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Contemporary Agriculture
Vol. 65, No. 3 - 4, Pp. 51 - 56, 2016.

The Serbian Journal of Agricultural Sciences
ISSN (Online) 2466-4774 UDC: 63(497.1)(051)-"540.2"
www.contagri.info

Original scientific paper

UDC: 599.735.52
DOI: 10.1515/contagri-2016-0018

QUALITY OF HARD CHEESE MADE FROM VALUE ADED ORGANIC GOAT MILK*

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Summary: *Products with added value are all those products which, in addition to requirements set by laws of food safety and quality, meet the additional requirements. The added value of products resulting from its higher nutritional and commercial value and very often involve products originating from organic production or products with geographical indications. Consumer knowledge of production values has increased exponentially and has fuelled a demand for healthy, quality products such as goats' milk and cheeses. The single most important factor affecting cheese quality and yield is the composition of the milk, particularly the concentrations of fat and casein. Nutritional value of goat cheese derives from its energy value, content of essential fatty and amino acids, the content of vitamins, minerals and its digestibility. In this paper, organic goat milk and hard goat cheese were analyzed for fatty and amino acids profile. In addition, cheese was assayed for fat, protein, moisture, total solids, Ca, P, Mg and pH. The evaluation of the cheeses was performed to establish the relationship between quality and composition of milk and cheese. Obtained values for saturated, monounsaturated and polyunsaturated fatty acid content in cheese were on average 42.0, 54.4, and 3.60 %, respectively. Levels of glutamic, aspartic acid, lysine and leucine significantly increased in cheese comparing with milk samples. Mean values for fat in dry matter in cheese was 47.1 %, while for pH this value amounted 5:55.*

Keywords*: added value, organic milk, hard goat cheese, chemical composition*

INTRODUCTION

Each product represented on the market must own composition and the same quality that meets the requirements defined by legal and sub-legal acts. The quality of milk and its nutritional and biological value were determined by the content of nutrients. Goat milk and its products are products that have high nutritional value, good digestibility and healing properties. It contains vitamins, minerals, trace elements, enzymes, proteins and fatty acids that can be easily assimilated in the body (*Abbas et al.*, 2014). Goats' milk has long been associated with certain health benefits, particularly due to high levels of fatty acids with a short and medium chain. These fatty acids own medicinal value in many healthy disorders and diseases of humans and have unique qualities in the human diet because of their antibacterial and immunological properties (*Haenlein*, 2004). The quality of the cheese varies depending on the stage of lactation, milk composition, fatty acids profile and sensory characteristics of milk (*Soryal et al*, 2005). Organic goat milk represents a good raw material for obtaining cheeses with special features. Production of cheese of certain composition, yield and quality from a given source of goat milk is of great economic concern to producers, manufacturers and consumers. Quality and composition of raw milk are among the major factors determining yield and quality of cheese *(Fekadu et al.*, 2005).

Hard goat cheese contains 46-52% of water,42-43% protein in the dry matter, fat in dry matter 50-60% and carbohydrates 0.6% (Popović-Vranješ, 2015). Cheeses which containing generally less moisture have spicier flavor and a stronger aroma. The production of hard cheese from whole milk has a number of advantages over the production of cheeses with reduced fat content. Fat is a "tissue" of cheese, it is variable and affects the flavor of the cheese (*Popović-Vranješ et al.*, 2013)

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The taste of goat cheese also can greatly depend on the food that goats consume because goats have very strong digestive system. They are able to consume more than 90 different plant species and they prefer different and frequent change of food. Morand-Fehr (2005) reviewed the recent developments in goat nutrition and stated that the quality of the cheese flavor and the quality of the cheese coagulum tended to be reduced when the milk protein content was lower than the fat content. Balancing the fat or fiber content of the diet may increase the fat content of the milk and reduce these defects. Farming systems of small ruminants in the Mediterranean countries mainly dependent on the exploitation of pastures. The quality of the environment (unpolluted land, water and air) should be an added value and contribute to qualification agricultural products (*Ronchi and Nardone*, 2003).

There is no one method by which we could determine the quality of the cheese. In this paper attention is focused on the research quality of organic milk and cheese. The objective of this research was to study the fatty and amino acid profile of goat milk and cheese samples. Particular attention has been also given to the chemical composition of hard goat cheeses and their nutritional values.

MATERIAL AND METHODS

Samples of organic milk and cheese were taken from producers. Physical-chemical analysis of milk and cheese was done in the Laboratory for quality control of feed and animal products, Department of Animal Science, Faculty of Agriculture, Novi Sad, Serbia.

To determine fatty acids (FA) in milk and cheese, gas chromatograph (GC) with FID detectors was used, while for detection of amino acids (AA) in cheese was used HPLC method with fluorescence detection.

