Perspective the use of goat milk in the production of soft milk cheeses

Oksana Kochubei-Lytvynenko, Irina Korolchuk, Nataliia Yushchenko, Uliana Kuzmyk, Nataliia Frolova, Vasiliy Pasichny, Ivan Mykoliv

National University of Food Technologies, Kyiv, Ukraine

Keywords:

Milk
Goat
Cheese
Spices
Fenugreek
Turmeric.

Article history:

Received 20.07.2019
Received in revised form 01.11.2019
Accepted 28.11.2019

Corresponding author:

Uliana Kuzmyk
E-mail:
ukuzmik@gmail.com

DOI: 10.24263/2310-1008-2019-7-2-9

Abstract

Introduction. The purpose of research is analysis the chemical composition, nutritional value and technological properties of goat milk as a potentially promising raw material for the production of soft cheeses.

Materials and methods. Object of research – full-cream goat's milk as raw material in production of rennet soft cheese.

Results and discussion. Biochemical and technological properties of the unique qualities of goat milk are just barely known and little exploited, especially not the high levels in goat milk of short and medium chain fatty acids, which have recognized medical values for many disorders and diseases of people. The new concept of tailor making foods to better fit human needs has not been applied to goat milk and its products so far.

One of the promising areas is the production of soft cheese. Today, soft cheese technologies have been developed to use increased amounts of bacterial preparations and rennet; addition of organic acid solutions, ultrasonic treatment of milk or its concentration by ultrafiltration. By the number of developments that implement the principles of food combinatorics, priority is given to the production of combined products in which raw materials of animal origin are combined with plant components.

In the technology of soft cheeses used vegetable crops in the form of dried powders, legume products, extruded flour from the embryos of chickpea seeds, amaranth flour.

The potential for the development of goat milk-based soft cheeses production corresponds to two trends – product value due to the usage of biologically valuable raw materials and resource-saving and have the increase direction of industrial volumes of goat milk processing and the development of new technologies.

Conclusions. Usage of spices will improve and diversify the taste and aromatic properties of goat milk cheeses, enrich them with a complex of biologically active substances, increase the yield of products and increase their stability during storage.

Introduction

In recent years, more and more people in the world pay great attention to healthy and balanced products made using exclusively natural ingredients. There is a steady increase in demand for farm products that are successfully gaining consumer trust and confidence. Most work on projects for the sale of natural local products.

Moreover, today the cheese market mainly consists of hard cheese, the share of which production structure was some 90%. Pickled and soft cheeses produce in approximately equal amounts, their share in the overall structure is approximately 3% [1].

Therefore, the development of new and improvement of existing technologies for protein dairy products will allow improving food patterns of the population, compensating for the lack of native protein in the diet, increasing the competitiveness of domestic enterprises and taking its appropriate place in both the domestic and foreign cheese markets.

Soft rennet cheeses deserve special attention in the assortment of enterprises. They are a source of digestible native milk protein and have more attractive price policy as compared to hard rennet cheeses.

Historically, up until recently, only private households were involved in goat farming. Today there is a tendency for the development of farmings and small family farms involved in the processing of goat milk [2].

Goat milk and its products of yoghurt, cheese and powder have three-fold significance in human nutrition: 1 – feeding more starving and malnourished people in the developing world than from cow milk; 2 – treating people afflicted with cow milk allergies and gastro-intestinal disorders, which is a significant segment in many populations of developed countries; and 3 – filling the gastronomic needs of connoisseur consumers, which is a growing market share in many developed countries. Concerning 1, very much improvement in milk yield and lactation length of dairy goats, especially in developing countries must be accomplished through better education/extension, feeding and genetics. Concerning 2, little unbiased medical research to provide evidence and promotional facts has been conducted, but is very much needed to reduce discrimination against goats and substantiate the many anecdotal experiences about the medical benefits from goat milk consumption, which abound in trade publications and the popular press. Goats have many unique differences in anatomy, physiology and product biochemistry from sheep and cattle, which supports the contention of many unique qualities of dairy goat products for human nutrition. Concerning 3, a few countries like France have pioneered a very well-organized industry of goat milk production, processing, marketing, promotion and research, which has created a strong consumer clientele like in no other country, but deserves very much to be copied for the general benefit to human nutrition and goat milkproducers. The physiological and biochemical facts of the unique qualities of goat milk are just barely known and little exploited, especially not the high levels in goat milk of short and medium chain fatty acids, which have recognized medical values for many disorders and diseases of people. The new concept of tailor making foods to better fit human needs has not been applied to goat milk and its products so far, otherwise the enrichment of short and medium chain fatty acids in goat butter, and their greater concentration compared to cow butter, could have become a valued consumer item. Also revisions to human dietary recommendations towards admitting the health benefits of some essential fats supports the idea of promoting goat butter. While goat yoghurt, goat cheeses and goat milk powder are widely appreciated around the world, goatbutter is not produced anywhere commercially in significant volume[3].

The potential for the development of goat milk-based soft cheeses production corresponds to two trends – product value due to the usage of biologically valuable raw materials and resource-saving and have the increase direction of industrial volumes of goat milk processing and the development of new technologies. The advantages of the soft cheese production segment are the economic and technological aspects, which allows the efficient use of dairy raw materials, sale of end product without maturation in order to save labor, energy and financial resources. This is a promising area of scientific research to develop new and improve classical technologies of goat milk based soft cheeses based on the principles of consumer value, resource efficiency and safety.

