

**SENSORY EVALUATION AND MICROBIOLOGICAL CHARACTERIZATION OF  
AUTOCHTHONOUS SOMBOR CHEESE**

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*In this paper the results of organoleptic evaluation, chemical and microbiological analysis of Sombor cheese were presented. Sombor cheese is a type of autochthonous cheese whose traditional processing method is still in use in areas of northern part of Serbia. The sensory profile, chemical and microbiological analysis were performed on 19 samples of traditionally made cheeses collected from two households. The sensory evaluation of cheese samples showed its variation in taste and consistency, as well as an unstable cheese flavour. Generally, the traditionally made Sombor cheese in wood modules received a higher score than the cheese produced in the cylindrical form. According to the fat content in dry matter Sombor cheese can be classified as a fat cheese and depending of water content in non fat cheese matter, Sombor cheese belongs to the group of soft cheeses. Fat in dry matter and content of total nitrogen showed great variations which indicate the unevenness in technology and inconsistent quality of the raw substrate. Results of microbiological examination showed that lactic acid bacteria were the most abundant flora during manufacturing and early ripening of this cheese. Among them, Lactococci, Lactobacilli and Enterococci represented the main microbial groups of lactic microflora.*

*Key words: Sombor cheese, sensory evaluation, chemical analysis, microbiological investigation*

INTRODUCTION

There is a growing interest in traditional dairy products, especially cheeses, manufactured at the farm level due in part to the uniqueness of such food and the difficulties in mimicking them on an industrial scale. In a global market, these traditionally produced cheeses are now highly appreciated and are considered to be of premium value because of their flavor characteristics, which are not found in varieties of cheese produced industrially (Garabal, 2007). In Europe, such products are elaborated according to well-established rules governing the production of registered designations of origin. In Serbia, Sombor cheese is one such product. Sombor cheese is a soft cheese traditionally produced from raw

sheep milk in the northern part of Serbia; it is highly appreciated for its unique flavour and shape. The appearance and taste of cheese loosely reminds of those of famous cheeses like Trappist and Port de Salut. Historical data showed that earliest record of Sombor cheese dating back to 1748, describing its position on the local market of Novi Sad (Antić, 1969). According to Antić (1969) Sombor cheese was made from ewes' milk obtained from both evening and morning milkings. After mixing the sour evening milk with fresh raw milk, the milk was renneted with powdered rennet, and coagulation took place in 30 minutes. Curd was cut in thick slices and left in brine for 2-3 hours and then transferred into vats with perforated inner walls and bottom and was pressed by a weight equal to that of the curd. Cheese was thereafter transferred to a storage room (15°C-17°C) to complete ripening up to the age of 1 month. Very few studies have been conducted on Sombor cheese. The influence of various technological parameters on cheese ripening process was studied by many authors (Petrović and Mišić, 1974; Petrović, 1986). The studies regarding microbiological examination was not undertaken. So, now there is a need for a complete characterization of Sombor cheese based on microbiological, physicochemical and biochemical aspects which may permit a comparison with some other soft cheeses.

The traditional cheese-making technique utilized has almost remained unchanged over the years in line with local practice. Nowadays, traditional cheese-making of Sombor cheese still remains at few local farms near Sombor and is being sold at the local market in the cylindrical form so called "sheit", or in the wooden module called "kačica". It is well documented (Buchin *et al.*, 1998) that cheeses manufactured from raw milk acquire a more intense flavor than those produced from pasteurized or heat-treated milk; such realization is mainly due to the high levels of native lactic acid bacteria present in raw milk (Grappin and Beuvier, 1997). As a consequence, variability is a major drawback in cheeses manufactured from raw milk which is accounted for, among other causes such as seasonal variations in their indigenous microflora. The aroma/flavour and textural characteristics of cheese depend heavily on the method of production, type of milk and metabolic activities of selected starter organisms, and also diversity of species and strains of local and specific indigenous milk microflora.

Cheese is a dynamic biochemical product and, unlike many processed food products for which stability is essential, it undergoes significant changes during the ripening process. Acidifying *Lactococci* usually occur as dominant bacteria early in the ripening process. Afterwards their numbers decrease as they give way to *Lactobacilli*, which, due to their higher versatility for fermentation, can survive in the cheese at stages when concentration of major carbohydrates and free water decrease. Apart from the above-mentioned major genera of lactic acid bacteria, other bacteria, including non-starter lactic acid bacteria like *Enterococci* and non-lactic acid bacteria like *Staphylococci*, *Micrococci* and propionic acid bacteria which develop as secondary microbiota, are often responsible for the cheese biochemistry. They play a crucial role in the microbial balance in this special living ecosystem (Garabal, 2007).

