of kidding, stage of lactation, species, age, parity, colostrums, feed, environmental conditions, length of dry period, disease, body weight etc. can cause change in GM composition [14].

Continent	Total <sup>2</sup> [million head (%)]		Dairy [million head (%)]		Milk [Mt (%)]		Yield <sup>3</sup> [L/head]	
	Sheep	Goats	Sheep	Goats	Sheep	Goats	Sheep	Goats
Asia	512 (43.6)	556 (55.4)	135 (54.0)	106 (52.1)	4.73 (45.6)	8.04 (52.7)	35.1	76.2
Africa	352 (30.0)	388 (38.7)	79 (31.7)	80 (39.6)	2.54 (24.5)	3.93 (25.7)	32.2	48.9
Europe	131 (11.2)	17 (1.7)	33 (13.3)	9 (4.3)	3.01 (29.0)	2.54 (16.6)	90.8	290.1
America	84 (7.1)	38 (3.8)	3 (1.1)	8 (4.0)	0.09 (0.9)	0.75 (4.9)	33.0	93.4
Oceania	95 (8.1)	4 (0.4)	<0.1 (0)	<0.1 (0)	<0.01 (0)	<0.01 (0)	—	—
Total	1,173 (100)	1,003 (100)	250 (100)	203 (100)	10.37 (100)	15.26 (100)	41.5	75.3

Source: Ref. [7].

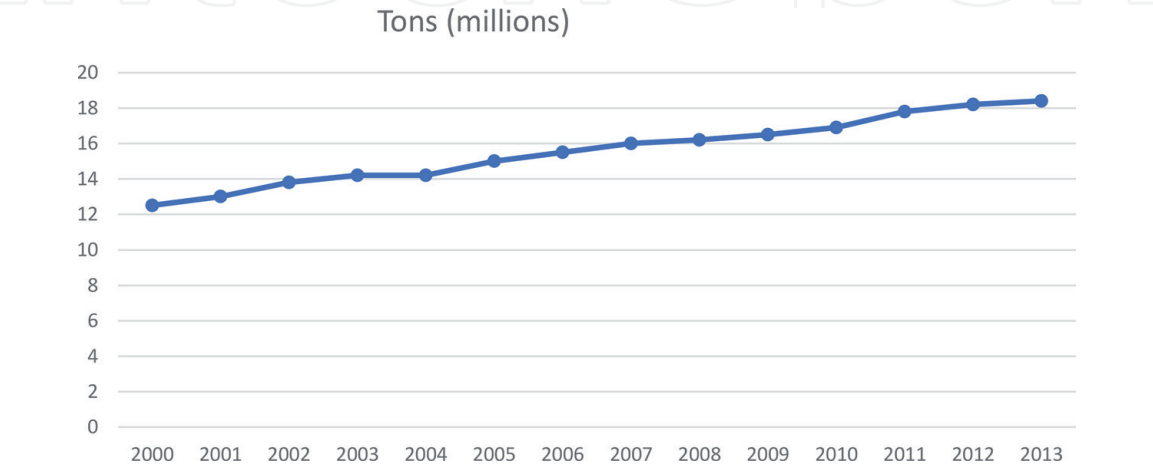
**Table 1.**  
*World panorama of dairy sheep and goats.*



**Figure 1.**  
World goat milk production trends from 1916 to 2016 (solid line) and forecast to 2030 by using time series model (dashed line). Source: Ref. [7].

Milk is clean lacteal secretion from mammals shortly after parturition. GM being highly compatible and nourishing complete natural food, can serve as a substitute for a meal. Its acceptability has increased in recent years which is mainly due to its low fat and capacity to neutralize acids and toxins present in body and also due to higher gross composition than that of cow's milk. GM has potential that enable tolerating different technological treatments to obtain a product which have ability to satisfy the demand of consumer in terms of health, nutrition, safety and pleasure. Beside qualitative criteria (colour and odour), other aspects should also be given equal importance (milk protein, fat, bacteriology, freezing point, lipolysis, somatic cell count, immunoglobulins, inhibitors etc) for improving the quality of milk [15]. Human milk consumption as defined by the International Congress of Food "milk is the product of the total, full and uninterrupted milking of dairy female in good health, also nourished and not overworked". It must be collected properly with no colostrum [16].