The **aim** of the research is to study the chemical composition, nutritional value and technological properties of goat milk as a potentially promising raw material for the production of soft cheeses.

To accomplish the aim, the following tasks have been set:

- Justify the choice of raw materials for the production of soft cheese;
- To investigate the chemical composition, nutritional value and technological properties of goat milk as a potentially promising raw material for the production of soft cheeses;
- Justify the feasibility of using natural spices in the production of soft cheeses.

Materials and methods

Object of research – full-cream goat's milk as raw material in production of rennet soft cheese [1, 3].

Scientific and research works, articles, proceedings of the conferences, thesis of the conferences, monographs of different methods, modes, processes of liquid systems treatment and equipment for processing were analyzed.

Results and discussion

Characteristics of the chemical composition of goat's milk

Goat milk is a valuable raw material of high nutritional value, is a source of high-grade milk protein and fat with a high level of digestibility and a number of other nutritional and biologically active compounds [4]. Additionally, to its nutritional value, it is hypoallergenic and exhibits immunological properties [3].

The most valuable component of goat milk is protein, which average content is 3.6% [5] (in cow's milk – 3.2% [5]), and which is presented in highly dispersed state, the average particle diameter of casein micelles is 73 nm [5] (100 nm in cow's milk). It leads to a better digestibility indicator compared to cow's milk protein and is 97% [5].

Protein in general and milk plays a significant role in the normal development and functioning of the human body [1]. It is a source of indispensable amino acids, a structural and functional basis for the formation of nerve, muscle tissue, connective tissues, joints, and human internal organs [1]. It is also a part of all body cells, found in enzymes, hormones, and immune bodies [6].

Furthermore, the protein is the most technologically crucial milk component, the content and characteristics of which depend on the protein dairy products output [6].

It is also worth mentioning that the chemical composition of milk as a whole, including the total protein content, its fractional composition, depends on the goat breed, genotype, season and feeding ration [6].

As an example, a comparative characteristic of the fractional composition of goat (Saanen breed) and cow's milk proteins is given in Table 1.

Table 1

Fractional composition of goat and cow's milk [7]

Protein and its fractions	Goat milk n=80		Cow milk, n=123	
	g/100 ml	%	g/100 ml	%
General protein	**3,196±0,040**	**100**	3,360±0,040**	100
Casein:	**2,452±0,037**	**76,7**	2,609±0,045**	77,6
αs_1	**0,393±0,010**	**16,4**	0,859±0,025***	25,5
αs_2	**0,526±0,027****	**11,5**	0,321±0,009	9,6
β	**1,122±0,014*****	**35,1**	0,767±0,021	22,8
Whey protein:	**0,744±0,001**	**23,6**	0,751±0,012	22,4

The difference in the composition and structure of goat and cow milk proteins is the basis of their structural and physicochemical characteristics. Therefore, a low content of αs1-casein and a higher content of whey proteins, unlike cow's milk, contributes to the softer clot formation, small size and small loose flakes, which facilitates milk digestion by proteolytic enzymes [8]. In this regard, goat milk is easier to digest, does not cause digestive disorders, and has hypoallergenic characteristics [9].

The quantitative content of the αs1 casein fraction has a significant effect on the technological characteristics of milk, in particular cheese quality. Dairy raw materials with higher casein αs1-fraction content are of greater importance in the cheese production, reducing the loss of protein in milk whey when cultivating a clot formed under the action of milk-clotting enzymes [10].

The protein of goat milk is more biologically complete in comparison with the protein of cow's milk. Comparative characteristics of the biological value of goat and cow milk are given in Table 2.

Table 2

Comparative characteristics of the biological value of goat's and cow's milk [10]

The name of the essential amino acid	Content of amino acids, g/100 g of protein		Scale FAO/WHO, g/100 g of protein	Amino-acid score, %	
	Goat's milk	Cow's milk		Goat's milk	Cow's milk
Valine	5,4	5,8	5,0	108,0	116,0
Isoleucine	4,9	5,2	4,0	122,5	130,0
Leucine	7,2	7,6	7,0	102,9	108,6
Lysin	5,7	6,1	5,5	103,6	110,9
Methionine +cysteine	3,7	3,6	3,5	105,7	102,8
Phenylalanine +tyrosine	8,0	7,6	6,0	133,3	126,7
Threonine	4,0	3,6	4,0	100,0	90,0

Based on the analysis of the data in Table 2, we can draw a conclusion about the usefulness of protein in goat and cow milk. The limiting amino acid for cow's milk is threonine, while for goat's milk the score of this amino acid is 100%.

The share of dominant acids of isoleucine and phenylalanine in goat milk protein is quite high and even exceeds the level recommended by the FAO/WHO by 22.5 and 33.3%, respectively. The remaining amino acids exceed the recommended level by 2-8%.

Milk fat is one of the indicators that determines the technological, nutritional quality and biological value. It averages 4.3% [11] for goat milk and 3.6% [11] for cow milk. Fat is present in milk as fat globules. The core of the fat globules consists mainly of triglycerides and is surrounded by a complex membrane synthesized from mammary epithelial cells. A specific feature of the fat composition of goat milk is the small size of globules – an average of 2 microns [11], which is about 10 times less than cow's fat globules. As a result, fat represents a thin fat emulsion that characterizes its homogeneity, does not form foam and aggregates, unlike cow's milk. The small size of the fat globules is safer because of greater absorption of goat milk fat due to the accessibility of the effect of pancreatic lipase [12].