The aim of the present study was therefore to determine the organoleptic, physicochemical properties of Sombor cheese, an artisanal cheese with

traditional farmhouse cheese-making technology. The main groups of lactic acid bacteria were also investigated. The quality and overall sensory profile of cheese were estimated in dependency on its characteristic shape and storage period.

#### MATERIALS AND METHODS

Sensory evaluation, chemical and microbiological analysis were performed on 19 samples of cheese produced in a traditional way in two households (10 samples in the form of "kacica" and 9 samples represented in the cylindrical form). The cheeses were analyzed after a ripening period of 10 days. Organoleptic properties and chemical parameters were also determined after a storage period of 30 days at  $6^{\circ}\text{C} \pm 1^{\circ}\text{C}$  in order to estimate the durability of final product.

The quality of investigated cheese samples were established on the basis of physicochemical parameters: dry matter (DM), fat in dry matter (FDM), moisture in nonfat substance (MNFS), pH values and titrable acidity.

Dry matter (DM) content in cheese was determined by heating at  $105^{\circ}\text{C}$  until constant weight (Harrigan and McCance, 1976). Fat in cheese (F) was determined by Gerber method using a butyrometer with a calibrated range from 0 to 40%. Fat in dry matter (FDM) was calculated as follows:

$$\text{FDM}\% = \text{F}\% \times 100/\text{DM}.$$

Total nitrogen (TN) and water soluble nitrogen (WSN), were determined using the Kjeldahl method. The proteolytic index was expressed as the WSN% of TN.

A trained panel of 6 panellists was used to evaluate the sensory attributes of the cheese. All panellists were experienced in sensory evaluation of cheese texture. The applied panel rated the aroma, colour, taste, texture and overall acceptability of investigated cheese samples by using a 0 to 5 scale. Each of the investigated sensory attributes were scored from 1 to 5 (1:the worst, 5:the best). Final score was calculated by multiplying with coefficient of significance which represent contribution of individual parameters in the maximum sensory profile (aroma 10% of maximum sensory profile, colour 5%, taste 50%, texture 20% and overall acceptability 15% of maximum sensory profile).

For microbiological analysis, cheese samples (20 g) were diluted in 180 mL 2% sodium citrate solution and homogenized in a stomacher (Bag Mixer, Interscience). Serial dilutions were made in quarter strength Ringer's solution and plated on specific media for viable counts: thermophilic *Lactobacilli* on MRS Agar (Merck) at  $42^{\circ}\text{C}$  for 48h, mesophilic *Lactococci* on M17 Agar (Merck) at  $30^{\circ}\text{C}$  for 48h; *Enterococci* on kanamycin aesculin azide agar (Oxoid) at  $37^{\circ}\text{C}$  for 24h.

#### RESULTS

The sensory evaluation of traditionally made Sombor cheese was as follows (Table 1).

Table 1. Sensory evaluation of traditionally made Sombor cheese after ripening period and after storage period of 30 days at  $6^{\circ}\text{C}\pm 1^{\circ}\text{C}$

Sombor cheese	Sensory evaluation			
	n	$X\pm SD$	Max	Min
"Kacica"	10	$91.07\pm 5.57$	100	77
Cylindric form	9	$78.48\pm 12.69$	95	53
After storage period of 30 days at $6^{\circ}\text{C}\pm 1^{\circ}\text{C}$	5	$91.61\pm 5.18$	98.5	81

The best scores in the overall sensorial profile were awarded to traditionally manufactured cheeses produced in wood modules ("kacica") which were assigned as 91.07% of maximum sensory quality. According to the results of sensory evaluation, the cheeses in the cylindric form received inferior scores for overall sensory profile and were assigned as 78.48% of maximum sensory quality. The favourable scores (91.61% of maximum sensory quality) in overall sensory profile were assigned to cheeses evaluated after storage period of 30 days at  $6^{\circ}\text{C}\pm 1^{\circ}\text{C}$ .

The contribution of each of the quality parameters in overall sensorial quality of cheese were as follows (Table 2, Table 3)

Table 2. Contribution of individual quality parameters in overall sensorial quality of traditionally made Sombor cheese in the form of "kacica"

Quality parameters	Sensory evaluation			
	n	$X\pm s$	max	min
Aroma	10	$9.07\pm 1.18$	10	7
Colour	10	$4.96\pm 0.19$	5	4
Taste	10	$43.39\pm 4.31$	50	30
Texture	10	$18.48\pm 2.29$	20	12
Overall acceptability	10	$14.78\pm 0.53$	15	13.5

The taste as the most important quality parameter received favorable scores and showed significant deviation comparing the samples of traditionally made Sombor cheese in the form of "kacica".

