EFFECT OF ADDITIVE ON THE PROCESS PARAMETERS AND COAGULATION IN A PRODUCTION OF FETA CHEESE

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Abstract: Milk and milky products are multicomponent systems. The technology of milk processing mostly depends on the ways of separating these components. In addition to classic methods of separation (evaporation, suction and distillation), modern methods allow separation of similar compounds and mixtures that are sensitive to temperature changes, pH, light, etc. The most important separation processes are: reverse osmosis, microfiltration and ultrafiltration. The membrane technique of the ultrafiltration process is the separation of the components of one solution depending on its molecular size (10-1000). In the process of milk tetrating, two separate fractions are obtained: retentate - a fraction containing proteins with minimal amounts of lactose and mineral matter and permeate - fraction containing lactose, mineral matter, non-protein nitrogen, free amino acids and vitamins. In this paper, the results of physical and chemical testing of feta in the process of ripening after 15 days, after a month, after a half and after 2 months are presented. The results of the material balance in feta are also given in the paper. They are calculated by the relationship between the standard quantity of milk (100 l) and the amount of feta cheese that is obtained as the final product after ripening.

Keywords: feta, cheese, ultrafiltration, retentate, permeate.

1. INTRODUCTION

This paper presents the process of production of feta cheese, which is described on the basis of the technological process in the former cheese fabric "Džersi" DOO in Knjaževac, with special emphasis on the influence of parameters and additives on the process of coagulation in the production of feta cheese.

2. EXPERIMENTAL

2.1. Physical – chemical methods for milk testing

2.1.1. Determination of milk acidity by SOXHLET – HENKEL

Acidity by SOXHLET – HENKEL is number of cm³ ¼ NaOH necessary for neutralization 100 cm³ milk with phenolphthalein as an indicator. Equipment: pipette of 20 cm³, burette, Erlenmeyer of 100 cm³. Chemicals: 1M NaOH, 2% alcoholic solution of phenolphthalein. Work flow: Measure 20 cm³ of milk in the Erlenmeyer of 100 cm³, add 2-3 caps of phenolphthalein and start titration with 1M NaOH to the appearance of a pale pink color that is not lost for 2 minutes. Number of spent milliliters of 1M NaOH multiplied by 2 is °SH of tested milk.

2.1.2. Determination of milk fat by GERBER

Equipment: stand for tubes, butyrometers for milk, elastic rubber belt, pipettes of 10 cm³ for milk, H₂SO₄ and amyl alcohol, water bath, centrifuge. Chemicals: H₂SO₄, amyl alcohol. Work flow: Carefully measure 10 cm³ of H₂SO₄ and pour into the butyrometer in the stand where are the tubes with samples. Since the milk test is a good mix, measure 11 cm³ (T = 20°C) and pour into the butyrometer. Then add 1 cm³ of amyl alcohol. After closing the butyrometer, place it in a water bath with temperature of 65°C. Before centrifuging the dots, the upper edge of the contents of the butyrometer to the last section on the scale and then the centrifugation is performed for 5 minutes, at speeds of 1200 turns/min. After 5 minutes turn off the centrifuge and the butyrometer are removed and refer to the water bath on 65°. After 3-5 minutes, the plunger cuts off the thickness of the fatty column to one of the main lines and points. The difference between the lower and upper menisc of the fatty column is the milk fat in %.

2.1.3. Determination of specific milk weight by lactodenzimeter

Under the specific weight of milk, it is understood that the milk is at a temperature of 20°C weight percent of distilled water of the same volume and temperature. Equipment: lactodenzimeter, scale of 300 ml. Work flow: Along the wall of scale gently pour 300 ml of milk into the foam, so that the foam can read the specific weight. Then lightly lower the lactodenzimeter into milk up to the mark 30 on the scale. When the lactodenzimeter calm down, read the lactodenzimeter number at the height of the upper meniscus. The specific milk weight should be measured at a temperature between 15°C and 20°C with correction being done. They are arranged so that for each degree lower than 20 take it away and higher than 20 added 0,2.

