

TECHNOLOGY AND CHEMICAL COMPOSITION OF BEATEN CHEESE IN REPUBLIC OF MACEDONIA**

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Abstract: Beaten cheese is autochthonous product of our country whose production started long time ago. In the past it was produced only in the region Mariovo where it was made from pure sheep milk, but today it is produced in other regions of the country and from mix of sheep and cow milk and mix from sheep and goat milk.

In the most parts of the country beaten cheese is manufactured in industrial conditions, but in some places it is still made at home.

According to our research using two different types of rennet, Chy-max (genetic rennet) and Stabbo (combined rennet) we developed technology for production of two variants of beaten cheese by industrial way.

Chemical composition of beaten cheese produced by genetic rennet on 45th day of the ripening was: dry matter 59.67%, fat 21.74%, proteins 21.95%, salt 3.58%, acidity 191°T and pH 5.24. Beaten cheese made using combined rennet showed this chemical composition: dry matter 58.01%, fat 21.54%, proteins 22.09, salt 3.51%, acidity 184°T and pH 5.17. The level of protein hydrolyses was in the type produced with combined rennet. Soluble nitrogen at the end of ripening was 0.66%, primary nitrogen materials 0.60% and secondary nitrogen materials 0.05%. On 45th day of ripening in brine quantity of soluble nitrogen in beaten cheese made with genetic rennet was 0.62%, primary nitrogen materials 0.57% and secondary nitrogen materials 0.05%.

The kinetics of salt diffusion was nearly equal and to the end of ripening in the first variant it was 3.5% and in the second 3.51%. Because the level of dry matter used in first type was higher, cheese yield was 10.96%, compared to the second type where cheese yield was 8.63%.

Key words: beaten cheese, chemical composition, technology

Introduction

Presently there are mainly three types of beaten cheese produced in Republic of Macedonia, namely: yellow cheese, white brine cheese, and beaten cheese. Beaten cheese is an authentic product according to its hard consistence and exceptionally salty taste (5-10%), and with its properties to be maintained even in ordinary conditions. In the past beaten cheese was produced solely from sheep milk, however, presently, it is produced from a mixture of sheep and cow milk, pure cow milk and a mixture of sheep and goat milk.

Today, beaten cheese is generally produced in industrial conditions although traditionally it is still being produced in households.

Published information on the beaten cheese are rather poor, therefore this work aims at providing an impression on the chemical composition and the technology of beaten cheese produced under industrial conditions.

Materials and methods

As raw material to conduct the experiments collected cow's milk was used. As supplementary the following raw materials were used: ground rennet, chy-max (100% chymosin-genetic rennet) with strength of 2080 imcv/g variant 1 and ground rennet, stabbo (80% beef pepsin + 20% chymosin-combined rennet) with strength 1290 imcv/g variant 2.

During the course of the research two variants of beaten cheese were manufactured in industrial conditions, during which the effect of the two enzymes was closely monitored with particular emphasis on the dynamics of the proteins in the process of ripening of beaten cheese.

In the case of milk and whey the following analysis was conducted:

Content of the dry matter by means of drying up to a constant weight complying with the AOAC standard, 1995;

Milk-fat content in accordance with the Gerber method (*Inihov, 1971*);

Total nitrogen content in accordance with the Kjeldahl method, in compliance with the AOAC standard, 1995;

Lactose content – jodomethric method:

Ashes content – by burning to constant weight (*Inihov, 1971*), only for a milk ;

Titration acidity in accordance with the Törner method (*Inihov, 1971*);

Ph of the milk and whey by use of ph-meter Checker with combined electrode and Ama-digit;

In the case of cheese the following analysis was conducted:

Titration acidity in accordance with the Törner method (expressed in °T);

Ph established by means of using digital ph-meter Checker with combined electrode and Ama-digit;

Dry matter content (%) by means of drying to constant weight, in accordance with the AOAC standard, 1995;

Milk-fat content in accordance with the Soxlet method;

Total nitrogen content, in accordance with the Kjeldahl method, and the AOAC standard, 1995;

Salt content – standard method;

Dissolvable nitrogen content in accordance with the Van Sluke method;

Primary and secondary nitrogen products in accordance with the Gjorgjevic method; ripening coefficient (proportional between the total and dissolvable nitrogen)

At the end of the research period, after the 45th day of ripening in brine, a calculation was performed of the yield in the two variants of the beaten cheese, according to *Baltazieva, 1993*. Each type of cheese was organoleptic evaluated after the 45th day of ripening in brine (*Dozet et al., 1985*) on the scale of 50 points.