Chemical and compositional analyses (total solids, moisture, fat, protein, minerals, pH) of cheese samples were determined after 330 days of ripening. Total protein milk and cheese was determined by measuring total nitrogen in the cheeses using the Kjeldahl method. Dry matter was measured by drying the sample to a constant weight. Fat content was determined according to Gerber, and pH was measured with a pH meter (WTW, Type pH inoLab 720. The presence of trace elements was done by atomic absorption spectrophotometry (AAS) on the atomic absorption spectrometer (Perkin-Elmer, type PinAAcle 900T). Phosphorus was determined by spectrophotometry, spectrophotometer manufacturers PG Instruments (type T80 +), while for Ca, Na, Mg was used flame photometry (Sherwood, type M410).

Results are statistically processed using Microsoft Excel 10 and showed as arithmetic mean, standard deviation and coefficient of variation.

RESULTS AND DISCUSSION

The results have shown that the protein and fat content of the milk is undergone significant changes in relation to the original state. Proteolysis and lipolysis are two main biochemical processes that include chemical, physical and microbiological changes within controlled environmental conditions. The biggest changes during cheese ripening, however, occur on proteins and the changes in amino acids profile and their difference in relation to the milk are shown with Figure 1.

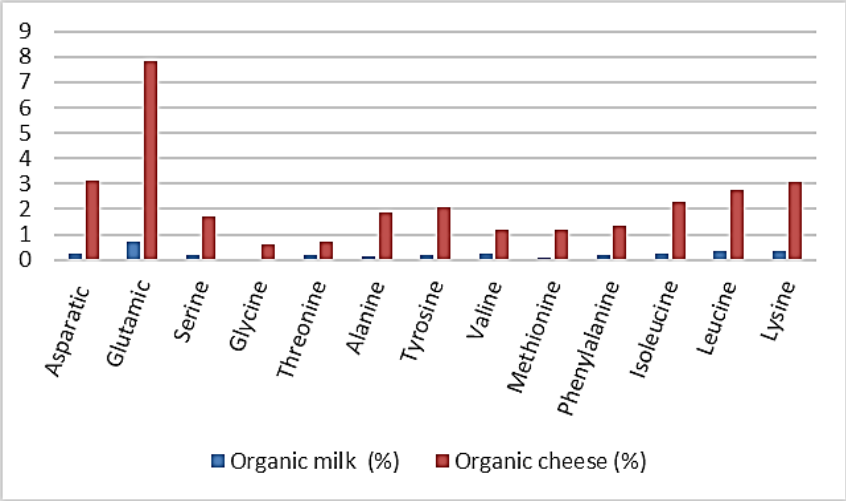

Figure 1. Amino acids profile of organic goat milk and hard cheese (arithmetic mean, n=4).

Free AA are products of proteolysis in cheese (*Fox et al*, 2000). As can be seen from the chart due to proteolysis we got significantly higher levels of amino acids in cheese. In particular, significantly increased the content of glutamic and aspartic acid, following with lysine and leucine. Current reports indicate that goat cheeses have the higher degree of protein degradation in relation to the cheese made from the cow milk and the length of maturation and temperature is significantly influenced by the indices of proteolysis and lipolysis with the goat cheese *(Park*, 2001). Regarding to, Fox et. al (2000) the cheese made of milk from goats given a diet with a supply of unsaturated fat appeared to have a slower proteolysis and thereby a later ripening. The scope and pace of degradation of proteins depend on the production technology, cheese ripening conditions, the activities of starter cultures, enzymes and no starter lactic acid bacteria (*Fox and Cogan*, 2000; *Fox et al*., 1993).

In milk and dairy products, fatty acids are included in triacylglycerol molecules. The main condition for flavor perception is the release of these fatty acids from the triacylglycerol molecule by the lipases. It can be either lipase from milk or from microorganisms. Fatty acids (C10:0, C14.0, C16:0, C18:0, C18:1) represent 75% of the total fatty acid composition in goat milk (*Park et al.*, 2007).While many papers in the literature refer to the FA compositions of goat milk, only few papers report detailed FA composition of hard goat cheese.

Regarding the Figure 2. where is represented fatty acid composition of organic goat milk and cheese it can be concluded that some fatty acid in cheese have lower content, as palmitic and linolenic. Palmitic, myristic, stearic and oleic acid were the most abundant acids in goat milk and cheese samples. In contrary, content of SSCFA (saturated short-chain fatty acids) and SMCFA (saturated medium-chain fatty acids) were higher in cheese samples.

