Recent advancements in the functionality of the components from goat milk and its products

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Abstract: The purpose of this review is to present inclusive information regarding the recent advancements in the functionality of the components from goat milk and its products. In view of the expected revenues from global goat milk and products touching USD 15 billion in 2024, there is an urgent need to capitalize on designed fermented dairy products from goats with increased participation of bioactive ingredients in goat milk which in turn lead to excellent biological effects in terms of higher therapeutic and nutritional value. Functional properties enhanced the development of innovative goat dairy products and increased the consumer demand. Goat milk as a potential functional food which is an emerging area for the development of goat milk products by using prebiotics and probiotics. A detailed list of dairy goat milk processors and products commercially available worldwide has also been discussed. The paper suggests that in future the Goat Breeder's Associations need to be established in India on the pattern of US/International Associations to improve the quantity and quality of goat milk for in-depth studies on functionality of the components from goat milk and its products related to medicinal properties of goat milk as therapeutic health food (nutraceutical) and fermented milk beverages/products made with probiotic microflora.

Keywords: Bioactive components, Fermented food, Functional, Goat products, Goat, Milk, Prebiotic

Introduction

Goats are termed as “*Wet nurse of infants*” in the United Kingdom and “*Poor man's cow*” in India due to its significant contribution to rural economy. One of the best features of goats is that they are easily adapted into tough weather, which makes them fit for landless and marginal farmers. Goat's contribution is very high in milk and milk products distribution and has major role in rural economy and health (Zenebe et al. 2014). Goat's milk has functional components, such as conjugated linoleic acids; oligosaccharides and bioactive peptides; (Assis et al. 2016; Mukdsi et al. 2013; Kullisaar et al. 2003; Songisepp et al. 2005; Salva et al. 2011).

Goats' milk is rich in protein, calcium, and phosphorus also an appropriate substitute for consumers suffering from cows' milk allergy. Such specialties of goat milk create knowledge of nutrition-health relation and result in the development of the functional food concept.

The share of functional dairy products is 40% of functional foods which is organized sector in the market by dietary fibres, carotenoids, minerals, fatty acids, prebiotics/probiotics, vitamins and minerals. The foods including enzymes, antioxidants and phytochemicals are also increasing their market share continually (Ortiz et al. 2017). Similarly, functional properties enhanced the development of innovative Goat dairy products and increased the consumer demand (Aguilar-Toalá et al. 2018).

Goat milk as a potential functional food which is an emerging area for the development of goat milk products by using prebiotics and probiotics. Prebiotics are defined as the indigestible food ingredients that promote the growth or activity of beneficial bacteria, thereby benefiting the host. Prebiotics are being added to the food products to stimulate the colonic microflora to get health benefits to the consumers, besides providing textural attributes to the foods (Saad et al. 2013). However, the word probiotic is coined by Kollath (1953) and is derived from the Greek language, which means “for life”. Goat milk acts as a main probiotic carrier into humans. These products can be considered as suitable vehicles for delivering probiotics to humans due to their ability in maintaining sufficient probiotic viability during

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shelf life. However, dairy products produced with bovine milk represent the major share of the probiotic market, with only a relatively small number of studies examining functional probiotic goat milk products (Turkmen, et al. 2019). According to Lilly and Stillwell (1965), probiotics are substances produced by microorganisms that promote the growth of other microorganisms. According to FAO/WHO (2001), probiotics are defined as “live microorganisms that, when administered in adequate amounts, confer a health benefit to the host.”

The purpose of this review is to present an overall knowledge regarding the recent advancements in the functionality of the components from goat milk and its products. The necessary speculative contexts with some practices on bioactive components in goat milk products have also been discussed. It also summarizes the most recent studies on goat milk and human health and critically, discusses the putative actions of principal goat milk components and goat milk products.

Global market scenario for goat milk and its products

According to the United Nations' Food and Agriculture Organization (FAO) statistics goat milk as the third most produced variety after bovine milk in the world, (Belewu & Adewole, 2009). In 2016, there were approximately 1 billion goats worldwide with a milk production of around 15,262 tons (FAO, 2018). India is leading country in goat's milk production followed by Bangladesh and Pakistan in Asia. In Africa, Sudan, South Sudan and Somalia are the major goat milk producers. America is also rising significantly as goat milk producing country (Verruck et al. 2019).