GM can be consumed as an alternative to cow milk as it is less allergenic [17] and highly digestible [18]. It has been reported by Park (1994) that between 40 and 100% of patients allergic to cow milk proteins can tolerate GM. It is also recommended to pregnant women and infant to fulfil their nutritional requirement at growing stage [19] and also to old and convalescent people [20]. It is immune to



**Figure 2.**  
Goat milk production in the world from 2000 to 2013 (million tons). Source: Ref. [21].

several diseases and boost the immunity system of human. It differs from cow and human milk as it shows distinct alkalinity, higher buffering capacity and certain therapeutic values in medicine and human nutrition. The nutritional and health benefits of GM are related to a number of medical problems, the most important being food allergies and a pure substitute for those who are allergic to cow milk (Figure 2) [22].

## 2. Methodology

This review chapter is a compilation of numerous research and review paper. In the course of writing this chapter we have reviewed number of articles, proceedings, magazines, newspaper, bulletin, editorial etc, Solids so that a broad range of information could be collected and presented. So, this is a thorough and detailed information regarding goat milk and its nutritive as well as medicinal values, accordingly which its conclusion has been drawn.

## 3. Composition of GM

GM because of its specific composition is being considered as a high-quality raw material for manufacturing food of infants along with population with particular needs [23]. Fresh goat milk appears as a white, opaque liquid with a little sweet in taste having no odour in practical life [24]. The Solid content in goat milk ranges from 12 to 18% while protein content in solid lies between 3 and 4.5% in goat milk [25]. Compositional and nutritive value of goat milk can be preserved, enhanced and improved by the aid of processing [26].

The composition and milk yield of goat varies with varying factors such as diet, breed, management, environment, age, stage of lactation, season, plane of nutrition etc. [27]. GM having all the composition in adequate amount is preferred as a high-quality milk and it should be free from pathogens and foreign substances such as antibiotics, antiseptics or residue of pesticides and should not differ from that of cow's milk in taste and odour. GM is proven to have a better and efficient digestibility, buffering capacity, alkalinity and therapeutic values as compared to human and cow's milk in human nutrition and medicine [28].

### 3.1 Fat

The physical properties like surface tension, viscosity and specific gravity of GM are higher in comparison with cow milk [17]. The fat globules of GM are smaller than bovine milk. The smaller sized fat globules allow dispersion and more homogeneous mixing of fat in milk. The average diameter of globules in GM ranges from 1.5–2  $\mu\text{m}$  while that of cow's milk ranges from 2.5–3.5  $\mu\text{m}$  [24] which is the reason behind GM to be known as “self homogenised or naturally homogenised milk”. Having smaller fat globules and greater surface area facilitate GM to be more digestible than cow milk as total surface area of globules gets effectively connected with the lipids [29]. Also, lipases in the gut tentatively attack the lipids ester linkages in the short chain fatty acids more readily and rapidly helping in faster digestion of GM [30]. GM is enriched with higher proportion of short and medium chain fatty acids, mostly butyric, palmitic, caproic, capric, caprylic, linolenic, alpha- linolenic, lauric, myristic acid while lower in longer chain fatty acids like oleic and stearic [23]. Among these 3 (Capric, Caprylic and Caproic) have been named after goat because of their predominance in GM [31].



3.2 Protein

Milk is composed of casein and whey protein where casein (alpha s1, alpha s2, beta and K-caseins) represent 80% of proteins while rest part is filled by major whey proteins (alpha-lactoglobulin and alpha-lactalbumin) [32]. The major protein in cow milk is alpha s1 casein while in GM it is beta casein. One of the most representative free amino acid in GM is Taurine [33] which is higher in GM as compared to cow milk [34]. Out of 10 essential amino acids 6 (threonine, isoleucine, lysine, cystine, tyrosine, valine) are found in high amount in GM than in cow milk [35]. Main reason behind the low amount of folic acid in GM is that it contains high concentration of folate binding protein making it unavailable for human to digest and absorb. The heavy fat content and mucus-producing components of cow milk are absent in GM and it is complete source of proteins containing all essential amino acids [36, 37]. Fragments of GM caseins have been found to possess antimicrobial peptides that shows strong activity against gram negative bacteria [38].