The fatty acid composition of goat milk is mainly represented by short- and medium-chain fatty acids (C6:0-C14:0) – caproic acid, caprylic acid, caprinic acid and lauric acid [13]. Short and medium-chain triglycerides, as an energy substrate for enterocytes, improve nutrient transportation through the cell membrane and contribute to the restoration of damaged cells of the intestinal mucosa [14].

Goat milk contains 2 times more low-molecular weight fatty acids, as compared with cow milk, which determines the specific taste and after-taste of goat milk, especially taking into account the content of caproic, caprylic and caprinic acids [14].

Despite the increased content of low molecular weight fat, the stability of goat milk fat stage to thermal and enzymatic factors of influence during production has been proved [12].

Quality, processing ability and sensory properties of milk are highly correlated with content and composition of milk fat. Biologically active lipid substances are primarily saturated fatty acids (SFAs), monounsaturated fatty acids (MUFAs; linoleic acid; C18:2 n-6) and polyunsaturated fatty acids (PUFAs; α-linolenic acid; C18:3 n-3). PUFAs with 20C, mainly docosahexaenoic acid (DHA; C20:5 n-3) and eicosapentaenoic acid (EPA; SC22:6 n-3), are precursors of eicosanoids, which regulate various physiological processes. Fatty acid composition depends on many different factors, such as animal species, breed, season, lactation stage, geographical location, and diet. Goat and sheep milk are rich in the medium chain fatty acids, caproic (C6:0), caprylic (C8:0) and capric (C10:0), which is the reason for the specific aroma of those kinds of milk. Goat and sheep milk have more conjugated linoleic acid, and usually lower n-6/n-3 ratios, with higher amounts of α-linolenic acid, compared to cow milk. Compared to goat and cow milk, sheep milk has the lowest amounts of lauric (C12:0), myristic (C14:0) and palmitic (C16:0) acids i.e. fatty acids associated with negative effects on human health. The addition of forage, especially fresh grass, to dairy animal diets enhances the proportion of unsaturated fatty acids in milk fat compared to SFAs and increases the amount of conjugated linoleic acid [15].

Goat milk is globally consumed but nutritional profiling at retail level is scarce. This study compared the nutrient composition of retail cow and goat milk (basic solids, fatty acids, minerals, and phytoestrogens) throughout the year and quantified the potential implications on the consumers' nutrient intakes. When compared to cow milk, goat milk demonstrated nutritionally desirable traits, such as lower concentrations of C12:0, C14:0, C16:0 and Na: K ratio, and the higher concentrations of cis polyunsaturated fatty acids (PUFA), eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), isoflavones, B, Cu, Mg, Mn, P and I, although the latter may be less desirable in cases of high milk intakes.

However, in contrast with nutritional targets, it had lower concentrations of omega-3 PUFA, vaccenic acid, lignans, Ca, S and Zn. The extent of these differences was strongly influenced by season and may demonstrate a combination of differences on intrinsic species metabolism, and farm breeding/husbandry practices [16].

One of the important characteristics of both dairy raw materials and final products is availability of minerals and vitamins. Both goat and cow milk are characterized by a high degree of mineralization. Goat milk has a high potassium content, which plays an important role in the activity of the cardiovascular system. Goat milk has a high content of calcium, copper, vitamin C, D, A, B and PP. Goat milk, in comparison with cow milk, has a lower iron content, however, the degree of its assimilation is higher (30%) as compared to the cow milk (10%) [17, 18].

Goat milk contains a significant level of carbohydrates (4.6% averagely), namely a class of oligosaccharides that have prebiotic characteristics, thereby promoting the growth of bifidobacteria in the gastrointestinal tract. With the proper microflora of gastric colonization of bacteria, complex carbohydrates, as well as lactose, are broken down into several components of monosaccharides, which are then metabolized to side-products, with subsequent transformation into an energy source [19, 20].

Milk oligosaccharides are compounds capable of modulating intestinal microbiota by exerting a prebiotic, anti-adhesive and anti-inflammatory effect. Technological advances in equipment and analytical methods have indicated that goat milk is a good source of oligosaccharides, and that some of these oligosaccharides are similar to those found in human milk. Scope and approach: This review focuses on recent scientific information regarding the structure and composition of oligosaccharides in goat milk and their benefits, thereby providing an overview of what has been tested and proven about goat milk. Key findings and Conclusions: The quantification and the profile of oligosaccharides depend on the methodology applied for this purpose. Those based on HPLC and mass spectrometry are the best methods for oligosaccharide identification and quantification in goat milk. Membrane technology is also a successful method applied in the isolation and concentration of oligosaccharides. Beneficial effects of goat milk oligosaccharides are related to gastrointestinal activities, inflammatory reactions and nervous system development [21].

Analysis of the current state of technology of soft cheese

One of the promising directions is the soft cheeses production. However, the difficulty is both the lack of raw materials and technological features due to the low titratable acidity, the fractional composition of the protein (dominance of β-casein, and α-lactalbumin) and slower coagulation under the action of rennet.

The technology of goat milk soft cheeses production has been developed with the usage of high doses of bacterial starter cultures and calcium chloride, due to which the rate of clot syneresis and cheesecurd dehydration has been increased [18].