Table 3. Contribution of individual quality parameters in overall sensorial quality of traditionally made Sombor cheese in cylindric form

Quality parameters	Sensory evaluation			
	n	$X\pm SD$	Max	Min
Aroma	9	$7.44\pm 2.26$	10	3
Colour	9	$4.92\pm 0.26$	5	4
Taste	9	$34.81\pm 8.71$	45	20
Texture	9	$17.04\pm 2.32$	20	12
Overall acceptability	9	$14.28\pm 1.85$	15	12

Autochthonous Sombor cheese produced in cylindrical forms showed significant deviations in taste with high variations, and also significant deviations in cheese aroma. In this case, the unsatisfactory scores for aroma and taste resulted in an overall unfavourable sensory profile.

At the end of storage period of 30 days at 6°C the cheeses were tasted for acceptability. The contribution of individual sensorial parameters in the overall sensory profile of investigated cheese samples after a storage period of 30 days at 6°C was presented in Table 4.

Table 4. The contribution of individual sensorial parameters in overall sensory profile of traditionally made Sombor cheese kept at 6°C for 30 days

Quality parameters	Sensory evaluation			
	n	X±SD	Max	Min
Aroma	5	8.43±0.94	10	7
Colour	5	4.50±0.48	5	3.5
Taste	5	45.00±4.38	50	35
Texture	5	19.86±0.53	20	18
Overall acceptability	5	14.82±1.20	15	12

According to the obtained results it was concluded that during the above mentioned storage period the cheese samples received a more consistent taste, and spreadable texture which represented the characteristic attributes of Sombor cheese. The tested cheese samples received a favourable score for taste.

Sombor cheese is still produced on a small, farmhouse style production level. For the purpose of quality testing based on chemical composition two households were selected characterized by traditional cheese making procedures. The chemical composition of Sombor cheese in wood modules is shown in Table 5.

Table 5. The chemical composition of Sombor cheese ("kacica")

Chemical parameters	Chemical composition			
	n	X±SD	max	min
Water	10	55.78±2.78	58.96	50.21
Total solids	10	44.22±2.78	49.79	41.04
Fat in dry matter	10	52.40±4.36	59.35	45.26
Total nitrogen	10	17.16±2.39	22.67	14.50
Water soluble nitrogens	10	1.98±0.87	3.73	0.88
Moisture in nonfat substance	10	72.63±2.53	77.25	68.31

According to the fat content in dry matter Sombor cheese can be classified as fat cheese and depending on water content in non fat cheese matter Sombor cheese belongs to the group of soft cheeses. Total nitrogen and water soluble nitrogen showed significant deviations from mean values probably as the result of

mixing sheep's and cows' milk. The significant deviations in the content of water soluble nitrogen indicates the different ripening period.

The quality of Sombor cheese in the cylindrical form based on chemical composition is shown in Table 6.

Table 6. Chemical composition of Sombor cheese in the cylindrical form

Chemical parameters	Chemical composition			
	n	X±SD	Max	Min
Water	9	59.94±2.78	63.99	55.43
Total solids	9	40.06±2.77	44.57	36.01
Fat in dry matter	9	44.50±4.73	51.18	37.49
Total nitrogen	9	17.52±1.18	19.91	16.17
Water soluble nitrogens	9	1.76±0.40	2.2	1.02
Moisture in nonfat substance	9	72.99±2.04	75.94	70.16

Sombor cheese in the cylindrical form was characterized by lower values for fat, proteins and water soluble nitrogen in comparison to Sombor cheese in the form of "kacica". The obtained values for moisture in nonfat substance indicates that Sombor cheese is a soft cheese.

The quality of Sombor cheeses after a storage period of 30 days at 6°C/1°C is presented in Table 7.

Table 7. The chemical composition of traditionally made Sombor cheese after a storage period of 30 days at 6°C±1°C

Chemical parameters	Chemical composition			
	n	X±SD	Max	Min
Water	5	55.82±6.58	59.56	43.70
Total solids	5	44.88±6.58	56.30	40.44
Fat in dry matter	5	51.96±3.42	55.95	47.08
Total nitrogen	5	17.00±1.64	19.56	15.56
Water soluble nitrogen	5	2.63±0.42	3.07	2.13
Moisture in nonfat substance	5	72.15±5.36	76.65	63.80

The investigated 5 samples of Sombor cheeses after a storage period of 30 days at 6°C±1°C were characterized by significant variations in water soluble nitrogen content which indicates the long-term duration of ripening through the storage period.