3.3 Vitamin

The content of Vitamin A in GM is higher than in cow milk as goat convert all beta carotene from foods to Vitamin A (retinol) in milk which is the reason for whiter GM and milk fat [17]. Also, higher casein content in GM promotes the same [39]. It contains 25% more Vitamin B6, 47% more Vitamin A than cow's milk and it mainly possesses Vitamin A2 [40]. Content of Vitamin D of both GM and cow milk is similar that is mostly needed during infancy (Table 2) [41].

3.4 Lactose

Major carbohydrate in GM is Lactose whose content is slightly lower in GM than in cow's milk [42]. Lactose, a valuable nutrient favours intestinal absorption of calcium, phosphorus and also in proper utilisation of vitamin D [31]. It is crucial for milk synthesis and during secretion of milk in the duct system of udder [5]. As compared to cow milk, GM contains surplus amount of lactose derived oligosaccharides. Other carbohydrates that are present in small amount includes oligosaccharides,

Vitamin	Goat milk	Cow milk
Vitamin A (IU)	185	126
Vitamin D (IU)	2.2	2.0
Thiamine (mg)	0.068	0.045
Riboflavin (mg)	0.21	0.16
Niacin (mg)	0.27	0.08
Pantothenic acid (mg)	0.31	0.32
Vitamin B6 (mg)	0.046	0.042
Folic acid (ug)	1.0	5.0
Biotin (ug)	1.5	2.0
Vitamin B12 (ug)	0.065	0.357
Vitamin C (mg)	1.29	0.94

Source: Ref. [17].

Table 2.  
Composition of vitamin (per 100 g) of goat and cow milk.

glycopeptides, glycoproteins and nucleotides [42]. GM oligosaccharides are thought to be exhibiting the anti-inflammatory effects in induced colitis [43]. GM oligosaccharides are especially beneficial for infants due to their prebiotic and anti-infective properties (**Table 3**) [45].

3.5 Minerals

GM contains major and trace minerals that includes Ca, Na, Mg, P, K, Zn, Mn, Se, Cu, Co, Fe which have great health benefits. Percentage of Zn in GM is higher than in cow’s milk that is responsible for maintaining healthy skin, healing of wound, act as antioxidant and eliminate reactive oxygen species via its role as a cofactor for antioxidant enzyme superoxide dismutase (SOD). Mineral content in GM is higher than that of human and cow milk ranging from 0.7 to 0.85% [46]. GM contains 13% more calcium than cow’s milk per serving and 134% more potassium [47]. Selenium content in goat and human milk is higher than that found in cow milk [48]. The Selenium in GM plays a key role in acting as a cofactor for the functioning of glutathione peroxidase (GPX), an antioxidant enzyme which scavenges harmful free radical in body and helps in macrophage activation (**Table 4**) [49].

Component	Cow milk	Goat milk	Human milk
Protein	3.58	3.52	1.63
Fat	4.14	4.25	3.75
Total solids	13.19	13.00	12.57
Solids not fat	9.25	7.75	8.82
Lactose	4.96	4.27	6.98
Ash	0.71	0.86	0.21

Source: Ref. [44].

**Table 3.**  
Average composition of cow, goat and human milk (%).

Mineral (mg)	Goat milk	Cow milk
Ca	134	122
P	121	119
Mg	16	12
K	181	152
Na	41	58
Cl	150	100
S	28	32
Fe	0.07	0.08
Cu	0.05	0.06
Mn	0.032	0.02
Zn	0.56	0.53
Se	1.33	0.96

Source: Ref. [17].

**Table 4.**  
Mineral contents (per 100 g) of goat and cow.

#### 4. Nutritional value in GM

Because of the highest nutritional value, GM is preferred over cow and buffalo milk [50]. The nutritional and health benefits of GM are directly related to the medical problems that are faced by people of which main being allergies towards milk proteins obtained from cow's milk [51]. It provides 70 calories per 100 ml. The superior digestibility of GM, its proper fatty acid composition and content of bioactive compounds seem to give those properties to it that help in treating or preventing certain medical conditions. Bioactive peptides derived from milk plays vital role in human health and nutrition. The most vulnerable ones are infants, aged people and pregnant women as their immune system could answer at any time if extra supplement is not administered.