In order to increase the density of a goat milk clot, it was proposed to launch a method for preparing goat milk by increasing its titratable acidity to 21°T by introducing aqueous solutions of organic (citric, ascorbic) acids and their mixture in an amount of 0.01-0.04 wt.%. This made it possible to increase the density of rennet clots, reduce the loss of milk proteins with cheese dust and provide an increase in rennet cheese withdrawal from 1 ton of goat milk by 1-2% [19].

Among the developments in which the principles of food combinatorics are implemented, the priority belongs to the production of combined products in which raw materials of animal origin are combined with plant components. Both cereals, for example, wheat, rice, oats, and legumes such as soy, chickpeas, lentils, and the like are widely used in the capacity of vegetable raw materials used in the production of combined foods.

In products with complex composition milk and vegetable raw materials are used in different combinations, which allow to give them certain functional properties. Increasing the production of biologically wholesome products is a highly topical issue. One of the possible solutions of the problem is combining milk basis with vegetable raw material. Studies have been conducted on the development of soft cheeses from goat's milkwith chickpea flour. The aim of this research is to study the properties, consumer value and possibility of creation of soft cheese formulation with chickpea flour. In this field of study, an extruded chickpea flour is an innovative additive that had never been used before. Optimal proportion of ingredients was determined by nutritional, biological and energy value under the limitations arising from structural and parametrical models of adequate nutrition. The optimal concentration of bean filler in cheese mass that allows for the insignificant change in qualitative indicators of lacto-vegetarian product (taste, smell, consistency and color) was determined. During the experiments an effective fracture of bean component was selected and qualitative indicators of the developed soft cheese were determined. The paper gives scientific substantiation for the effectiveness of manufacture of soft goat cheese with chickpea flour [22].

Technological techniques such as bioactivation of cereals and legumes, including those with the simultaneous enrichment of essential microelements (iodine, selenium) and extrusion [23-25], have positively established themselves as pretreatment of leguminous crops.

In the technology of soft cheeses and cheese products, vegetable crops are used in form of dry powders, for example, girasol, and sterilized mashed puree for example, from carrot [26].

The technology of goat milk soft cheese has been developed. The implementation of this technology uses legume processing products – lentil and chickpea flour as functional additives, applied with the aim of saving resources. The definitive weight content of bean filler for lentil flour is 3%, for chickpea flour – 5% by weight of the product [27]. It has been established that the use of the bean component affects the change in the acidity of the product and contributes to an increase in the product yield by 2.5% on average [27].The disadvantage is that the flour of legumes is an additional favorable environment for the development of extraneous microflora, which leads to a reduction in expiration dating period.

A technology of introducing spicy aromatic and medicinal herbs to goat milk has been developed in order to improve its technological features. A well-known method for the production of soft cheese without ripening, in the implementation of which the functional phytocomponents of medicinal plants (0.5-1.5% by weight of the initial mixture) and soluble dietary fiber (0.3-0.5% by weight of the initial mixture) are intended to be applied in a dry, finely divided form into the mixture before formation (after removal of up to 70% of serum) [28].

Food fibers, which are introduced in an amount of 0.3-0.5%, can increase the final product yield by 5-7%. They also contribute to the extension of expiration dating period, preservation of freshness and improvement of organoleptic characteristics of cheese [28].

A special research was conducted in which extruded flour from chickpea seed embryos and dry powder of crushed girasol fibers were selected as plant components. A feature of obtaining chickpea embryos is the introduction of selenite and potassium iodide into the nutrient medium during germination, due to which they are organized and bioavailable. Food fibers in the composition of plant ingredients expand the range of functional properties of goat milk, and in combination with probiotic cultures, they provide the symbiotic properties of the final product. Improving the technology in this manner is appropriate, since food fibers are hydrocolloids and have the ability to bind and retain moisture, that increases of product yield [29].

The technology of soft cheese with Amaranth powder has been also developed. Amaranth powder is intended to be introduced into pasteurized and cooled to a temperature of 28-32°C milk in an amount of up to 7.5% by weight of the mixture. Amaranth flour was prepared at a temperature of 120 ... 130° C. The resulting mixture was thoroughly mixed for 10-15 minutes. Further, the technological process was carried out according to classical technology. The use of amaranth flour provides an increase in the nutritional and biological value of cheeses, enriches micro- and macroelements, facilitates to save raw material resources and to reduce the cost of the final product [30].

However the demand for goat milk products remains persistently high, the lack of raw materials limits the volume and range of such products and causes a higher cost. Additionally, the perceptual aspect of goat milk products, such as a more intense smell and taste, also contribute to the low perception of these products by some consumers. In this context, the partial replacement of goat milk with cow milk as part of a product such as cheese may be an alternative for consumers who want to consume more dairy products from goat milk. Partial replacement of goat milk with cow milk may provide an opportunity to diversify the dairy market, since it allows creating products with high nutritional value and unique characteristics compared to products made exclusively from cows milk [31].

In the domestic market of Brazil one of the traditional and widespread is fresh cheese Minas [32]. Advantages in the production of Minas cheese are a short technological cycle, high final product yield and high consumer properties.

