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THE QUALITY INFLUENCE OF GOAT MILK AND TECHNOLOGY OF PRODUCTION ON THE CHARACTERISTIC OF THE GOAT MILK CHEESE OF THE CAMEMBERT TYPE

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The purpose of this work was to provide high quality goat milk production of a goat cheese of Camembert type. The results of the work are showing us that in row milk, the total number of bacteria was in a range from $4x10^3$ to $20x10^3$/mL, and the number of somatic cells is from $230x10^3$ to $390x10^3$/mL. Bacteria Listeria monocytogenes and Bacillus cereus were not found. Milk did not contain antibiotic residues, mycotoxins, pesticides, hard metals or radionucleoides. From the hygienic view, the milk was healthy and safe. Milk from German does i.e. the race of the studied goat had 3.2 ± 0.10% of fat and a mild taste and smell. The part of the middlechain fatty acids (C6-C12) was 15.31% and capric acid was 6.29%. Polyunsaturated fatty acids were 26.69% and linolic-acid 3.1%. According to protein content, as well as other indicators of the contents and physical-chemical characteristics, the milk was technologically suitable for cheese production. The selection of the cultures MM100 and TA052, as well as the mold Geotrichum condidum and Penicillium camemberti and the tehnologyc process with the HACCP system implemented, enabled the production of a healthy and safe cheese with the well known characteristics.

Key words: the goat milk, Camembert, technology

INTRODUCTION

In Serbia, goat breeding is in expansion and that is a sector of production which, for many reasons, has to be developed. The cheese made from goat's milk has a specific unusual taste and aroma, which it makes very respectable, modern gastronomic speciality in spite of tradition. Especially, the cheese with white noble molds of the type Camemberta, has a high rating. The German doe race of goat, which we were milking for cheese production, in the third lactation, produced 769 L milk and 24.61 kg of fat. Outside factors, especially feeding, have an influence on the quantity of milk fat and its structure (Ferh and Delage, 1973). The fat in the goat milk does not contain carotene, so the cheese has an extremely white colour. Because of smaller fat globules (Attaie *et al*., 2000), the goat's milk fat curdles well

and there are less losses of milk fat in the whey. In goat milk the connection between the fat content and the concentration of the fatty acids is established. The concentration of fatty acids is larger in the autumn than in spring (St-Gelais *et al*., 2002). The fat in goat's milk contains, more fatty acids, like caprionic, capril and capriolic, which give the specific flavour to the product (Salvadore del Prato, 2001; Popović-Vranjes *et al*., 2005). It is considered that *P. camemberti* is more suitable for the production of Camembert if under lipolys the fats released the liquid fatty acids, like caprilic, from which in further transformation we get the metil-nonil ketones. Beside this ketone in Camembert there are other ketones, like methyl-n propyl ketone (Scott, 1986). Fats have a very important role in the cheese microstructure (St-Gelais, 2002). The protein content is very important for the returns and for the quality of the cheese. Goat's milk clots faster, but the curd is softer which is connected with the smaller protein micelle and smaller particles such as casein (Alichandis and Polychroniadou, 1997). The characteristics of the milk curdle depend from the season and the breed of the goat (St-Gelais *et al*., 2002). The goat milk is rich with nonprotein nitrogen (6%) opposite to cow's milk (4%) (Božanić, 2002). For the production of Camembert, numerous procedures were developed. Also, there are some changes in the chemical regime and different "recipes" are used (Salvadori del Prato, 2001; Perko *et al*., 2002; Popovic-Vranješ *et al*., 2002). Researches are not considering enough goat's milk and Camembert cheese. The target of this paper is to produce goat's milk which is healthy, safe and has good quality and is suitable for cheese production. A further interest is in the study on the influence of the characteristics of goats' milk quality and production technology on Chamembert type goat cheese.

MATERIAL AND METHODS

Milk was taken from a well equipped farm in Indjija which has about 200 goats of the German doe race, used for milking. The control for antibiotic residues in the milk was done with Delvotests SP. Counting of somatic cells was carried out on the apparatus Coulter Counter. The research of other residua in milk was performed with the following methods: radioactive elements by gamma spectrophotometry, heavy metals by atomic absorption spectrofotometry (AAS), mycotoxins on thin layer hromography (TLC) and pesticides by liquid chromatography. The fatty acid profile was determined with the method JUS E.K8.038. and the physical-chemical components of milk by standard protocols according to Ordinance No. 32/83. In the samples of raw goat's milk and in cheese samples the presence of *Listeria monocytogenes* and *Bacillus cereus* was studied. Mycrobiotic regulative was worked according to the methods from Ordinance No. 25/80. *Listeria monocytogenes* was determined with the method ISO (11290-1:1:1996/Amd.1), and *Bacillus cereus* according to IDF 181:1998. The process of cheese making is shown on Figure 1. which includes also the control points (CP).