The amount of calcium and phosphate supplied from GM is of much importance to human nutrition. It contains 1.2 g calcium and 1 g phosphate per litre which is higher than that contained in human milk. So, GM offer excess of calcium and phosphorus to human infant that is easily absorbed by them [30]. GM supply adequate amount of Vitamin A and niacin to human infant. Though it supplies excess of thiamine, riboflavin and pantothenic acid [5, 30] it is deficient in terms of Vitamin C, D, B<sub>12</sub>, pyridoxine and folate [52]. So, these nutrients should be supplied at the time of infant feeding by applying appropriate fortification. American Academy of Paediatrics forbade the use of GM products for infants under one year mainly because they can cause intestinal irritation and anaemia. Infants of such age who are allergic to cow's milk-based formulas are only fed on goat's milk formula after properly consulting baby's doctor or paediatric nutritionist [53].

One of the reasons that consumers are accepting GM and its products in an appreciable manner is due to its nutritive value. It is beneficial in maintaining health, physiological functions, in the nutrition of child and elderly ones [54]. It is reported that it contains off flavour. This is due to the fact that membranes around fat globules in GM are more fragile which may relate to their greater susceptibility in developing off flavour than in cow milk. However, fresh milk obtained under sanitary conditions from properly fed and hygienically managed goats is found to be free from such objectionable flavour and odour [55].

Cow's milk is reported to be mucus forming for many people but goat milk is not only non-mucus forming but also help in neutralising the mucus. GM has been a viable alternative for those children who are having difficulties in digesting cow's milk as it is second best option, first being mother's milk. The composition of goat and human milk is almost similar. Children who drink goat milk tend to remain more satisfied between meals and sleep through the night [56]. 2.5% of infants during first 3 years of their life suffer from cow milk allergy [57] while this percentage rise from 12 to 30% for infants who are less than 3 months old [58]. Not just for infants but also for adults and nursing mother, GM has been good alternative because of its unique properties. GM is rich in vitamins, minerals, trace minerals, enzymes, protein, fatty acids and amino acids (especially tryptophan) that are easily utilised by human body. The greatest advantage of consuming GM by many people lies in the fact that those who cannot digest cow's milk find it easy in digesting GM without any complications. The reason for this is yet to be known but it is thought that this action in GM is due to lower lactose content (7% less than that of cow milk). There is one fact which says that our body takes 20 minutes to digest GM while it takes 2–3 hours in digesting cow's milk [56].

Conjugated Linoleic Acid (CLA), an important bioactive component is naturally found in GM which helps in immune response stimulation. Mediators of immunity such as cytokines, prostaglandins, immunoglobulins etc, are modified by the action of CLA. The CLA possess ability to reduce the allergy related immunoglobulin IgE



in humans that suggest anti-allergic potential of lipid [38]. The richness of GM in Medium Chain Triglycerides (MCT) helps in improving nutrients absorption and energy production in the body. MCT along with other amino acids exhibits antimicrobial activity [59].

Taurine (free amino acid) performs different roles in human body such as growth and brain development, formation of bile salts, calcium flux modulation, stabilisation of membranes as an osmoregulation by attenuating toxic substances. Its deficiency in human tissues may be the result of cardiomyopathy, epilepsy, lack of growth etc. [60]. In case of animal studies, Taurine is suggested as an important amino acid in alleviating muscle fatigue and can build up exercise capacity during workouts [46].

Amount of Vitamin A contained in GM is similar to human milk which is crucial for innate and adaptive immune responses that also includes cell-mediated immunity and antibody responses as well. Deficiency of this vitamin leads to decreased innate immunity that will affect NK cell function and phagocytic activity. Vitamin D plays an important role in the immune system and help preventing infections, autoimmune diseases, cancer and diabetes. Vitamin C which is present in greater amount in GM than in cow's milk has shown to affect many aspects of the immune system including regulation of immunity via antiviral and anti-oxidant properties [49].

As compared to cow's milk GM has higher content of Ca, P, K, Se, chloride, Zn, Cu [61, 62]. Potassium is crucial in acid/base balance and also in the proper functioning of muscles, nerves and kidneys. Chloride maintains fluid balance, blood pH and osmotic pressure. Calcium and phosphorus strengthen the structure of bones, muscles and help in blood coagulation. Selenium is vital in protecting cell against free radicals and also it acts as a major component in preventing dengue fever. Copper helps in metabolism of iron and oxygen and also defence the cell against free radicals [49].