Fresh cheese Minas is produced in the result of enzymatic coagulation of goat, cow and a mixture of goat (50%) and cow (50%) milk from starter cultures (R-704 *Lactococcuslactis*ssp *Lactis* та *Lactococcuslactis* ssp *Cremoris*; ChrHansenIndústria e Comércio Ltda, Valinhos, Brazil) or with subsequent processing of the clot, self-pressing and salting in brine. It has a soft texture, slightly acidic aroma and high moisture content. Cheeses were vacuum packed in sterile plastic bags and stored for 21 days at 4°C. It was determined that all control samples showed similar physicochemical characteristics and storage ability, except hardness – cheese based on goat milk had a very soft structure and higher moisture content. Although, the goat milk-based sample had a specific taste and smell, which is due to the higher content of caprylic, caprinic, oleic and linoleic fatty acids in comparison with cheese made from cow milk. The color of such cheese is white with a less noticeable yellowish tint, typical for cheeses based on cow milk. Therefore, the development of derivative products, in particular fresh Minas cheese with partial replacement of goat milk with cow milk, can be a viable alternative to marketable, high-quality dairy products that meet demand of a wider range of consumers [32].

A similar technology was developed for Coalho cheese using a mixture of cow and goat milk to obtain a product with the appropriate physicochemical, organoleptic characteristics and satisfactory consumer perception.Cheese samples based on cow, goat and a mixture of cow and goat milk were made according to the traditional technology for Coalho cheese, suggested by the Brazilian research company Embrapa. A particularity of this technology is the heat treatment of cow milk, goat milk or a mixture of cow and goat milk (1:1) at 90 ± 1°C by aging in containers for 10 minutes and subsequent acidification with lactic acid in an amount of 0.25 ml/l.Milk (its mixture) was refrigerated to a temperature of (36 ± 2)°C, then the technological process was implemented according to the classical technology for soft cheeses with rennet-acid coagulation of proteins [33].

Studied that thermosonication was used as a combined treatment of raw goat milk (RGM) using pasteurization (72 °C for 15 s) and ultrasound treatments (20 kHz at the power variance of 150 W, 200 W, 300 W and 400 W for 10 min). Investigation on the impact of the microbial load, protein content, protein aggregation, the particle size of fat and casein micelles, pH, viscosity, turbidity, color, and soluble calcium and phosphorus contents were carried out, whiles RGM and PGM served as the control. Our results revealed that at 400 W, that thermosonication resulted in a significant reduction ($\alpha = 0.05$) in the microbial load of the samples to less than 2.3 log cfu/mL in comparison to those of RGM and pasteurized goat milk(PGM) at 5.94 log cfu/mL and 4.76 log cfu/mL respectively. In RGM, the fat size (3.5 μm) decreased to 0.4 μm at 300 W; while those of casein micelles also decreased from 406 to 256.4 nm at 400 W. However, no significant effect was observed in the color and soluble calcium and phosphorus contents of all samples. The effect on the microbial load and fat homogenization would promote thermosonication process in the dairy industry [34].

As an alternative to pasteurization and in order to improve the coagulation properties of milk under the action of rennet the studies on the effect of ultrasonic pretreatment on goat milk before coagulation are being conducted [35].It is common knowledge thatpart of milk proteins, in particular whey proteins, are thermolabile and at temperature processing above 60°C they are denatured and partially coagulated.The use of ultrasound is suggested as an alternative to pasteurization. It does not lead to coagulation of non-thermostatic milk proteins. The studied milk was subjected to ultrasound at 800W for various amounts of time (0-20 sec). It is established that compared with the control sample, which was not amenable to ultrasonic treatment, the degree of protein denaturation of the studied samples increased by 9.57%, the content of soluble calcium and phosphorus by 16.9 and 13.7%, respectively. Clot density, coagulation rate water-holding ability and expiration dating period of produced products also increased.

One of the promising methods for processing dairy raw materials in the production of soft cheeses is ultrafiltration.It helps to improve traditional and develop new technological approaches, while minimizing the denaturing effect on proteins, vitamins and other biologically active components of raw materials [36].

The ultrafiltration method allows one to obtain a concentrated mixture and save 20-25% on the consumption of electricity, steam, and starter samples Ultrafiltration processing of milk allows to increase the yield of fresh cheeses by 20% and reduce the cost of rennet by 30% [37].

The manufacturing procedures and compositional characteristics were studied for fresh soft cottage cheese (Domiati type) made from goat milk using ultrafiltration (UV) and without its use [38].It was determined that cheeses obtained with a concentrated mixture had a lower pH, moisture and ash content, while protein and fat were higher in comparison with cheeses made from whole milk.The use of milk ultrafiltration ensured an increase in cheese yield by 21%, protein utilization by 21 ... 26%, fat 15 ... 19%.Moreover, the ultrafiltration process showed a decrease in the total time for the technological process, and reduced the consumption of salt, starter cultures, milk-clotting enzyme and calcium chloride, respectively, and positively influenced the consistency of cheeses.

Scientists at the Ukrainian State University of Food Technologies suggested using fenugreek and turmeric in production of goat milk soft cheeses. They are a source of biologically active substances and components that ensure the stability of quality indicators of final products during its storage.It was found that adding spices to the normalized mixture before thermal conditioning in the amount of $1.0 \pm 0.2\%$ leads to a decrease in the active acidity of goat milk and serum, allocated during processing of rennet in an average of 0.2 pH units. Besides, it provides the formation of a denser clot, accelerates serum separation, probably due to the adsorption of components of spices on the surface of casein micelles and, as a result, a decrease in their surface charge and aggregation [39].