The global goat milk market is estimated to reach revenues of around \$15 billion by 2024, growing at a compound annual growth rate of more than 7% during 2018-2024. Pulina et al. (2018) suggested that in the last decade, goat's milk production increased by more than two-fold and it will increase by another 53% by 2030. Majority of the goats are used for meat production and a limited proportion is used for milk production. Goat meat (chevon) is one of the most preferred meat types by the consumers in several countries including India. Goat rearing is the second most important activity of livestock sector. There are a total of 102 goat breeds in the world, out of which as many as 28 breeds are found in India (NBAGR, 2018; <http://www.nbagr.res.in/reggot.html>).

Goat constitutes 26.40% of the total livestock population in India and the 19th livestock census puts the number of goats in the country at 135.17 million. A decline by 4% in goat population was noticed from 2007 census to 2012 census. This is certainly not a positive trend, especially in view of the increase in demand for meat as well as milk and due to increase in population and changing pattern of food consumption in favour of protein rich food. The total goat milk production in India is 5.377 million tonnes which is around 3.5% of the total milk production

(155.5million tonnes). The country stands first in goat milk production and its share is 26.31% in total goat milk production in the world. The global functional dairy beverages market is a very powerful sector of the dairy industry and global dairy-based beverages market is forecasted to reach a market value of 13.9 billion USD by 2021, excluding traditional dairy beverages such as kefir, buttermilk, koumiss, etc (Anonymous, 2018).

Functional properties of goat milk components

The specific composition of Goat dairy products showed remarkable characteristics in fats, proteins, amino and fatty acids as well as their levels of flavour, taste, aromas and leanness (Goswami et al. 2017). Although goat milk proteins have similarity with major cow milk proteins like α -, β -, γ -caseins, α -lactoglobulin, α -lactalbumin, but differ in genetic polymorphisms (Boyazoglu et al. 2001). Moreover, medium chain fatty acids like caproic, caprylic, capric have been used for the treatment of premature infant nutrition, malabsorption syndromes, gallstone problems, cystic fibrosis intestinal disorders, and coronary diseases because of their unique metabolic ability to provide energy while at the same time lowering, inhibiting and dissolving cholesterol deposits (Ariane et al. 2014). However, the most innovative feature in goat milk fats reported was 18-carbon fatty acids conjugated linoleic acids (CLA), (Amigo & Fontecha, 2011). (Bauman et al. 2011) studied health benefits and risk reducing cardiovascular disease by using some CLA isomers (Elwood et al. 2010). In addition, goats' milk has been attributed to individuals suffering from malabsorption syndrome due to therapeutic properties in human nutrition, such as better utilization of fat and mineral salts. Recently, several oligosaccharides have been suggested as potentially bioactive ingredients (Hanson et al. 1961). Oligosaccharides have been proposed as important for child development (Taylor et al. 1986, El-Agamy et al. 2007). Neutral oligosaccharides are vital for the development of the neonates because of their immunomodulating actions (Saini et al. 1991). On the contrary, acidic oligosaccharides help to check the adhesion of pathogens to the intestinal mucosa which help in healthy microbiota (Park et al. 1999, Steger et al. 1960, Wolff et al. 1994). However, goat milk is much richer in lactose-derived oligosaccharides (lactulose, lactitol, lactobionic acid, and galactooligosaccharides), that are beneficial to humans due to their prebiotic and anti-infective features (Turkmen et al. 2017). (Pruksasri & Supee, 2013) evaluated the feasibility of producing goat milk containing galacto-oligosaccharides (GOS) by treating milk with the enzyme β -galactosidase. The result indicated significant improvements in taste and overall acceptability, high heat stability and shelf life conditions over the acidic conditions of goat milk containing higher GOS concentration. (Silveira et al. 2015) formulated probiotic chocolate beverage with enhanced viscosity and sensory characteristics in which inulin with oligo-fructose in combination with goat cheese whey was used as functional ingredients. The bifidogenic effect of inulin and fructo-oligosaccharides, stimulated the intestinal growth of

bifidobacteria, antagonistically, which suppress other undesirable bacterial growth (Gibson et al. 2017).