## 5. GM medicinal value

Multivitamins, proteins, minerals (including trace one), fatty acids as well as Lactic acid bacteria in GM help in fighting human against diseases including diarrhoea, vomiting, constipation, gastric discomfort, respiratory disorders and many other [20].

### 5.1 Prevention of dengue fever

Dengue fever which is transmitted by the bite of *Aedes aegypti* mosquito is of great problem in tropical countries. Each serotypes of dengue virus (DEN 1, 2, 3 and 4) are equally responsible to cause severe dengue and haemorrhagic syndrome [63]. Ferropenic anaemia and bone demineralization were better recovered with GM. Dengue is endemic in 112 countries of the world [64]. Regular consumption of GM is suggested by doctors in case of dengue fever because it is necessary to maintain body fluid balance and also transfusion of platelets is not possible in all cases. If platelet level drops (below 20,000) and there is significant bleeding then platelet transfusion should be provided. Selenium (Se) which is present in GM act in preventing dengue. GM have more than 2.5 times the Se powdered infant formula (19.98 mg/L vs. 7.47 mg/L) as compared to cow milk and nearly 35% greater than pasteurised cow milk (19.98 mg/L vs. 14.85 mg/L) [65]. As compared to cow milk GM possesses 27% more Se [33]. Se if become deficient can cause an irreversible cardiomyopathy [66]. Se helps in controlling the human immune system in

case of autoimmune disease by upgrading it when necessary and degrading it when it is overactive. Se has anticlotting effect while thrombotic and pro-clotting effects are due to its deficiency. The replication of dengue virus is prevented by Se. T cell and interleukin both are vital component of immune system and Se help by modulating the production of interleukin or by increasing the T cell function [67]. In treatment of dengue fever GM and its products are very helpful as they directly modulate human immune system. Immune response and antioxidant protection of host can be significantly improved by the incorporation of Se as selenocysteine in GPx [68]. Deficiency of Se can be prevented by having pills and animal products that contain Se [69].

## 5.2 Antimicrobial properties

Proteins derived from milk are proved to be precursors of antimicrobial peptides. GM have been reported to have antimicrobial activity of several pathogenic bacteria that are contained in food materials. GM caseins fragments are good source of antimicrobial peptides that are effective against gram negative bacteria [38]. Alpha-S2 Casein (CSN1S2) in GM is studied for its antimicrobial property. The result indicated that this caprine protein has inhibition activity that opposes the pathogenic bacteria by optimal concentration of 5 mg/ml in all bacteria especially Gram positive (*Listeria monocytogenes*, *Staphylococcus aureus* and *Bacillus cereus*) and negative (*Escherichia coli*, *Salmonella typhi* and *Shigella flexneri*) [70]. This property of CSN1S2 casein is detected when it goes through degradation by gastrointestinal enzyme pepsin [38]. The distinct antimicrobial impact of GM and its specific chemical composition can result in increased antimicrobial compounds production [71]. Another study shows that during the fermentation of GM with individual microorganisms of kefir grains, bioactive substances were released that have antimicrobial properties against deadly strains of bacteria present in food [72]. Short chain fatty acids (SCFA), Medium Chain Triglycerides (MCT), capric, caproic and caprylic acids found in GM have been proved to possesses antimicrobial activity [59]. GM proteins can be in-vitro hydrolysed by enzymes or can be fermented by lactic acid bacteria which give potent antioxidant peptides [73].

## 5.3 Treatment of cardiovascular disease (CVD)

CVD includes diseases that involves heart and blood vessels, veins, coronary heart diseases, high blood pressure, arrhythmias, atherosclerosis etc. In order to maintain normal blood pressure and proper heart functioning a good amount of potassium rich food is needed and GM serves for the same. GM supply 498.7 mg of K and 121.5 mg of Na that is sufficient in preventing high blood pressure and protecting against atherosclerosis. Atherosclerosis is likely to occur if people are adopting unhygienic inactive lifestyle (smoking, diet and exercise) and after incidence of dyslipidemia, diabetes, high blood pressure etc. [74]. The Angiotensin converting enzyme (ACE) inhibitory peptides obtained after hydrolysis of GM caseins have shown beneficial effects on blood pressure regulation [75]. Fat in GM reduces total cholesterol levels thereby making it as a food of choice for the prevention of cardiac disorders. GM have selenium and its absence is thought to cause irreversible cardiomyopathy [66]. When excess amount of fat is deposited in the arterial wall and blood vessels then cardiac arrest is common. In case of goat, fat present in its milk and meat is considered as user friendly [76]. The Low-density lipoprotein (LDL) is known as "bad cholesterol" as it transports cholesterol from liver to blood vessels while High-density lipoprotein is "good cholesterol" as it transports cholesterol from vessels to oxidative modification of LDL which suppresses atherosclerosis [74].