2.1.4. Determination of dry milk content by FLEISCHMANN

It is carried out using the formula based on the results obtained for % of fat milk and specific milk weight.

$$C = 1,2 \times f + 2,665(100d - 100/d),$$

C – % of dry milk content; f – % of milk fat; d – specific milk weight.

2.1.5. Determination of dry milk content without fat

Dry milk content without fat is represents a fairly stable milk constant used to prove and determine falsification of milk by adding water. % of dry milk content without fat is obtained by subtracting % of milk fat and the dry milk content.

2.1.6. Determination of milk quality by fermentation test by A. Peter

Fermentation test is a simple practical test by which court is passed on measures to be taken in the technological process in order to obtain a better quality. Equipment: tubes, cover for tubes made of galvanized sheet metal, metal stand, water bath. Work flow: In the tube, milk is poured up to 1 cm³ of the upper edge of the tube and covered with a lid. As other tubes are filled up, the stand with the tubes is lowered to a water bath at a temperature of about 38-40°C. The first observation of the test is done after 12h, the second after 15-16h and the final third after 24h. Based on the observed changes in milk after the last observation, a table compare with the Peter's test table and determine the fermentation properties of milk for making feta.

2.1.7. Alcoholic test for determining acidity of milk in °SH

Pipette 2 ml of milk, transfer to the tube, heat a little, add 2ml of 75% etyl alcohol and mix it. If there are flakes, then milk cannot be used as sterile, because it has a higher degree of acidity. Up to 8°SH reaction is negative, milk is suspicious, but not grub. Over 8°SH reaction is positive and milk is sour.

2.1.8. Examination on the presence of carbonates

Rosaceal acid is used to examine the falsification of milk when carbonates is added in milk. Equipment: normal court of 500 ml, glass stick, Erlenmeyer of 300 ml, veggel, glass leak. Chemicals: Rosaceal acid, etyl alcohol. Work flow: In a veggel measure 1g of rosaceal acid and transfer to normal court with glass stick and Erlenmeyer. Add etyl alcohol to the line and mix well. Color is being watched. Milk without soda (NaOH) will be dull yellow while milk with soda will be dull red. Rosaceal acid with alcohol is an indicator.

2.2. Psysical – chemical methods for feta cheese

2.2.1. Determination of acidity by THORNER

Equipment: porcelain avan with a fist, birette. Chemicals: 1M NaOH, 2% of alcohol solution of phenolphthalein. Work flow: Acidity of milk by THORNER is number of milliliters 1M NaOH consumed to neutralize 100g cheese, with indicator phenolphthalein. Measure 5g of cheese on a technical scale. Put in a porcelain avan and rub it with a fist. Then add 100ml distilled water in small quantities and mix well with cheese. Titrate the resulting emulsion with NaOH with phenolphthalein until a pale red color appears, which will not be lost within 2 minutes.

2.2.2. Determination of % fat of feta cheese by butyrometric method by GERBER – SIEGFELD

Equipment: Erlenmeyer of 30 cm³, butyrometer for milk, water bath, leak, centrifuge. Chemicals: HCl with specific weight of 1,125, amyl alcohol. Work flow: 2-2,5g of chopped cheese is placed in an erlenmeyer, add 10 cm³ of HCl and heat. During heating, the contents are spilled into the butyrometer for milk, spills with 1 cm³ of amyl alcohol, the butyrometer is clogged, then it's mix for 2-3 minutes, then it comes in the same way as when determining fat by Gerber.

% fat = $m \times 11,33 / A$,

m – % fat read on butyrometer; A – weight of cheese in grams.

2.2.3. Determination of the content of kitchen salt in feta

Equipment: porcelain trowel, leak, filter paper, birette, erlenmeyer. Chemicals: 1M AgNO₃, 5% solution of K₂CrO₄. Work flow: In a porcelain trowel add 2-3g cheese and heat to charcoal cheese mass, then a smaller amount of distilled water is poured and the contents filtered. Filtrate is caught in a glass. For each 50 cm³ of the obtained filtrates, 1cm³ solution of K₂SO₄ was added as an indicator, well titrate with 1M AgNO₃ until the appearance of cigills colour.