Natural spices in protein-based technology

Spices are a source of biologically active compounds (essential oils, terpenoids, phenolic and polyphenolic substances, vitamins, micro- and macronutrients, etc.), that evince antioxidant antimicrobial and bacteriostatic effects [40].The food industry typically uses dried vegetable raw materials containing from 8% to 14% moisture [41].

Natural spices have a high content of aromatic substances, which are mainly essential oil. The amount of aromatic substances in natural spices is subject to considerable fluctuations. Thus, in some plants the content of aromatic substances is up to 1%, while in others it reaches 14% or more. Particularly rich in essential oil of the family of conifers, labia flowers, umbrellas [41].

By forming the taste properties of products, spices also increase the activity of the effect of food on the digestive system, contributing to a better absorption of nutrients. This is not only due to the more intense secretion of gastric juice, but also due to the spice content of the components, which are catalysts for a number of processes and contribute to the intensification of metabolism as a whole [42].

Thus, natural spices are a promising raw material not only for the preparation of culinary dishes, but also can be used as an enrichment component in the composition of dairy products. The use of spices is quite limited. Therefore, at the current level of dairy technology development, the actual task is to use spices in their composition.

Ripened cheese varieties containing herbs are traditional in Turkey and have been manufactured for more than 200 years in the east and southeast of the country. They are manufactured from raw milk, semi-hard in texture and salty in taste and have the aroma of garlic or thyme due to added herbs. Twenty-five types of herb, including Allium, Thymus, Silene and Ferula species which are most popular, are used individually or as appropriate mixtures. The most popular of these cheeses is Otlu which is produced mainly in the Van province of Turkey in small dairies and villages, but now is produced in other cities of the eastern region of Turkey and its popularity increases continuously throughout Turkey. The manufacturing technology, chemical, biochemical and microbiological status of Otlu cheese and the most common herbs used in its manufacture are reviewed. The possible effect of herbs used on the biochemical and microbiological characteristics of the cheeses are discussed also. In addition, some varieties of Otlu cheese and cheeses flavoured with spices(chilli pepper, black pepper, cinnamon, allspice, mint, thyme, cumin, etc.), including Carra, Surk and related cheeses, are discussed briefly [43].

Essential oils (EOs) are natural substances extracted from aromatic and medicinal plants (AMPs), important in food preservation. Several studies have shown that AMPs, as well as their EOs have antimicrobial (antibacterial and antifungal) activity. Indeed, our in vitro studies have shown that oregano and thyme EOs are effective against foodborne bacteria, isolated from fermented meat products and cheeses, such as Escherichia coli, Listeria monocytogenes, Salmonella spp., and Staphylococcus aureus. However, EOs of thyme and oregano seem to control the growth of fungi, namely Botrytis cinerea and Aspergillus spp., affecting the shelf-life of fruits during postharvest. The EOs of sage and rosemary have shown little or no antimicrobial activity. Shelf-life extension studies using several EOs (cinnamon, clove, oregano, rosemary, sage, and thyme) and AMPs were performed using pork meat, goat cheese, strawberries, and table grapes. Preliminary results regarding food safety and sensory acceptability are discussed. Practical applications Consumers' demands for more traditional and healthier food products led to a search for alternatives to replace synthetic by natural additives. EOs of AMPs contribute to food safety, due to their antimicrobial properties. Consequently, the use of AMPs' EOs may also extend the shelf-life of food products. In the present study, experimental shelf-life trials using EOs with different food products were performed, with promising preliminary results. Cinnamon, sage, and thyme EOs extended the shelf-life of strawberries and table grapes. Oregano EO prolonged the shelf-life of soft cheese. Thyme EO controlled the population of enterobacteria present in pork meat. Furthermore, the conditions used in this study can be directly applied in the food industry. Moreover, AMPs may be interesting alternatives to replace or reduce artificial food additives [44].

Despite the availability of scientific findings and research, the high nutritional value and functionality of goat milk, its industrial processing in our country is only just beginning to be introduced. The technology of soft cheeses requires a search of new ways to improve the organoleptic and functional characteristics, the stability of quality indicators during storage, and increase the level of resource and energy efficiency of production.

Conclusion

1. The limitation for the wider use of goat milk for industrial processing lies in its worse ability to coagulate under the influence of rennet, due to the fractional composition of the protein and low titratable acidity. This requires additional adjustment of the technological characteristics of goat milk, which is currently performed either by mixing with goat and cow milk, or by adding food additives, both natural and synthetic.
2. A promising area of scientific research is to improve the technology of soft goat cheeses by using natural ingredients, in particular spices, to improve and diversify the taste and aroma characteristics of goat milk cheeses, enrich them with a complex of biologically active substances, increase the yield of products and increase their stability during its storage.
3. The collaborative mechanism of milk components and spices requires a theoretical explanation, providing the desired technological effect and original organoleptic characteristics of the products.

Acknowledgments. The studies were conducted on the example of conditions of Central and Eastern Europe,the framework of the scientific research (R&D) «Scientific principles for the development of resource-saving technologies of protein-containing polyfunctional concentrates for food products for special purposes» (State registration number 0117U001243).

References

1. Popovici C., Caragia V., Cartasev A., Migaltiev O., Coev Gh., Golubi R., Bogdan N., Grumeza I. (2017), InoBioProd: innovation challenges and scientific Perspectives, *Ukrainian Food Journal*, 6(2), pp. 379–390.