Results and discussion

Fundamental parameters for quality of cow cheese used in this experiment are shown below in table 1.

Table 1. Chemical composition and milk acidity
Tabela 1. Hemijski sastav i kiselost mleka

Parameters/Parametri %	Variant/Varijanta 1			Variant/Varijanta 2		
	X	Sd	Cv	X	Sd	Cv
Moisture/Vlaga	88.08	0.6766	0.7682	88.5	1.3770	1.5560
Dry matter/SM	11.92	0.6766	5.6768	11.5	1.3770	11.9744
Total proteins/UP	3.09	0.1985	6.4195	3.11	0.3415	10.9694
Fat/Mast	3.76	0.2122	5.6389	3.73	0.3214	8.6104
Lactose/Laktoza	4.36	0.0305	0.6995	3.96	0.04	1.0101
Total nitrogen/UA	0.4843	0.0311	6.4214	0.4879	0.0535	10.9707
Titration acidity/Titraciona kiselost	15.65	0.05	0.3100	16.50	0.1000	0.6000
Ph	6.63	0.0115	0.174	6.60	0.1178	1.786

From the table shown above it can be seen that in both cases, during the course of production of beaten cheese, milk of almost identical chemical composition was used. The identical composition was not a coincidence, but it aimed at better note of the changes occurring during the course of the process of ripening of the cheese and which will not be conditioned by the differences in the chemical composition of the milk in the use of different rennet.

Our results of the chemical composition of cow milk were compared with the chemical composition of cow milk used for production of white brine cheese (*Cizbanovski, 1989*). A similarity has been noted, with the exception of the dry matter content, which was 12.31%.

During the process of manufacturing the cheese whey appears as a secondary product, the composition of which is of particular significance for the milk industry. In fact its quality and quantity analysis gives an overview on the course of the curding process. Therefore, apart from the production of beaten cheese, we conducted an analysis of the chemical composition and acidity of the curd, which can be seen bellow in table 2.

Table 2. Chemical composition of whey
Tabela 2. Hemijski sastav surutke

Parameters/Parametri	Genetic rennet-Var.1/ Gen.sirilo-Var.1			combined rennet-Var.2/kom.sirilo- Var.2		
	X	Sd	Cv	X	Sd	Cv
% dry matter/SM	6.27	1.5632	24.93	5.43	2.1094	38.84
% total proteins/UP	1.42	0.3620	25.49	1.44	0.4230	29.37
% milk fat/MM	0.19	0.0563	29.63	0.17	0.0536	31.52
% lactose/laktoza	4.34	0.0115	0.264	3.49	0.0057	0.163
% total nitrogen/UA	0.22	0.0561	25.50	0.22	0.0531	24.13

From the results shown in the table 2 it can be seen that through the use genetic and combined rennet differ considerably in terms of % of dry matter and % of lactose, whereas other examined parameters show no particular difference. With the use of genetic rennet, the percentage of dry matter is 6.27, and the level of lactose is 4.34, whereas in the pepsin one, dry matter is 5.43 and lactose 3.49.

In our research the loss of fats and protein are very small, however level of fats, percentage-wise, in the whey is almost identical in both types.

Our research was confirmed also by *Eino et al. (1976)*, who conducted their research on curd cheddar, coagulated with different ferments, pepsin and chymosin, by use of microscope. They established that the curd produced by using chymosin had a more compact sponge-like structure compared to the one produced by using pepsin, whose structure was weaker.

The content of dry matter is one of the most important factors that influence the course of the ripening. Casein and the milk fat represent main components in the content of the dry matter in cheese. This amount is in close link with the type of cheese, and, in our research, it ranges from 58.01-59.94. In cheese with higher content of water the process of ripening is faster.