Goat milk contains a lower concentration of Potassium, Calcium, Chloride, Phosphorus, Selenium, Zinc and Copper than cow milk (Krstanovic et al. 2010, Lopez-Aliaga et al. 2005). Goat milk has beneficial effects on malabsorption disorders and inflammatory bowel diseases (Geissler et al. 2011). Goat milk improves Zn bioavailability, a mineral with prevented antioxidant capacity (Zago et al. 2001). Zinc shows antioxidant activity. Similarly, selenium as a key mineral for innate and adaptive immunity with B-lymphocytes (B-cells), Natural Killer (NK) cells and T-lymphocytes (T-cells) in goat milk showed immunological properties and acts as a key cofactor for the functioning of the antioxidant enzyme glutathione peroxidase (GPX), which is important for macrophage activation and scavenging harmful free radicals in the body. Goat milk boosted digestibility, due to more zinc, magnesium, alkalinity, iron, and buffering capacity (Pinto et al. 2017). Goat milk plays a key role in all biological reactions and exerts antioxidant and anti-inflammatory effects in the body (Shea et al. 2004, Zenebe et al. 2014). Bergillos-Meca et al. (2015) prepared probiotic fermented milk from concentrated goat milk enriched Ca, Mg, Zn and P bioavailability (*Lactobacillus plantarum* C4) using ultrafiltration. (Randheera et al. 2019) reported that Goat's milk comprises higher concentration of vitamin A and whiter in colour than bovine milk (Verruck et al. 2017). Goat milk is also rich in thiamine, riboflavin, niacin, and pantothenate (Turkmen et al. 2017).

Functional properties of goat milk and its products

Goat milk has stronger flavour and its higher protein content with different phosphates arrangement makes it alkaline in nature (Agnihotri & Prasad, 1993). Goat milk has smaller size fat globules compared to cow milk which provides a smoother texture. The lower amounts of alphas1-casein present in goat milk results in softer gel products, a higher water holding capacity and a lower viscosity (Gomes et al. 2013). (Tseng et al. 2012) evaluated three types of goat milk viz. full-fat goat milk, low-fat goat milk and skim goat milk. They reported that the colour, 'L' value, 'a' value and 'b' value of the goat milk decreased with increased milk fat. No significant differences were found in short-chain and middle-chain fatty acid (C4-C12), saturated fatty acid (SFA), unsaturated fatty acid (UFA) or the ratio of SFA/UFA among all the three types of milks. Low fat goat milk had the highest appearance score among all the types of milks, whereas the full fat goat milk had higher aroma, flavour, tasty and overall acceptability score than the other groups. (Slacanac et al. 2010) informed significant role of fermented goat milk products in securing food for rural communities by incorporation of live probiotic cells in fermented goat milk represents nutritive and therapeutic properties. Goat milk contains good amount of taurine, which is a final metabolic products of sulphur containing amino acids. It is added to health drink and revitalizers and have several biological functions:

regulation of osteoblast metabolism; modulator of growth and of neuronal activity; protection of cells; conjugation of bile salts against various types of injury and prevention of cardiovascular damage; treatment of fatty liver of children and contributed in the treatment of diabetics also.

(Anaeto et al. 2010) studied for the first time a drug called Aimspro made from goat blood improves vision in multiple sclerosis patients and reduce an aspect of disability in the chronic phase of any treatment. Further, goats' milk assured therapeutic properties in malabsorption syndrome by utilization of fat and mineral salts. (Zhang et al. 2015) reported cholesterol-lowering effects and higher antioxidant activity in cultured goat's milk. As a result, of higher proteolytic activity and structural changes in the primary structure of goat's milk in comparison to cow's milk fermented with lactobacilli and bifidobacteria. Prasanna & Charalampopoulos (2018) showed better performances when *Bifidobacterium longum* subsp. *infantis* CCUG 52486 microencapsulated in a variety of matrices: sodium alginate-goat's milk (SAGM), sodium alginate-cow's milk (SACM), sodium alginate (SA) and sodium alginate-casein hydrolysate (SACH) in simulated gastrointestinal conditions. The goat milk is nutritionally and therapeutically healthy and can be used to manufacture a wide variety of products due to its chemical characteristics, including fluid beverage products (low fat/ flavoured/ fortified) and UHT (Ultra High Temperature) milk, fermented products such as cheese, buttermilk/ yogurt, frozen products such as ice cream/ butter, frozen yogurt, condensed/ dried products, sweets and candies (Riberio & Riberio, 2010). Furthermore, goat milk recently gaining attention in forte products like cosmetic, hair and skincare products. Yet, high quality products can be achieved from fine quality goat milk which has potential to tolerate the technological treatment and be transformed into a product that fulfils the consumer's expectations, in terms of hygiene, nutrition and sensory attributes (Yalinger, 2013).