2. Tita M., Popovici C., Tamosaitiene L., Bradauskiene V. (2019), Research about sales possibilities of processed dairy products by small manufacturers, *Management of Sustainable Development Sibiu*, Romania, 11(1), pp. 29–31.
3. Haenlein G.F.W. (2004), Goat milk in human nutrition, *Small Ruminant Research,* 51(2), pp. 155–163.
4. Pastuszka R., Barłowska J., Litwinczuk Z. (2015), Nutritional value and health-promoting properties of goat milk, *Medycyna Weterynaryjna,* 71(8), pp. 480–485.
5. Ryzhkova T. N., Bondarenko T.A. (2011), Comparative Characterization of the Casein and Cow Milk Casein Micelles Size, *Progressive technology of technology of food production of restaurant economy and trade: collection of scientific works of KSU nutrition and trade*, 1(13), pp. 378–383.
6. Bevilacqua C., Martin P., Candalh C. et al. (2001), Goat's milk of defective alpha (sl)-casein genotype decreases intestinal and systemic sensitization to beta-lactoglobulin in guinea pigs, *Journal Dairy Res*, 68, pp. 217–227.
7. Fatihov A.G., Haertdinov R.A. (2017), The effect of the content of αs1- and β-caseins in goat milk on its allergenic, thermostable and cheese-making properties, *Scientific notes of Kazan State Academy of Veterinary Medicine named after N.E. Bauman,* 230(II), pp. 163–167.
8. 8. Ballabio C., Chessa S., Rignanese D., Gigliotti C., Pagnacco G., Terracciano L., Fiocchi A., Restani P., Caroli A. (2011), Goat milk allergenicity as a function of αS1-casein genetic polymorphism, *Journal of Dairy Science*, 94(2), pp. 998–1004.
9. 9. Chilliard Y., Ferlay A., Rouel J., Lamberet G. (2003). A Review of Nutritional and Physiological Factors Affecting Goat Milk Lipid Synthesis and Lipolysis, *Journal of Dairy Science*, 86(5), pp. 1751–1770.
10. Heinlein G. F., Caccese, R. (2011), Goat milk versus cow milk, *More efficiently*, 8, pp. 40–43
11. Samojlov A.V., Suraeva N. M., Kopcev S. V., Rachkova V. P., Kolpakov E. Ju., Petrov, A. N. (2018), Features of the fatty acid composition of goat milk and products based on it, *Herald KrasGau*, 4, pp. 151–156.
12. Haenlein G.F.W. (2004), Goat milk in human nutrition, *Small Ruminant Research,* 51(2), pp. 155–163.
13. Kon I.Ya. (2000), Goat's milk in nutrition of infants, *Children's doctor*, 2, pp. 55–58.
14. Denisova S. N., Sencova T. B., Gmoshinskaja M. V., Belickaja M. Ju. (2004), The use of goat milk in the nutrition of nursing mothers for the treatment and prevention of atopic dermatitis in children, *Child Nutrition Issues*, 2, pp. 21–24.
15. Djordjevic J., Ledina T., Baltic M.Z., Trbovic D., Babic M., Bulajic S. (2019), Fatty acid profile of milk, *IOP Conference Series: Earth and Environmental Science,* 1, pp. 333.
16. Stergiadis S., Nørskov N.P., Purup S., Givens I., Lee M.R.F. (2019), Comparative nutrient profiling of retail goat and cow milk, *Nutrients*, 11(10), pp. 2282.
17. Raynal-Ljutovac K., Lagriffoul G., Paccard P., Guillet I., Chilliard Y. (2008), Composition of goat and sheep milk products: An update, *Small Ruminant Research,* 79, pp. 57–72.
18. Russel D., Ross R., Fitzgerald G., Stanton C. (2011), Metabolic activities and probiotic potential of Bifidobacteria, *International Journal of Food Microbiology*, 149, pp. 88–105.
19. Voblikova T. V., Rylkina N. N., Buerakova D. Ju., Shlykov S. N. (2012), The study of the effect of thermal bacterial sanitation of goat milk on its technological and microbiological parameters during storage, *Political Internet electronic scientific journal of the Kuban State Agrarian University*, 83, pp. 425–435.
20. Ryzhkova T. N., Ivanov S. V. (2013), Methods of preparing goat milk for processing for cheese, *SWorld*, pp. 10.
21. Sousa Y.R.F., Medeiros L.B., Pintado M.M.E., Queiroga R.C.R.E. (2019), Goat milk oligosaccharides: Composition, analytical methods and bioactive and nutritional properties, *Trends in Food Science and Technology,* 92, pp. 152–161