$X = b \times 0,00585 / a \times 100$,

X – % of NaCl; b – weight of cheese in grams; a – amount of AgNO₃ in cm³.

2.2.4. Determination of water content in cheese

Take 20g of quartz sand and about 5g of cheese and dry it to 105-110°C to constant weight.

2.2.5. Determination of the % of dry matter in cheese

Under dry cheese matter is the remainder after drying the sample at 103°C to constant weight. Equipment: Ni or Al cup with sand which is washed with HCl and water and then heated, glass stick. Work flow: Place around 30g of sand and glass stick in a cup, then dry in dryer at 105°C. Cool the cup in the desiccator and measure it on the analytical balance. Repeat the drying and measurement with alternating cooling to constant weight. Then put 3g of cheese into a cup and re-measure it. Mix the sample cheese well with a glass stick with sand, then dry in a dryer at 105°C for 3-4h. In the event of an increase in weight, the weight is taken before the increase.

% of dry matter = $a \times 100 / b$,

a – the rest after drying; b – weight of the measured sample. The maximum allowed difference between the two samples may be +/- 0,1%.

3. RESULTS

3.1. Results of milk quality testing

3.1.1. Physical – chemical tests

The Table 1 shows that milk acidity is moving at the border 6.8-7.2 °SH, the mean value of milk acidity is 7.0 °SH.

Table 1. The results of milk acidity testing used for making feta

Milk acidity °SH							
Beli potok	Donje zuniče	Gornje zuniče	Kalna	Vasilj	Tupižnica	Vina	Middle value
Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	
7.2	7.0	7.0	6.8	7.2	7.2	6.8	7.0

Table 2. The results of fat milk

Milk fat in %							
Beli potok	Donje zuniče	Gornje zuniče	Kalna	Vasilj	Tupižnica	Vina	Middle value
Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	
3.79	3.93	3.93	3.69	3.89	3.80	3.92	3.84

The Table 2 shows that milk fat is moving at the border 3.69-3.92, the mean value of milk fat is 3.84%.

Table 3. The results of specific milk weight

Specific milk weight in g/l							
Beli potok	Donje zuniče	Gornje zuniče	Kalna	Vasilj	Tupižnica	Vina	Middle value
Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	
1.0298	1.0296	1.0296	1.0274	1.0298	1.0286	1.0290	1.0286

The Table 3 shows that specific milk weight is moving at the border 1.0274-1.0298 g/l, the mean value of specific milk weight is 1.0286 g/l.

Table 4. The results of dry matter in milk

Dry matter in %							
Beli potok	Donje zuniče	Gornje zuniče	Kalna	Vasilj	Tupižnica	Vina	Middle value
Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	
12.48	12.36	12.36	11.50	12.36	11.94	12.19	11.98

The Table 4 shows that dry matter in milk is moving at the border 11.50-12.48%, the mean value of dry matter in milk is 11.98%.

The Table 5 shows that dry matter in milk without fat is moving at the border 7,81-8,49%, the mean value of dry matter in milk is 8,14%.

The results of testing milk quality for making feta cheese by fermentation test by A.Peter based on laboratory testing and comparison with tabelary data found that milk of cheesy type of fermentation, the grub is more or less compact, but compact, and the dried out whey is greenish and slightly acidic.

The Table 6 shows that carbonates are not present in milk.