The production of cheese according to French technology (Veisseyre, 1975) is adapted to conditions in the industrial diary production Selekt Milk from

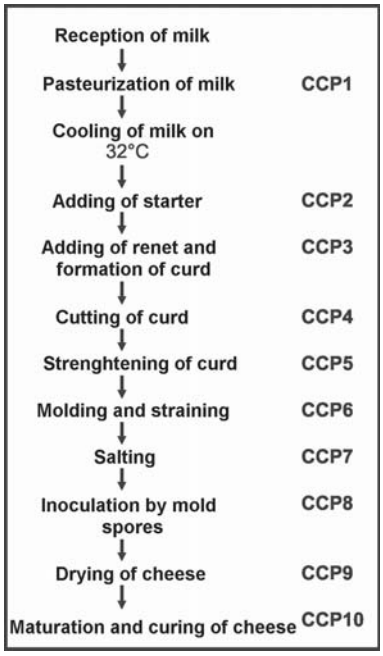

Figure 1. Diagram of the course of production cheese (Kosikowski *et al*, 1997., modif.)

Indjija. It was done in 12 production phases with the application of HACCP system (Hazard Analysis and Critical Control Points) in 2007.

After the pasteurisation process (72°C/15"), the milk was cooled at 32°C. Calcium chloride was added (0.04%) and after steering, starter cultures: TA052 (*Streptococcus thermophilius*, 0.5 gr/100L and MM100 (*Lactococcus lactis ssp. lactis*, *lactococcus lactis ssp. Cremoris*, *Lactoccoccus lactis ssp. Lactis biovar diacetyllactis*, 4gr/100L). After sour fermentation molds (*Geotrichum candidum* 0.11 gr/100L and *Penicillium candidum* 0.17 gr/100) and rennet (1.6 gr/100) were added.

The cultures and molds are produced by Texel, Rhodia Food, France and the rennet by Caglio Clerici, Italy. The coagulation of milk was performed for about 1 hour. The formed curdle was cut with knifes (2 cm spaced) and steered. Afterward the curdle was put into molds and was strained for the next 15-18 hours. When the cheese was ripe enough, it was turned every 12 hours on room temperature from 18-20°C. After finishing the process of straining, the cheese was put into brine with 18-20% of salt (from 125 up to 150 g of cheese stays into the brine from 50 up to 80 min.). After salting, the cheese was dried for two days at 18°C (RV 70-80%). Inoculation of the cheese with the mold *Penicillium candidum* was done in a water suspension, and after that the cheese was dried for two days and than put into chambers to ripen 10-12 days at 12-13°C at RV of 90-95%. After maturation, the cheese was packed and the cheese was tested after production (2-3 days), and then after 15, 30 and 45 days of maturation. The cheese becomes mature usually after 21-35 days. The statistical research was done according to Zizic *et al*. (2006).

RESULTS AND DISCUSSION

It is well known that from unhygienic goat milk we can not get good cheese, that is why on farms is necessary to have hygienic conditions which provide safe and good quality milk. This attitude resulted in UBB (the total number of bacteria) being 4-20 x 10^3/mL and the number of somatic cells from 230x10^3- 390x10^3, which is under the demands 92/46/EEC (Table 1).

Table 1. Total number of bacteria and somatic cells in raw goat's milk

Statistical parameters	UBB*/mL in raw milk	Number of somatic cells/mL
N	12	12
X*	1.2×10^3	297×10^3
Xmin.	4×10^3	230×10^3
Xmax.	20×10^3	390×10^3

*UBB – Number of somatic cells; X – mean value; N – number of samples

Pathogenic microorganisms are not found according to the Ordinance No. 26/93, as well as the pathogenic *Listeria mnocytogenes* and *Bacillus cereus*. The chemical contents of milk (°SH) and pH values are shown in Table 2.

Table 2. Chemical composition, acidity and pH value

Portion (%)	X ± s.d*	CV (%)
Milk fat	3.20 ± 0.10	7.79
Dry matter	11.27 ± 0.47	4.13
Dry matter without fat	8.07 ± 0.28	3.45
Proteins	2.99 ± 0.17	5.73
Casein	2.36 ± 0.11	8.55
Lactose	4.31 ± 0.20	6.02
Mineral matters	0.77 ± 0.053	6.94
Acidity, °SH	7.12 ± 0.61	7.58
pH value	6.57 ± 0.07	1.13

*X – mean value; s.d – standard deviation; CV (%) – coefficient of variation

The sampled milk did not contain residues of antibiotics, mycroxine, pesticide, heavy metals and radionuclides. The composition of the milk samples is in accordance with the results obtained by St-Gelais *et al.* (2002), where in the milk of the doe race, lower contents of protein, fats and lactose were found.