22. Chechetkina A., Iakovchenko N., Zabodalova L. (2016), The technology of soft cheese with a vegetable component, *Agronomy Research,* 14(5), pp. 1562–1572.
23. Karpenko E. V., Zlobina E. Ju., Starodubova Ju. V., Grishin B. C. (2017), Formulation of a soft cheese product with iodized protein-vegetable component, *Bulletin of the Voronezh State Agricultural University*, 3(54), pp. 132–142.
24. Rudakova A. Ju., Zabodalova A. A., Serova O. P. (2014), Development and production of cheese products with vegetable components, *Scientific journal NRU ITMO. Series: Processes and Food Production Equipment*, 4, pp. 204–209.
25. Glotova I. A., Galochkina H. A., Gura O. S. (2013), The use of bioactivated cereals in the production of dairy products: production and economic aspects, *Innovative technologies in the food industry: science, education and production: Mater. Int. scientific and technical conf.*, pp. 501–504.
26. Jakovchenko N. V., Silant'eva A. A. (2010), Obtaining soft rennet cheeses from ultrafiltration milk concentrate with the addition of vegetable fillers, *University News. Food technology*, pp. 35–37.
27. Chechetkina A. Ju., Serova O. P. (2012), Development of soft cheese technology with legumes, *Master's Bulletin*, 9-10(11-12), pp. 21–25.
28. Kotova V. Ju., Ionova N. O. (2015), Technology of soft cheeses using aromatic and medicinal herbs of the Stavropol Territory, *Innovations in the production, storage and processing of agricultural products: materials of the scientific-practical conference of students, graduate students and young scientists*, pp. 14–18.
29. Gar'janova V. A., Hramova V.N., Korotkova A.A., Gorlov I.F., Mosolova N. I. (2015), The effectiveness of the use of chickpea and Jerusalem artichoke in the technology of making soft goat cheese cheeses, *Food industry*, 7, pp. 21–26.
30. Sysoeva M. G., Glotova I. A., Aristova A. B., Pronina E. A., Polenov I. V., Smol'skaja L.G. (2017), Justification and development of cheese product technology using amaranth flour, *Technologies of the food and processing industry of the agro-industrial complex - healthy food products*, 5, pp. 64–72.
31. Vargas M., Cháfer M., Albors A., Chiralt A., González-Martínez C. (2008), Physicochemical and sensory characteristics of yoghurt produced from mixtures of cow's and goat's milk, *Int. Dairy J.*, 18, pp. 1142–1152.
32. Sant'Ana A. M. S., Bezerril F. F., Madruga M. S., Batista A. S. M., Magnani M., Souza E.L., Queiroga R.C.R.E. (2013), Nutritional and sensory characteristics of Minas fresh cheese made with goat milk, cow milk, or a mixture of both, *Journal of Dairy Science*, 96(12), pp. 7442–7453.
33. R. de C. R. do E. Queiroga, Santos B. M., Gomes A. M. P., Monteiro M. J., Teixeira S. M., E. Leite de Souza, C. J. Dias Pereira, Estevez Pintado M. M. (2013), Nutritional, textural and sensory properties of Coalho cheese made of goats', cows' milk and their mixture, *LWT - Food Science and Technology*, 50(2), pp. 538–544.
34. Ragab E.S., Lu J., Pang X.Y., Nassar K.S., Yang B.Y., Zhang S.W., Lv J.P. (2019), Effect of thermosonication process on physicochemical properties and microbial load of goat's milk,*Journal of Food Science and Technology,* 56(12), pp. 5309–5316.
35. Zhao L., Zhang S., Uluko H., Liu L., Lu J., Xue H., Kong F., Lv J. (2014), Effect of ultrasound pretreatment on rennet-induced coagulation properties of goat's milk, *Food Chemistry*, 15, pp. 167–174.
36. Bergovin A.M. (2008), Membrane filtration in the dairy industry, *Milk processing*, 3, pp. 10–11.
37. Kravchenko Je. F., Pliskov N. V. (2005), Advanced milk processing technology, *Cheesemaking and butter making*, 2, pp. 30–31.
38. Mehaia M. A. (2002), Manufacture of fresh soft white cheese (Domiati-type) from ultrafiltered goats' milk, *Food Chemistry*, 79(4), pp. 445–452.

39. Frolova N., Yushchenko N., Korolchuk I., Korablova O. (2019), Prospects of using spices in technology soft-ripened goat cheese, *Agrobiodiversity*, pp. 212–223.
40. Teterina S., Yushchenko N., Kuzmyk U. (2015), Usage of natural spicy aromatic raw material for avoiding of microbiological deterioration of dairy products, *Eastern-European Journal of Enterprise Technologies,* 4/10, pp. 45–49.
41. Pavliuk R.Yu., Poharska V.V., Radchenko L.O., Yurieva O.O., Hasanova A.E., Abramova T.S., Kolomiiets T.M. (2015), Rozrobka tekhnolohii nanoekstraktiv ta nanoporoshkiv iz prianoshchiv dlia ozdorovchykh produktiv, *Eastern-European Journal of Enterprise Technologies,* 3/10, pp. 54–59.
42. Du J., Cullen J., Buettner G. (2012), Ascorbic acid: chemistry, biology and the treatment of cancer, *Biochim Biophys Acta*, 20, pp. 443–457.
43. Hayaloglu A.A., Fox P.F. (2008), CheesesofTurkey: 3. Varietiescontainingherbs or spices, *Dairy Science* &Technology, 88(2), pp. 245–256.
44. Reyes-Jurado F., Franco-Vega A., Ramirez-Corona N., Palou E., Lopez-Malo A. (2015), Essential Oils: Antimicrobial Activities, Extraction Methods, and Their Modeling, *Food Engineering Reviews,* 7(3), pp. 275–297.
45. Hasna Bouhenni, Koula Doukani, Nazım Şekeroğlu, Sevgi Gezici, Souhila Tabak (2019), Comparative study on chemical composition and antibacterial activity of fenugreek (Trigonella Foenum graecum L.) and cumin (Cuminum cyminum L.) seeds, *Ukrainian Food Journal*, 8(4), pp. 755–767.