Proteolysis during cheese ripening has the important role in forming texture, body and flavours in all mature cheeses. The specificity of cheese making has a major impact on intensity of protein degradation, so it was very interesting to determine the proteolytic index of analyzed cheeses in order to evaluate intensity of proteolysis. The proteolytic index of Sombor cheese in cylindrical form and cheese samples in wood modules ("kacica") are presented in Table 8 and 9.

Table 8. The proteolytic index of Sombor cheese in cylindrical form

Statistical parameters	Sombor cheese - cylindrical form
X±SD	10.03±2.02
Max	12.55
Min	6.01

Table 9. The proteolytic index of Sombor cheese in the form of "kacica"

Statistical parameters	Sombor cheese - "kacica"
X±SD	11.72
Max	20.07
Min	3.8

The proteolytic index of analyzed cheese samples showed marked variations which indicate the different ripening periods of investigated cheeses.

Sombor cheese is made from raw sheep milk, without addition of starter cultures, using artisanal procedures through relying on colonization by microbial populations associated with the raw material, equipment and local environment. The knowledge of the microbial diversity of this traditional product is in turn fundamental for the attainment of its unique sensory properties. The prevalence of main microbial groups of lactic acid bacteria in investigated cheese samples is presented in Table 10 and 11.

Table 10. Mean counts (log cfu/g ± standard deviation) of presumptive *Lactococci*, *Lactobacilli* and *Enterococci* in cheeses produced in wooden modules

Statistical parameters	log cfu/g		
	<i>Lactococcus</i> spp.	<i>Lactobacillus</i> spp.	<i>Enterococcus</i> spp.
n	9	9	9
X±s	7.74±0.63	7.23±0.45	5.34±0.79
max	8.32	7.96	6.45
min	6.18	6.72	4.21

Table 11. Mean counts (log cfu/g ± standard deviation) of presumptive *Lactococci*, *Lactobacilli* and *Enterococci* in cheeses produced in cylindrical forms

Statistical parameters	log cfu/g		
	<i>Lactococcus</i> spp.	<i>Lactobacillus</i> spp.	<i>Enterococcus</i> spp.
n	10	10	10
X±s	8.36±0.90	6.91±1.43	6.38±0.85
max	9.45	4.0	8.10
min	7.93	6.72	5.10

According to results, lactococci and lactobacilli represented the dominant group of lactic acid bacteria, followed by *Enterococci*. The *Lactococcus* spp. reached level of  $10^7$ - $10^8$  cfu/g, and the microbial counts for presumptive lactobacilli and enterococci attained  $10^6$ - $10^7$  cfu/g and  $10^5$ - $10^6$  cfu/g, respectively.

#### DISCUSSION

Sensory quality of cheese is important in determining consumer acceptability. By sensory evaluation, the traditionally made Sombor cheese in the form of "kacica" received higher score than the cheese produced in cylindrical forms.

The currently valid regulation define the requirements for the quality of milk and milk products. According to this, the moisture content in non fat substance of Sombor cheese must not be lower than 67%. The fat percentage in dry matter must be 45% for whole fat cheeses. Briefly, the chemical characteristics of Sombor cheese analyzed in this study met the necessary legal requirements. According to Licitra *et al.* (2000) cheese composition variation is large due to salt and moisture gradients developed during the ripening period. In our study, marked variations in chemical composition of Sombor cheese were noticed in fat in dry matter and content in total nitrogen which indicated the unevenness in technology and inconsistent quality of raw substrate. Similarly to our results, Vujčić (1964) pointed out the variable chemical composition of Sombor cheese.

Sombor cheese can be aged up to 1 month, however, it is common to sell the cheese at different ripening period as semi-aged or as an aged cheese. Petrović *et al.* (1988) investigated the dynamics of total and soluble nitrogen and of individual free aminoacids in order to obtain ripening characteristics of this cheese. As a result of intensive proteolysis, the content of water soluble nitrogen showed typical increase with intensive progress during the first 10 days of ripening and slowly diminish in the later phases of cheese ripening. The data obtained from previous studies show that Sombor cheese achieved the commercial ripeness at the age of 20 to 30 days with the ripening coefficient of 23.66 to 24.76. Cheeses analyzed in our study represented a wide range of ages and different production facilities so a variation in proteolytic indices would be expected. According to our results, the marked variation in the ripening coefficient (proteolytic index) (3.8-20.07) were mainly due to different ripening periods of the analyzed cheese.