The relation of fat / casein was 1:0.737, and such milk is chemically suitable for cheese production (Scott, 1986). The souring of raw milk was in agreement to Ordinance No. 26/2002. and was in the range from 6.5 - 7.2 °SH, and pH value form 6.40 to 6.59. The contents of middle chain meat fatty acids was 15.31%, which is much more from the quantity which is in cow's milk, and less than the quantity mentioned by Souci *et al.* (2000) and Bozanic (2002) in goat's milk. This is probably due to the influence of breed and feeding of goats during the study. The long chain fatty acids in goat's milk were present in 73.17%, which is lower than cow's milk. The part of saturated fatty acids was 65.02% and half saturated 26.69%. Among half saturated fatty acids in the goat milk samples was linol acid

(3.1%). According to the results of Jahreis *et al.* (1999) the contents of linol acid depend of the season being the lowest in the winter months. Goat's milk has the lowest contents of conjugated linol acid compared with other ruminants. Only human milk has an even lower value of this acid (Souci *et al.,* 2000). In global, the presence of the fatty acidy is shown in Figure 2.

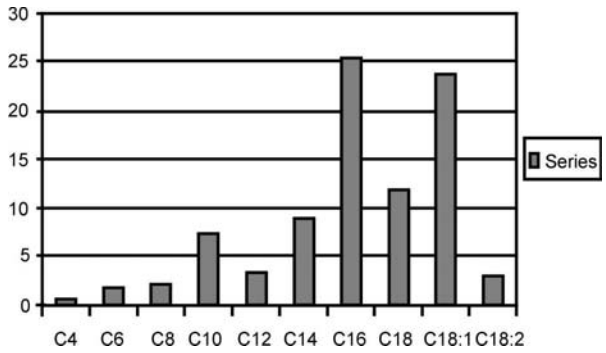

Figure 2. Presence of fatty acids in goat's milk

After the biological maturation of milk (pH 6.38-6.55, and sourness 7.4 to 7.6°SH) rennet was added and after finishing coagulation, the curdle was cut. The curdle was cut in uniform parts and appropriate sizes, which provides easy separation of the whey. In the moment of curdle transport into molds for filtration, the pH of the whey was 6.26-6.53 and the sournes 5.4-6.0°SH. In Cambembert cheese technology, the separation of the curdle grain from the whey starts immediately after curdle formination and practically it ends by placing it into the chambers in order to ripen. This phase is very important and basic for the success of production of high cheese quality (Ghitti, 1990), pH of cheese before salting was in the interval 4.9-5.1, and sourness 56.00-60.00°SH.

Implementation of the HACCP system in cheese production is important because it assures a healthy and safe production (Popovic-Vranjes *et al*., 2005). Because it is an unstable product (Fox, 1993), critical control points of production were clearly determined thus eliminating hazards.

There were some technical problems during the distribution of the whey into the molds, which affected the dispersion of the weight (Figure 3). In modern continual lines the distribution of the whey is uniform.

Figure 3 shows the changes during the process of ripening, which always happens gradually. After 6-7 days of maturation, progressive souring occours and developed of P. camemberti starts, and soon it covers the whole surface. The texture changes rapidly in the first 12 days of maturation, after which the cheese can be packed.

The development of the mold urges the neutralisation of the dough which becomes soft, especially under the core. Due to proteolyses the dough becomes

soft after 30 days and thereof creamy when the maturation comes to the "heart" of the cheese. As the ripeness advanced the texture of the cheese is at first elastic and then like creamy (after 35 days) and sometimes almost half liquid (45 days). The cheese becomes mature usually after 20-35 days.

Figure 3. Changes of apperance and texture of cheese during maturation

From the results in the Table 3, it can be seen that based on the contents of fat, dry matter and moisture, the produced cheese, according to Ordinance No. 26/2002 belongs to a group of soft (61-69% of moisture in the material without fat) and half fat cheeses (45-50% fats in the dry material), and in ripeness up to 30 days. The changes which appeared in the next period of maturation (45 days), can be controlled by packaging the cheese on time and keeping it at lower temperatures (1^{o}C).

The presence of water after the maturation of 12 days was 70.87±1.20%, and after 30 days 67.71±0.26%, which is in accordance to the biological characteristics of soft cheese. A further decrease of water content during maturtion (after 45 days 61.57±2.52%) can be stopped by the packing the cheese on time. The moulds are showed like very halotolerant, because the presence of salt in the cheese was from 2.14±0.21% up to 2.4±0.42% and it stimulated their development which resulted with the fine cheesy taste. Biochemical changes during the process of ripening are shown in Table 4.