Fermented goat milk products

Kullisaar et al. (2003) reported antioxidative and anti-atherogenic effects from fermented goat milk (*Lactobacillus fermentus* ME-3). (Widodo et al. 2010) investigated the quality of fermented goat milk and cow milk, as well as the viability of LAB added with skim milk (18% of solids) using three separately different starters; yoghurt starter (a combination of *Streptococcus thermophilus* FNCC-0040 and *Lactobacillus bulgaricus* FNCC-0041), single starter of *Lactobacillus acidophilus* FNCC-0029 and *Lactobacillus casei* FNCC-0051. It was, found that 10.83% decrease in LAB viability in fermented cow milk and 11.40% in fermented goat milk after 28 days of storage. In conclusion, quality of fermented milk is affected by the starters applied, raw milk source and storage period. (Salva et al. 2011) demonstrated in a mouse immunosuppressant model that Fermented goat milk (*Lactobacillus rhamnosus* CRL1505) increases the defence

against intestinal and respiratory infections by stimulating the mucosal immune system. Goat milk yogurt was manufactured from fortified 2% (wt/vol) skim goat milk powder (SGMP), sodium caseinate (NaCn), whey protein isolate (WPI), whey protein concentrate (WPC), or yogurt texture improver (YTI). “Kishk” is a traditional fermented milk of Lebanon. It is a dried mixture of yogurt and bulghur, prepared from goat milk. (Salameh & Hosri, 2016). Concentrated yogurt (Labneh) was made from cow and goat’s milk and their mixture. Labneh produced from goat’s milk has higher ash, moisture and fat content, but lower pH, total solids, protein and lactose content in comparison to the Labneh developed using cow’s milk. Labneh with goat’s milk had a higher short and medium-chain fatty acid groups (Serhan et al. 2016). Moreno- Montoro et al. (2017) using ultrafiltration process explored various whey fractions from ultrafiltered fermented skimmed goat’s milk. (Moreno-Montoro et al. 2018) manufactured highly nutritious novel fermented goat milk which is high in protein and mineral concentration whereas low in lactose and fat content, using probiotic strain *Lactobacillus plantarum* C4 in combination with *L. bulgaricus* and *Streptococcus thermophilus*. For best viscosity and syneresis a high casein content Ultrafiltration was chosen as the skimmed milk concentration method.

Cheese

Cheese is a fermented and renowned value added dairy product, which has hundreds of varieties (Pal, 2014). Sheep and goat cheeses are the first choice for connoisseurs as gastronomic and festive products. Goat cheese was invented in Mesopotamia. The milk was probably made into soft cheese, and then hard, ripened goat cheeses were later developed in the Mediterranean basin countries (Jenness, 1980). Yangilar (2013) stated that U.S. Department of Agriculture describes over 400 varieties of goat cheese and lists over 800 names of cheeses, many of which are made from goat milk or combinations of goat with cow, ewe, or buffalo milk. (Slaèanac et al. 2011) reported a higher concentration of P, Fe, and Mg in White Slice goat cheese than in White Slice cow cheese. “White Slice” goat cheese is traditional product characteristic for Eastern part of Croatia, as well as for Istria region. “White Slice” goat cheese has been produced on farms and some small cheese factories in East Croatia. (Badriah et al. 2013) prepared a hard cheese like product named as Oggtt which is mainly stable and safe dried fermented milk. It is mainly produced by Bedouins during the spring season when milk is produced in excess amount.

Yoghurt-probiotic dairy-based beverages

Yogurt, fermented milks (both drinkable and spoonable) has long been associated with longevity and wellbeing of the people (Granato et al. 2010, Özer & Kirmaci, 2011, Aryana & Olson, 2017). Conventional yogurt preparations have been in practice by adding value-added ingredients such as probiotics, prebiotics and

various plant extracts (Champagne et al. 2018; Fazilah et al. 2018). Probiotic yogurt has reached a great market success during the last two decades or more. Although solid texture, high fat content and pH values of cheese provide better protection of probiotic cells against undesirable environmental conditions, probiotic cheese market is far below its market potential (Özer & Kirmaci, 2011).