The composition of GM exceeds cow's milk in monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA) and MCT which have beneficial health effects especially in cardiovascular conditions [23]. Due to anti-inflammatory effects of CLA GM decreases the atherosclerosis incidence [38]. The MCT present in GM includes capric, caproic and caprylic acids which comprises 15% of total milk fat. The higher constituent of MCT in GM helps in lowering cholesterol deposits in the arteries, dissolve and prevent cholesterol deposits in the gallstones. Also, the presence of MCT decrease the synthesis of endogenous cholesterol thus helping to boost the immune system [77]. Capric, caprylic acids and MCT are used in treatment of many diseases including cystic fibrosis, coronary by-pass etc, because of their unique ability to provide energy directly without being deposited in adipose tissues [78]. GM is naturally homogenised while cow's milk requires homogeniser. When fat globules are forcibly broken down by mechanical homogeniser, an enzyme associated with milk fat i.e., xanthine oxidase become free and can penetrate intestinal wall. When it reaches blood stream via intestinal wall, it can cause tissue scar on the heart and arteries which leads to mechanism causing arteriosclerosis while it is prevented in case of GM [77].

#### 5.4 Treatment of gastrointestinal diseases

Infants who are suffering from problems like gastrointestinal disturbances, vomiting, colic, constipation and diarrhoea can be treated when they are fed GM. Pasteurised GM is easily tolerated by infants who are suffering from such diseases. GM easily assimilates in human body as chemical composition of GM is almost similar to human one which therefore enhances the bioavailability of nutrients in it. It is reported that GM consumption increases the uptake of Iron and Copper in digestive tract [79]. The readily bioavailable nature of GM has increased its consumption in recent years. The availability of beneficial gut microbes increases when GM is taken. Soft curd formed in fermented milk of goat is easily digested and absorbed [22]. People who are lactose intolerance can also easily digest it because of its small sized fat globules in which the total surface area of globules are effectively connected with lipids and also the fat globules of GM do not clump together as in cow's milk [29].

GM is the vital source of biorganic sodium, the absence of which causes arthritis. Human stomach stores more sodium than any other organ. The absence of sodium causes digestive discomforts and inhibits stomach from producing needed enzymes leading to bloating and even ulcers. Soft curd in GM can be advantageous for adult humans who are suffering from gastrointestinal disturbances and ulcers [5]. Also, the property of high buffering capacity of GM appears to be fruitful in treating gastric ulcers [52]. The intestinal inflammation and clinical symptoms (diarrhoea and bloody stools) in colitis can be decreased by consuming GM. The presence of oligosaccharides in its milk exhibits anti-inflammatory effect in the management of Inflammatory bowel disease (IBD) [43]. It has been reported in one study of rats infected with colitis when fed GM oligosaccharides reduces and promotes recovery of damaged colonic mucosa due to less severe lesions in colon and production of more favourable gut microbiota [38].

#### 5.5 Treatment of cancer, allergy and others

Alpha lactalbumin present in GM is anti-carcinogenic by nature. CLA in GM is full of anti-carcinogenic properties. It is also studied that tumour cells in patients with skin and bladder cancers were killed by alpha lactalbumin. The passive transfer



of serum albumin in GM to the blood has an inhibitory effect against growth and development of breast cancerous cells [75].