The sourness and pH change during the process of ripening and their influence on the texture of the cheese is very important. The starting pH of the cheese was 4.7±0.17 and the texture of the cheese was brittle. After some 30 days, when the pH of the environment was about 6.10±0.17 the texture of the whole cheese was half soft. The activity of the plasmas is growing with rising of the pH, especially at the cheese surface (Lawrance *et al*., 1987). During ripening it starts to increase the dissolved nitrogen to an average value from 0.35±0.21 to 0.94±0.20%

and connected with that is the coefficient of ripeness 27.31±2.20% after the 30 days. After 45 days intensive proteolyses of the protein starts (69.15±3.35% the coefficient of ripeness) and little native protein is left. During ripening the yeasts rapidly ferment the lactose and after 30 days of ripening, its quantity was reduced for more than 50% from the starting value. In the sensory view, the cheese has the appropriate characteristics for this kind of cheese. The return of the cheese was around 13.95% (7.17 L milk/kg cheese) which is in accordance with results of Tonkovic *et al.* (2003). The distribution and selling of cheese in the type of Camembert has to be on 2-4°C. In the microbiological view the tested cheese was microbiologically correct according to the Ordinance No. 26/93 and there were no *Listeria monocytogenes* and *Bacillus cereus* present.

Table 3. Chemical changes of cheese during maturation

N = 12	2 days	12 days	30 days	45 days
Percentage (%)	X ± s.d*	X ± s.d	X ± s.d	X ± s.d
Milk fat	18.03 ± 1.25	20.33 ± 3.33	23.83 ± 2.89	28.17 ± 2.36
Dry matter	39.03 ± 2.47	43.51 ± 2.81	48.00 ± 1.84	55.70 ± 4.75
Fat in dry matter	43.98 ± 1.76	46.54 ± 1.06	47.7 ± 1.12	50.57 ± 0.15
Moisture in dry matter without fat	74.63 ± 2.73	70.87 ± 1.20	67.71 ± 0.26	61.57 ± 2.52
Mineral matters	3.83 ± 1.24	3.95 ± 1.33	4.22 ± 1.91	4.46 ± 1.73
Kitchen salt	2.14 ± 0.21	2.20 ± 0.25	2.25 ± 0.38	2.40 ± 0.42

* X – mean value; s.d – standard deviation

Table 4. Biochemical changes of cheese during maturation

N=12	2 days	12 days	30 days	45 days
Percentage (%)	X±s.d*	X±s.d	X±s.d	X±s.d
Acidity°SH	77 ± 7.79	52.27 ± 13.61	40.2 ± 13.22	46.4 ± 14.99
pH value	4.78 ± 0.17	5.59 ± 0.43	6.10 ± 0.17	6.56 ± 0.03
Proteins	16.98 ± 1.75	19.36 ± 1.37	21.91 ± 0.52	23.72 ± 1.55
Total N	2.66 ± 0.27	3.03 ± 0.22	3.43 ± 0.08	3.72 ± 0.24
Soluble N	0.35 ± 0.21	0.70 ± 0.02	0.94 ± 0.20	2.57 ± 0.16
Lactose	1.02 ± 0.13	0.78 ± 0.69	0.44 ± 0.70	0.18 ± 0.11
Coefficient of maturity	10.86 ± 4.45	23.49 ± 0.16	27.31 ± 2.20	69.15 ± 3.35

* X – mean value; s.d – standard deviation

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UTICAJ KVALITETA KOZJEG MLEKA I TEHNOLOGIJE IZRADE NA OSOBINE KOZJEG SIRA U TIPU CAMEMBERT-a

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SADRŽAJ

Svrha rada je bila da se obezbedi kvalitetno kozje mleko i proizvede kozji sir u tipu Cammembert-a. Rezultati rada pokazuju da je kod sirovog mleka ukupan broj bakterija bio od 4 x 10^3 do 20 x10^3 / ml, a broj somatskih ćelija od 230x10^3 do 390x10^3/ml. Nisu nađene bakterije *Listeria monocytogenes i Bacillus cereus*. Mleko nije sadržavalo rezidue antibiotika, mikotoksina, pesticida, teških metala i radionuklida. U higijenskom pogledu mleko je bilo bezbedno. Mleko nemačke srnaste rase koza (stajski načina držanja) je imalo 3,2 ± 0,10% mlečne masti i blag ukus i miris po kozjem. Udeo srednjolančanih masnih kiselina (C_6-C_{12}) je bio 15,31 %, a kaprične kiseline 6,29 %. Polinezasićenih masnih kiselina je bilo 26,69 % u okviru kojih je bilo linolne kiseline 3,1 %. Na osnovu sadržaja proteina kao i ostalih pokazatelja sastava i fizičko-hemijskih osobina, mleko je tehnološki bilo pogodno za sir. Izbor starter kultura MM100 i TA052 kao i plesni *Geotrichum candidum* i *Penicillium camemberti* i provedenog tehnološka procesa uz implementaciju HACCP sistema, omogućuli su dobijanje bezbednog sira, karakterističnih osobina.