Probiotic dairy beverages have also long been available in the global beverages markets. Currently, yoghurt is growing in popularity throughout the world, as people are now become aware of health benefits of probiotics in yoghurt. It is a fermented milk product that can be prepared with milk, cream, and skim milk (Pal, 2014). Goat milk yogurt is the richest source of fatty acids, protein, and minerals but due to its typical flavour derived from capric, caprylic, and caproic acids present in this milk and dairy products are not accepted by many consumers (Costa et al. 2014). Goat milk yogurt was one of the traditional products from countries where fermented dairy foods originated. Yoghurt manufactured from cows, goats milk (100%, 75%, 50% and 25%) and their substitution blend exposed the highest protein content (4.2%), fat (4.27%) and caproic(C_6), caprylic(C_8) capric(C_{10}) and total solids (16.22%) from goat’s milk yoghurt (Ehirim & Onyeneke, 2013). Problems associated with goat milk yogurt manufacturing revealed some quantitative and qualitative properties (Park and Guo, 2006 and Patel & Roy, 2016). (Bano et al. 2011) manufactured yoghurt with improved sensory scores. Fermentation diminishes the “goaty” flavor, due to yogurt starter cultures. (Damunupola et al. 2014) incorporated beetroot extract at different level in goat milk yogurt to overcome goaty-flavor and goaty-odor. However, beetroot juice addition did not affect the acidity. However, (Costa et al. 2015) proposed to improve the texture of goat’s milk yogurt by incorporating of *Lactobacillus acidophilus* LA-5, inulin and cupuassu pulp. During storage *Lactobacillus acidophilus* LA-5 viability confer to probiotic physiological benefits which results in higher consistency of yogurts with added inulin at the end of the storage period. So, this strategy could be a technological key for the goat dairy industry (Costa et al. 2015).

Ice-cream and frozen desserts

Ice-cream is most popular value added dairy product made by freezing pasteurized mix with agitation to incorporate air and get uniform consistency (Pal, 2014). Silva et al. (2016) manufactured goat milk ice cream enriched with different amounts of carob powder. They reported that goat milk ice cream containing carob powder which was added @ 12% was found to be most acceptable with respect to all sensory attributes. Ranadheera et al. (2013) developed a technology for manufacturing of chocolate flavored probiotic ice cream from goat’s milk using probiotic bacterial culture comprising *Lactobacillus acidophilus* LA-5, *Bifidobacterium animalis* subsp. *lactis* BB-12, and novel probiotic *Propionibacterium jensenii* 702. During manufacturing, freezing process reduces viable cell numbers; however, the