Proteins are most common antigens that are important for proper body functioning. On the basis of nature, allergies can be acute or chronic that have symptoms ranging from non-life threatening to life threatening. It is recommended as an substitute for patients with cow milk allergy [54]. Eczema, Rhinitis and digestive problems are simple symptoms while bronchospasm, anaphylaxis and urcaria are severe one. GM is less allergenic than cow's milk. GM is thought to resolves 30–40% of problematic cases of childhood cow milk allergy. Some researches shows that alpha S1 casein in cow's milk is the reason of cow milk intolerance. It has been found that level of alpha S1 casein in GM is 89% lower than that of cow milk. Therefore, GM is less allergic and improves digestive disorder, colic diseases etc. in people with cow milk sensitivities [80]. Lactose intolerance in many child and adults is caused by the deficiency of lactase enzyme that functions in easing the digestion of lactose. Generally, in case of lactose intolerant individuals, unhydrolyzed lactose passes into the large intestine whereby it is fermented by the aid of microbes which results in the production of hydrogen, methane, carbon-dioxide, SCFA leading to flatulence, diarrhoea as well as abdominal pain [81]. When ulcers worsen it takes a new form i.e., cancer and it is well known that the high buffering capacity of GM prevents gastric ulcers [52].

GM is used as a good alternative to treat mammary, colorectal and colon cancer [82] in case of animal models, as well as in vitro models of human melanoma [83] colorectal and breast cancer [84] because of the known anticarcinogenic properties of CLA [85] which is in surplus amount in it. Lactic Acid Bacteria (LAB) present in goat milk exhibit potential role in combating against cancer [86]. The risk of occurrence of cancer, carcinogenic toxicity and tumour suppression are prevented by LAB present in GM [87]. The bacteria in GM after isolation and microencapsulation can be used as a probiotics to cure cancer [88]. The study of different strains of LAB in GM can strengthen the research of cancer prevention [89].

## 5.6 Immunological properties

Se is vital as it plays role in proper functioning of the immune system and thyroid activity as well as participates in spermiogenesis thereby affecting fertility [90]. It is an integral part of the antioxidant capacity of the organism [91]. GM and its products act as immunity booster and prevents from several illness in infants [87]. There is involvement of many cells like T lymphocytes (T-cells), Natural Killer (NK) cells and B-lymphocytes (B-cells) in the innate and adaptive immune response. Even though the structure of Immunoglobulin's (Ig) are similar, minor differences exist in the main immunological classes (IgG, IgM, IgA, IgD and IgE). The major properties of serum immunoglobulin accounts for IgG and IgA. Several researches have shown immunomodulatory effects of GM in case of both in-vitro and human studies. The release of nitric oxide (NO) from human blood cells exhibits cardio protective effects in the milk consumer and also possesses antibacterial activity which prevents them from infections. Content of sialic acid is higher in GM which acts as an important biological component in playing crucial role in brain development and in boosting infant immunity [92, 93].

## 6. Conclusion

Since GM is rich surplus to calcium, proteins, bioactive compounds it can be taken as a “functional and nutraceutical health drink”. The role played by GM in

eliminating major health complications including digestive, respiratory, immunological, viral, cardiac, cancer, allergy, osteoporosis, malabsorption, anaemia etc. favours longevity to human life. The contribution of small developing nations in the production of GM should not be neglected rather new technological innovation's assistance to those nations will uplift the production and contribute to mankind as the consumption of GM has increased in developed nations. The compositional attributes of GM can be raised if goats are provided with ample browsing, adequate temperature and stress-free environment. It should be supplemented with folic acid and can be fortified if consumers find its odour unpleasant.

Goat rearing has several economic returns after its milk, meat, hair etc. are marketed. Goat business can help uplifting the life standard of people in rural areas. The unique properties of GM and its products carve for its more marketing potential. Its nutritional value in treating diseases has broaden its future prospects. If grading up is followed to improve the performance of local breeds of different nations then eventually more milk can be produced that benefits human. That is why more thorough and detailed descriptive research in this field is needed to fight against life taking diseases.

## Author details

Rajendra Panta<sup>1\*</sup>, Vinod Kumar Paswan<sup>1</sup>, Pankaj Kumar Gupta<sup>2</sup>  
and Dhruba Narayan Kohar<sup>3</sup>

1 Department of Dairy Science and Food Technology, Banaras Hindu University, India

2 Integral Institute of Agricultural Science and Technology (IIAST), Integral University, Lucknow, India

3 Shree Jay Kalika Secondary School Technical and Vocational Training, Bardiya, Nepal

\*Address all correspondence to: rajendrapanta3@gmail.com

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