Table 3. Chemical composition of beaten cheese during the 45th day of ripening period
Tabela 3. Hemijski sastav bijenog sira tokom 45-dnevnog zrenja

Parameters/Parametri (45 th day of ripening/45. dan zrenja)	Genetic rennet/Gen.sirilo			Combined rennet/Komb.sirilo			T-test	X ₁ -X ₂
	X ₁	Sd	Cv	X ₂	Sd	Cv		
Dry matter/SM	59.67	0.77	1.29	58.01	0.16	0.27	0.131 ^{ns}	1.66
Total nitrogen/UA	3.44	0.17	4.94	3.45	0.13	3.76	0.367 ^{ns}	0.01
Total proteins/UP	21.95	1.14	5.17	22.09	0.88	3.99	0.388 ^{ns}	0.14
Fats/Masti	21.74	3.96	18.21	21.54	1.05	4.87	0.271 ^{ns}	1.64
Primary nitrogen materials/Primarne N materije	0.57	0.11	19.29	0.60	0.13	21.66	0.110 ^{ns}	0.03
Secondary nitrogen materials/Sekundarne N materije	0.05	0.010	20.00	0.06	0.0100	16.27	0.468 ^{ns}	0.01
Dissolvable nitrogen/Rastvorljivi N	0.62	0.12	19.35	0.66	0.14	21.21	0.064 ^{ns}	0.02
Ashes/Pepeo	8.51	1.05	12.33	9.52	0.57	5.99	0.169 ^{ns}	1.01
Salt/So	3.58	0.76	21.00	3.51	0.84	23.93	0.169 ^{ns}	0.07
Ripening coefficient/Koeficijent zrenja	18.03	3.32	18.41	19.06	5.66	29.68	0.058 ^{ns}	0.07

The data of our research on the value of dry matter comply with the data of *Abdulah Sh. M, 1979*.

At the end of the ripening period, on the 45th day in brine, the average value of salt in the first variant is 3.58% and 3.51 in second.

Our results compared with the only results published on beaten cheese (*N.Kapac-Parakecheva, T.Chizbanovski, 1974*) differ in terms of the percentage of salt, the values of which range from 5.57-8.19%, with an average of 6.75%.

The higher percentage of salt in this type of cheese is not considered a disadvantage, but a property of its technology which allows easier maintenance and long lasting of the product considering its primitive technology of production.

Dialysis of proteins is the most typical process in the course of ripening of the cheese and therefore in literature it is considered equal to the process of ripening. This component goes under deepest and biggest changes during the process of ripening, which manifest by specific features of the cheese, especially its aroma, consistence, texture and appearance.

Our results on the total nitrogen content correspond to the results acquired by *Thakur et al. 1975*; *Green et al. 1981*; *Sapru et al. 1997*; *Oommen et al. 2000*, who concluded that the total nitrogen content ranges in the limit of 3.20-3.60%.

If the content of dissolvable nitrogen is a measure for the ripening intensity, it can be concluded that in our experiments there is a very slow process of ripening in comparison with other types of cheese. The high percentage of salt in the cheese, which performs an inactivation of the microorganisms and their enzymes, thus slowing down the proteolysis, is considered to be the biggest obstacle in the ripening process of the beaten cheese.

Our results on the dissolvable nitrogen content partially corresponds to the results of *Micev, 1969*, who, while performing a chemical dialysis of the beaten cheese, established that it has got a lower amount of dry matter, fat and dissolvable nitrogen compared to the yellow cheese and the white brine cheese, while the values of the total nitrogen and total proteins ranged between the values of the yellow cheese and the white cheese.

The values of the primary nitrogen products on the 45th day of ripening in brine are: 0.57% with use of genetic rennet and 0.60% when using combined rennet.

Our results on the primary nitrogen product correspond to the results of *Macej, 1989*, in the case of white cheese, in which it ranges in the limits between 0.20%-0.50%.

The content of secondary nitrogen products depends on the intensity of growth and development of the milk acid bacteria i.e. on their increased enzyme activity. Our values on the ripening coefficient is approximate to the values of *Macej, 1989*, in the case of white cheese. In the case of the first variant in our experiments the value is 1.71% higher than the research of the above mentioned author of the soft white cheese, whereas in the second variant the percentage of ripening is 2.74% higher.