Table 1 International advanced research on designed fermented goat milk products

Product , Composition & Starter culture	Functional effects	Conclusions	References
Kefir : Goat milk, Ewe's milk, PUFA (Maize dried grain with solubles) & mixture of mesophilic strains of lactic acid bacteria, under joint trading code of 75106 (Abiasa Inc., Quebec, Canada)	<i>cis</i> -9, <i>trans</i> -11, and <i>trans</i> -10, <i>cis</i> -12 C18:2 are two CLA isomers considered biologically active agents that have beneficial effects on human health and are substrate for the biohydrogenation process as well as for de novo synthesis of fatty acids in the mammary gland	The highest level of 2, 3-butanedione was found in goat milk kefir. The increased content of PUFA level increases kefir lactase activity only in goat milk kefir, less prevalent whey aroma, eliminated animal odor and resultant in a more prominent cream aroma in ewe milk kefirs, helped to equal the rate of sheep milk acidification by increasing the acidification rate in the initial stage of fermentation.	Cais-so kolinska et al. 2015
Cheese: Goat milk & Two <i>L. lactis</i> and one <i>Weissella cybaria</i> strains, identified by 16S rDNA (primers 27 F and 1492R)	Fermented goat cheese whey used for the production of substances with bacteriocin-like activity with antilisterial properties and also as a functional ingredient for future application to improve food safety	The utilization of whey from the production of goat cheese as a growth medium for <i>L. lactis</i> with highest bacteriocin-like activity obtained, <i>L. lactis</i> were effective against <i>L. monocytogenes</i> . Goat cheese whey used as a low cost culture medium for the production of such antilisterial substances, but studies are required to test the efficacy of this fermented compound as a biopreservative in food models against <i>L. monocytogenes</i> .	Lima et al. 2017
Cheese: Goat milk & formulation (7% (w/v) yacon flour addition improved goat yogurt sugar profile, reducing lactose (0.94%) and increasing prebiotic fructooligosaccharides Probiotic strain <i>Enterococcus faecium</i> NRRL B-2354, <i>Bifidobacterium longum</i> NRRL B-41409,	Supplementation of goat yogurt + yacon to a high fat diet resulted in lower body weight, body mass index, fasting glucose levels, HOMA-IR and atherogenic indices of rats, goat yogurt+yacon is an excellent functional food that avoids the metabolic impact of high fat feeding	Functional product by combining a probiotic goat yogurt with yacon flour and evaluated its maintenance during storage. Yacon flour enhanced the number of viable probiotic microorganisms, so it's use as a prebiotic in the food matrix and improved the concentration of fiber in the goat yogurt and the formulation met the standards for the microbiological and physicochemical quality of the final products.	Kinik et al. 2017
Yogurt: <i>Lactobacillus paracasei</i> subsp. <i>paracasei</i> NRRL B-4560.	Exceptionally, reduces the metabolic impacts in high fat diets.	Excellent functional dairy product for small and medium-size dairy industries to enter into functional dairy food market. Goat's milk is widely using as a carrier of probiotic bacteria in the form of stirred yogurt in Arab cultures.	Fabersani E. et al. 2018
Yogurt (Rayeb milk): <i>Streptococcus thermophiles</i> (St), <i>Lactobacillus delbrueckii</i> subsp. <i>bulgaricus</i> (Lb)	Goat yogurt may act as Functional foods in inflammatory Bowel disease	The optimal fermentation conditions were the temperature of 35°C, 0.07% of CaCl ₂ and 0.04% of Tween-80. The angiotensin-I-converting enzyme-inhibitory activity of the fermented product reach 91.62% after purification.	Ismail et al. 2018
Fermented milk: <i>Bifidobacterium animalis</i> subsp. <i>lactis</i> Bb-12 (probiotic and <i>Lactobacillus acidophilus</i> Tm and honey (prebiotic) Pasteurized goat milk, mesophilic culture & <i>Lactobacillus plantarum</i> 69	High antihypertensive effect i.e lowering blood pressure	Goat milk fermented by <i>Lactobacillus plantarum</i> 69 effectively persisted in the gastrointestinal tract and sustained high angiotensin-I-converting enzyme-inhibitory activity.	Chen, Zhang, Ji, Shu, & Chen, 2018
Boursin-type cheese: <i>Bifidobacterium animalis</i> subsp. <i>lactis</i> and <i>Lactobacillus rhamnosus</i>	<i>Bifidobacterium</i> microorganisms able to survive the passage to the gastrointestinal tract and tolerate acids, bile salts, and gastric enzymes so that they can finally adhere to and colonize the intestinal epithelium	The viability of <i>B. lactis</i> and <i>Lb. rhamnosus</i> cultures were unaffected throughout 35 days of storage at 4 °C, with a final count of >7 log CFU/g. No significant difference was observed between probiotic treatments and control in pH and titratable acidity. <i>B. animalis</i> presented greater resistance to the artificial gastric and enteric juices than <i>Lb. rhamnosus</i> , with mean decreases in the initial populations of 0.2 and 4.0 log CFU/g within 35 days of storage, respectively.	Martins, Deliza, et al. 2018

viability of all probiotics remained 107 to 108 cfu g⁻¹ up to 52 weeks at -20°C storage. Three types of low-fat soft-serve goat milk ice creams were manufactured using whole milk (3.64% fat), 2% fat and skim (0.71% fat) goat milk, and evaluated for textural and sensory characteristics of the caprine ice cream products. (McGhee et al. 2015) also manufactured ice creams in which commercial powdered vanilla flavour pre-mix (Alpha Freeze, D466-A9047, Tampa, FL, USA) containing 0.25% fat was incorporated into the three types of goat milk base. The sensory properties were determined at 0, 2, 4, 8 weeks at -18°C frozen-storage. It was found that the low-fat goat milk ice creams were acceptable even after 8 weeks frozen-storage. (Keily et al. 2016) prepared goat milk frozen yogurt using cajá (*Spondias mombim* L.) flavor, a typical fruit of the Brazilian Cerrado with different concentrations of cajá pulp. The sensory evaluation indicated that formulations containing low concentrations of cajá pulp were most acceptable. Goat milk products except pasteurized milk, yoghurt and cheese, are considered to be the dairy products with highest market potential.