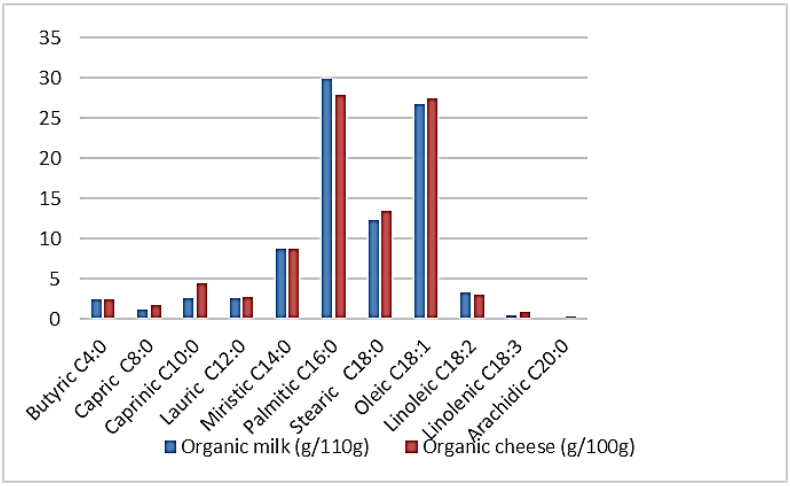

Figure 2. Fatty acid composition of milk (n=4) and cheese (n=4) (arithmetic mean).

Collins and McSweeney (2003) concluded that SCFA and MCFA can either contribute positive to the flavor of the cheese or to a rancidity defect depending on the concentration and perception threshold. Typical goat flavor is mainly linked to specific free fatty acids: caproïc (C6:0), caprylic (C8:0) and capric (C10:0) acids but the main marker is 4-ethyloctanoïc acid (4-Ethyl C8) (*Gaborit and Raynal-Ljutovac*, 2011).

Many researchers have highlighted the health benefits of some FA in goat milk, especially fatty acids with short and medium chain (*Kompan and Komprej*, (2012), *Raynal-Ljutovac et al*., (2008)).

Nutritional value of milk and cheese and fatty acid composition is represented in Table 1.

In goat cheese samples, SFA (saturated fatty acid) percentages were 42.0 and 41.8 % in milk, respectively. MUFA contents represented 54.3 and 54.4 % while levels of PUFA was higher in cheese samples (3.87 and 3.60 %, respectively). In research done by Bontinis et al. (2011) the free fatty acids increased considerably during goat cheese ripening, resulting in a predominance of long-chain acids and followed by medium-chain acids.

Table 1. Nutritional values of organic goat milk and hard cheese.

	Organic milk (n=4)			Organic cheese (n=4)		
	Arithmetic mean	SD	%	Arithmetic mean	SD	%
SSCFA	1.81	0.60	3.67	2.07	0.812	4.10
SMCFA	4.60	2.91	9.36	5.27	2.66	10.4
SLCFA	14.1	12.2	28.8	13.9	11.32	27.5
*SFA			41.8			42.0
MUFA	26.7	0.53	54.3	27.45	1.23	54.4
PUFA	1.90	1.46	3.87	1.82	1.24	3.60

n number of analyzed samples, *SD* standard deviation
SSCFA saturated short-chain fatty acids (C4:0, C8:0)
SMCFA saturated medium- chain fatty acids (C10:0, C12:0, C14:0,)
SLCFA saturated long-chain fatty acids (C16:0, C18:0, C20:0)
*SFA (sum) saturated fatty acids
MUFA monounsaturated fatty acids (C18:1)
PUFA polyunsaturated fatty acids (C18:2, C 18:3)

Technology of cheese production not only affects the overall chemical but mineral composition, too. The consumption of cheese is of great nutritional interest, due in particular to its composition of micronutrients and especially minerals (*Lucas et al.* 2008). Nega et al., (2011) concluded that calcium concentration was correlated strongly positively with cheese pH and negatively with cheese moisture and therefore calcium content configures for the most part the particular textural characteristics of each cheese category. In particular, the pH-value and content with water can serve as indicator for each type of cheese. The sourness and pH change during the process of ripening and their influence on the texture of the cheese is very important. Lawrence et al. (1987) found that starting pH was 4.70 with brittle texture of the cheese but after 30 days of ripening, when the pH of the cheese was about 6.1 the texture of the whole cheese was half soft.

Chemical composition (moisture, fat, protein and mineral contents and pH) and the descriptive statistics variables o of organic hard cheese samples are shown in Table 2.

Table 2. Descriptive statistics of chemical composition of cheese (n=4).