From the microbiological point of view, artisanal cheeses can be considered to be unique ecosystems in terms of considerable variety of lactic acid bacteria types that they contain (Garabal, 2007). In fact, the micro-ecological system prevailing under these conditions differs notably from those in standard cheeses that are produced from pasteurized milk with the addition of well-defined commercial starters (Tavaria and Malcata, 2000). Significant differences in the viable counts of *Lactococci*, *Lactobacilli* and *Enterococci* prone to a wide variability which reflects the intrinsic heterogeneity associated with production and handling. In other studies on raw milk cheeses, the predominance of *Lactococci* during the early stages of ripening has also been reported (Nunez,



1978; Litopoulou-Tzanetaki and Tzanetakis, 1992; Centeno *et al.*, 1996). A common feature of Sombor cheeses was a rather high number (6.91 - 7.23 log cfu/g) of mesophilic lactobacilli. Mesophilic homofermentative lactobacilli are the principal non-starter lactic acid bacteria (NSLAB) found in many varieties, especially artisanal cheeses. They are the only microbial group which grows well in the hostile environment in the interior of the cheese which has a low pH (5.0), a high salt content (4-6%), is anaerobic and may contain bacteriocins produced by starter bacteria (Fox, McSweeney and Lynch, 1998). The presence of *Enterococci* in relative high numbers in analyzed cheese samples could be due to their tolerance to a wide range of environmental conditions (Mundt, 1986; Garg and Mital, 1992). Enterococci is a group of microorganisms that may influence the ripening process due to their proteolytic and lipolytic activities, and their ability to stimulate acid production by some lactococci (Sarantinopoulos *et al.*, 2001). Similar levels of enterococci have also been reported for white-brined cheeses (Litopoulou-Tzanetaki and Tzanetakis, 1992) and other cheese varieties such as semicotto caprino, an artisanal goat's cheese (Suzzi *et al.*, 2000).

On the basis of our results it was generally concluded that there is an urgent need for standardization of manufacturing processes of Sombor cheese as the main imperative of producing the Sombor cheese of good and consistent quality. In the light of microbiological results it is obvious that the *Lactococci*, *Lactobacilli* and *Enterococci* are well adapted to Sombor cheese environment and can contribute to the physicochemical and sensory characteristics of Sombor cheese.

#### CONCLUSION

1. Sombor cheese in the form of "kacica" received a favourable score of  $91.07 \pm 5.57\%$  of maximum sensory quality, while Sombor cheese in the form of cylindrical baskets received the score of  $78.48 \pm 12.69$  of maximum sensory quality.

2. Average value of taste acceptability was higher for Sombor cheese in the form of "kacica".

3. According to the fat content in dry matter Sombor cheese can be classified as fat cheese and depending of water content in non fat cheese matter Sombor cheese belongs to the group of soft cheeses.

4. Fat in dry matter and content of total nitrogen showed great variations which indicate the unevenness in technology and inconsistent quality of the raw substrate.

5. Variations in proteolytic index between analyzed cheese samples represented the different ages of cheeses.

6. The main microbial groups of lactic microflora were *Lactococci*, *Lactobacilli* and *Enterococci*.

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## SENZORNA ANALIZA I MIKROBIOLOŠKA KARAKTERIZACIJA AUTOHTONOG SOMBORSKOG SIRA

MIJAČEVIĆ ZORA i BULAJIĆ SNEŽANA

### SADRŽAJ

U radu su prikazani rezultati senzorne, hemijske i mikrobiološke analize Somborskog sira. Somborski sir je tip autohtonog sira čija tradicionalna proizvodnja opstaje u severnim delovima Srbije, u okolini Sombora. Procena organoleptičkih karakteristika, hemijska i mikrobiološka analiza je izvedena na 19 uzoraka sira proizvedenih u dva domaćinstva na tradicionalan način, od čega 10 uzoraka sira u obliku kačica sa pečurkom, a 9 u obliku spljoštenog cilindra. Na osnovu rezultata senzorne analize, tradicionalno proizvedeni Somborski sir u formi kačice je bolje ocenjen u odnosu na sir u obliku spljoštenog cilindra ("scheit"). Prema sadržaju masti u suvoj materiji, Somborski sir se klasifikuje u grupu masnih sireva, a na osnovu sadržaja vode u ostatku bez masti sir pripada grupi mekih sireva. Količina masti u suvoj materiji i sadržaj belančevina u analiziranim uzorcima sira pokazuju velike intervale varijacije što ukazuje na neujednačenost procesa proizvodnje ali i neujednačen sastav sirovine. Rezultati mikrobiološke analize pokazuju da laktokoke, laktobacili i enterokoke predstavljaju dominantne grupe bakterija mleka.