The quantity of the beaten cheese as a ready-made-product gained from 100 liters of standardized cow milk- the yield in the two variants was the following:

- first variant (100% chymosin) – 10.96%
- second variant (75% chymosin and 25% pepsin) – 8.63%

This result of ours corresponds to the fact published in (*Chr. Hansen Newsletter, 2002*), in which it is established that the chymosin gained with such a technology gives a higher yield in comparison with other yield enzymes.

Our results on the yield of the beaten cheese, by use of genetic rennet correspond to the result of *Mihajlov, 2003*. The Author used four types of different yield enzymes in the production of Cheddar, among which also chymosin gained by means of using yield enzymes.

According to the evaluation of the two variants on a scale of 50 points (*Dozet et al., 1985*) they show good organoleptic properties. The comparatively low mark of variant 2 for 3.4 points compared to variant 1 results from the lower mark on appearance of the cut of the cheese, variant 2 has 6 points higher mark than variant 1.

Conclusions

During the course of the researched period of 45 days of ripening in brine, the quantity of total nitrogen matter in the first variant is 3.44%, while for the second one it is 3.45%. Generally, the total nitrogen content increases in both variants of the beaten cheese. The small deviation in the total nitrogen matter is due to the unchanged water content in those phases and the insignificant increase on the part of the other components in the cheese.

The increased content of dissolvable nitrogen in the second variant is due to the presence of pepsin i.e. enzyme which has a more prominent and prolonged proteolysis ability compared to the chymosin, who is considered a stronger coagulant, but with weaker proteolysis activity.

Due to the higher values on the part of the primary nitrogen products in the dissolvable and total nitrogen an intensive ripening process in width is noted in both components.

Since the content of secondary nitrogen products compared to the total nitrogen is very low in both variants, we have come to the conclusion that there is an insignificantly small depth of ripening.

Based on the results of ripening we have concluded that in the case of variant 2 there is a higher decomposition of the proteins and longer proteolysis.

The yield in the case of variant 1 was 10.96% compared to variant 8.63% i.e. the yield is higher in the case of variant 1 for 21.25%

On the basis of the acquired marks from the sensor evaluation we can conclude that variant 1 has 9.09% better organoleptic properties compared to variant 2. The deviation in the case of variant 2 is in the indicator-cut of the cheese, in which it has a higher mark than variant 1.

Tehnologija i hemijski sastav bijenog sira u Republici Makedoniji

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Rezime

Bijeni sir je autohton proizvod u našoj zemlji koji se nekad proizvodio isključivo od ovčijeg mleka, dok se danas proizvodi iz mešavine ovčijeg i kravljeg mleka, čisto kravljeg mleka i mešavine ovčijeg i kozijeg mleka.

Danas se bijeni sir proizvodi u potpuno industrijskim uslovima, iako se tradicionalni način proizvodnje jos zadržao.

Na osnovu naših istraživanja razrađena je tehnologija i hemijski sastav dve varijante bijenog sira proizvedenih u industrijskim uslovima sa dva različita sirila Chy-max (genetsko) i Stabbo (kombinovano sirilo).

Hemijski sastav bijenog sira dobivenog od genetskog sirila (varijanta 1), sa 45. dana zrenja iznosila je: suva materija 59,67%, mast 21,74%, proteini 21,95%, so 3,58%, kiselost 191^oT i pH 5.24. Varijanta 2 sa korišćenjem kombinovanog sirila imala je sledeći hemijski sastav: suva materija 58.01%, mast 21,54%, proteini 22,09%, so 3,51%, kiselost 184^oT i pH 5.17. Stupanj hidrolize proteina bio je veći kod varijante kod koje se koristilo kombinovano sirilo, s tim što je vrednost rastvorljivog azota na kraju zrenja iznosila 0,66%, primarne azotne materije 0,60% i sekundarne azotne materije 0,05%.

Bijeni sir koji je podsirivan genetskim sirilom, 45-og dana zrenja u salamuri imao je sledeći sastav azotnih materija: količina rastvorljivog azota je iznosila 0,62%, primarnih azotnih materija 0,57%, dok je količina sekundarnih azotnih materija bila 0,05%.

Kinetika difuzije soli kod dve varijante bila je skoro slična i iznosila je od 3,5-3,51%. Stupanj iskorišćavanja suvih materija kod varijante 1 bio je veći, tako što jennjegov randman iznosio 10,96%, dok je kod varijante 2 randman bio manji i iznosio 8,63%.

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