Variables	Range (min-max)	Arithmetic mean	SD	CV (%)
Dry matter (%)	59.4-68.6	65.1	4.05	6.22
Moisture (%)	31.4-40.6	34.9	4.05	11.6
Fat (%)	25.3-32.9	31.1	4.15	13.4
Fat in the dry matter (%) (FDA)	42.6-51.01	47.5	3.53	7.43
Proteins (%)	25.3-35.0	27.4	1.91	6.97
Ash (%)	4.78-4.91	4.84	0.06	1.24
Ca (%)	0.59-0.68	0.63	0.04	6.35
P (%)	0.56-0.60	0.58	0.01	1.72
Na (%)	0.88-0.97	0.92	0.04	4.35
Mg (mg/100g)	528.0-540.0	533.7	4.92	0.92
pH	5.20-6.05	5.55	0.36	6.49

SD – standard deviation, CV – coefficient of variation, minimal (min) and maximal (max) values of variables

Considerable variability was observed for coefficients of correlation for moisture and fat content 11.6 and 13.4%, respectively. Srbinovska et al. (2001) for Pecorino cheese made from goat milk reported pH values 5.36 (± 0.02) and levels of proteins and fat (26.44 % (±0.44) and 26.84 % (± 0.24), respectively). The content of proteins in our research was in the range from 25.3 to 35.0% and pH values varied from 5.20 to 6.05.

The results showed that the cheese making technology is reflected, not only in the gross composition, but also on the mineral content. Calcium showed larger variation relative to phosphorus (6.35 and 1.72 %, respectively), while the value of Mg and ash did not significantly deviate (0.92% and 1.24%, respectively) Bontinis et. al (2011) in forty eight cheese market samples, belonging to various cheese groups, (brined, gruyère, hard cheese, and pasta filata

types) got the results for Ca, P and Mg contents varied from 318 to 963, from 248 to 623 and from 22 to 59 mg·100 g-1, respectively.

CONCLUSIONS

Nutritional and chemical quality of food is regulated by laws and regulations and organic milk and cheese are considering as products with added values. Organic goat milk that does not contain harmful substances: pesticides, antibiotics, hormones with good fat and protein content represents a good basis for cheese. Products made from goat's milk possess exceptional nutritional value and quality, highlighting its specific taste and aroma.

This study provides an overview of the chemical composition of hard goat cheeses and the results obtained in this work showed that some nutritional values of goat dairy products are favorable in a health perspective. These results underline the important role of goat cheeses as a natural source of SSCFA and MSCFA with beneficial impact on human health. The results of goat cheese samples showed that saturated, monounsaturated and polyunsaturated fatty acid contents were on average 42.0, 54.4, and 3.60 %, respectively. The content of AA considerable increased in cheese. In particular, significantly increased the content of glutamic and aspartic acid, following with lysine and leucine. Coefficients of variation showed the highest deviation between the cheeses in terms of moisture content and fat content (11.6 and 13.4%), while the other parameters slightly varied. Results also showed that hard goat cheeses are valuable source of minerals (Ca, P, Na, Mg).

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KVALITET TVRDOG SIRA OD ORGANSKOG KOZJEG MLEKA SA DODATOM VREDNOŠĆU

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Izvod: Proizvodi sa dodatom vrednošću su svi oni proizvodi koji pored normativa utvrđenih zakonom o bezbednosti i kvalitetu hrane, ispunjavaju i neke dodatne zahteve. Dodatna vrednost proizvoda proističe iz njegove veće hranljive i komercijalne vrednosti i veoma često uključuje proizvode poreklom iz organske proizvodnje ili proizvode sa geografskim poreklom. Znanje potrošača o vrednosti proizvodnje se značajno povećalo i podstaklo njihovu tražnju u pogledu zdravih i kvalitetnih proizvoda poput kozjeg mleka i sireva. Jedan od najznačajnijih faktora koji utiču na kvalitet i prinos sira je sastav mleka, posebno koncentracija masti i kazeina. Hranljiva vrednost kozjeg sira proizilazi iz njegove energetske vrednosti, sadržaja esencijalnih masnih i amino kiselina, sadržaja vitamina, minerala i njegove svarljivosti.

U radu u organskom kozjem mleku i tvrdom kozjem siru je bio ispitivan profil amino i masnih kiselina. U dodatku, sirevi su bili analizirani na sadržaj masti, proteina, suve materije, Ca, P, Mg i pH vrednost. Evaluacija sireva je bila izvedena sa ciljem da se ustanovi povezanost kvaliteta i sastava mleka i dobijenih sireva. Rezultati uzoraka kozjeg sira su pokazali da je sadržaj zasićenih , mononezasićenih i polinezasićenih masnih kiselina u siru prosečno iznosio 42,0, 54,4 i 3,60%, pojedinačno. Sadržaj glutaminske i asparaginske kiseline, leucina i lizina se značajno povećao u siru poredeći sa mlekom. Prosečna vrednost za mast u suvoj materiji sira je iznosila 47,7% dok je prosečna pH imala vrednost od 5,55.

Ključne reči: dodata vrednost, organsko mleko, tvrdi kozji sir, hemijski sastav.

Received / Primljen: 16.10.2016.
Accepted / Prihvaćen: 29.11.2016.