International advanced research on designed fermented goat milk Products

Biada³a and Konieczny (2018) reviewed many designed fermented dairy beverages with increased participation of bioactive ingredients. Functional components present in milk fat are produced by bio-reacting unsaturated fatty acids in the rumen leads to higher nutritional value (Ciećlak et al. 2009; Szu-macher-Strabel, 2011). (Cais-Sokolińska et al. 2011) studied the effect of oilcake supplemented goat's milk, which results in reduced cholesterol content. Recently, (Niro et al. 2014) partially substituted cow milk with goat or sheep milks to produce acceptable Caciocavallo cheese. From a sensory standpoint, cow Caciocavallo cheeses were characterized by higher scores for sweetness, elasticity, adhesiveness, and humidity (moisture). Mixed cow/sheep cheeses had higher scores for intensity of flavor, acidic, astringent, friability, and salty attributes. In mixed cow/goat cheeses, solubility (fast melt in mouth), intensity of aroma, and bitter attributes predominated (Niro et al. 2014). In Norway, as consumption of the brown whey cheese (Brunost) has decreased, the interest in rennet- and acid-coagulated cheeses has increased (Inglingstad et al. 2014). As a result, the need for higher quality goat milk has increased in recent years. Inglingstad et al. (2014) examined the effect of 2 different hay qualities (low and high quality) and 2 different types of pasture (rangeland and cultivated) on goat milk composition and renneting properties. Milk from pastured goats was superior (higher casein and fat) to that from goats on hay, and goats on cultivated pasture had the highest yield; cultivated pasture yielded milk with higher áS1-CN and ê-CN (better renneting properties) compared with other treatments (Inglingstad et al. 2014). Faccia et al. (2015) reported satisfactory production of Fior di latte cheeses from sheep and goat milk after methodological modifications from the standard cow Fior di latte process. Providing additional support to the

findings, Revilla et al. (2016) analyzed the antioxidant capacity of 224 cheese samples in Spain, prepared using mixtures of milk from cows, sheep, and goats, in 2 manufacturing seasons (winter and summer) and over 6 month of ripening. Although animal species was not a significant factor correlated with total antioxidant capacity, statistically significant correlations were found between total antioxidant capacity and season of manufacturing (higher antioxidant activity in summer cheeses), time of ripening, retinol, fat and protein percentages, and some minerals (K, Mg, Na, and P; Revilla et al. 2016). Recently, many studies revealed adequate viability of probiotics in goat's milk products throughout storage period as shown in Table 1.

Conclusions

The market capacity needs to be opened to developing production and in accordance to the standard of living of the population. Goat farmers must be able to produce milk consistently with local breeds and with good sanitary quality. The dairy goat industry is now significant in India and goat breeder's association need to be established on the pattern of US/International Associations. The goat milk sector is very active with magazines, fairs and innovative products such as new goat cheeses, candy and cosmetic products and this need to be popularized. Goat rearing ensures self-employment and acts as a cushion in distress situations like drought and famine. Medicinal properties of goat milk increased the interest of society to use it as therapeutic health food nutraceutical. Fermented milk beverages made with probiotic microflora showed their documented functional properties, i.e. lactose intolerance, inhibition of pathogenic bacteria development, hypocholesterolemia, normalization of intestinal motility disorders and inhibition of bacterial nitroreductase which catalyses nitrosamines synthesis. To manufacture a product with the desired organoleptic qualities and to preserve the pro-health properties of pro-biotic cultures, they must be carefully selected and cultured. The characteristics that they should have are: moderate acidogenic activity, milk growth ability, antagonism to food spoilage bacteria, and good survival during storage. Moreover, biotechnologists are focusing on designer milk for human health. Promotes and facilitates the development of all segments of the dairy goat industry. Enhancing production and marketing of goat milk products, and promoting research beneficial to member of dairy and food organizations is the need of hour. Increasing the functional properties of goat milk products can also be achieved by using prebiotics, and probiotic bacteria for their production.

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