Table 5. The results of dry matter in milk without fat

Dry matter in milk without fat in %							
Beli potok	Donje zuniče	Gornje zuniče	Kalna	Vasilj	Tupižnica	Vina	Middle value
Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	
8.49	8.43	8.43	7.81	8.45	8.14	8.27	8.14

Table 6. Results of presence of carbonates in milk

Carbonates							
Beli potok	Donje zuniče	Gornje zuniče	Kalna	Vasilj	Tupižnica	Vina	Middle value
Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	
Not present	Not present	Not present	Not present	Not present	Not present	Not present	Not present

Table 7. The results of alcoholic tests

Alcoholic test of milk							
Beli potok	Donje zuniče	Gornje zuniče	Kalna	Vasilj	Tupižnica	Vina	Middle value
Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	
Not	Not	Not	Not	Not	Not	Not	Not

The Table 7 shows that does not gruse.

3.1.2. Bacteriological tests

Table 8. Results of bacteriological tests of milk for making feta

Bacteriological correctness of raw milk			
	Test 1	Test 2	Test 3
Total number of microorganisms	About 400.000		
Staphylococcus aureus	-	-	-
Escherichiae coli	-	-	-
Clostridium species	-	-	-
Proteus species	-	-	-

The Table 8 shows that milk does not contain harmful microorganisms that could lead to a change in feta cheese.

3.1.3. Organoleptic tests

Table 9. Results of organoleptic tests of milk

Taste	Smell	Colour	Consistency
Mild, nice	Pleasant, characteristic, fresh	White or whitish, uniform	Homogeneous liquid, without separation of fat bulbs

3.2. Results of feta quality testing

3.2.1. Physical – chemical tests

Table 10. Test results of aggregate raw milk before ultrafiltration

°SH	pH	Milk fat in %	Specific weight	Dry matter in %	Dry matter without fat
7.0	6.64	3.841	1.0286	11.98	8.14

The Table 10 shows the basic parameters of the milk from which the concentrated concentrate will be obtained.

Table 11. Test results of concentrate for feta cheese with ultrafiltration

°SH	pH	Milk fat in %	Dry matter	% of moisture
16.6	6.54	16	35	65

Table 12. Test results of freshly fetched feta

Milk fat	°SH	pH	% of moisture	% of dry matter	% of salt	% of milk fat
16	150	4,94	65	35	-	45.71

Table 13. Test results for feta in the process of ripening

% of milk fat	Milk acidity °SH	pH	% of moisture	% of dry matter	% of salt	% of milk fat in SM
After 15 days						
17	206	4.72	62.98	37.02	1.93	45.94
After a month						
18.5	232	4.62	62.93	37.07	1.75	49.90
After a month and a half						
18.7	238	4.68	62.79	37.61	1.60	49.85
After 2 months						
19	240	4.66	62.61	30.40	2.45	50.80

Table 14. Test results of strength of the rennet

Strength of the rennet in minutes			
Test 1	Test 2	Test 3	Middle value
9,32	9.50	9.45	9.42

$$X = 4262 - 1:42462 (10000:9,42) = 42462.$$

The ratio spreads and milk is such that 1g of the spread can spread 42462 cm³ of milk.

3.2.2. Bacteriological tests

During the examination of the bacteriological tests of the feta, pasteurized and unpasteurized milk and pasteurized concentrate, it was determined that there no present of: *Echericiae coli*, *Staphylococcus aureus*, *Clostridium* and *Proteus* species. It was found that in pasteurized milk the total number of microorganisms is 30 000 in 1 ml, in unpasteurized milk 318 000 in 1 ml, in pasteurized concentrate 49 500 in 1 ml.

3.2.3. Organoleptic tests

Table 15. Results of organoleptic feta testing

Salad cheese soft, Denmark technology	
Shape, size, weight	Cubes or squares of per 700-1000
Outside	No edge, white
Inside	Color-white; Consistency-soft, solid on cutting; Smell and taste-a little sour, picantly; Compatibility-none

4. DISCUSSION

For the production of feta, the milk was used by several producers from several sites, and the characteristics of the cheese directly depend on the quality of the milk. The milk must be completely fresh, hygienically correct and must satisfy the following conditions:

- Must have normal physical and chemical properties: taste, smell, colour, density, fat, properties of fat, proteins and mineral matters, and normal acidity and maturity.
- Must have normal microflora and that under certain conditions can achieve normal maturity.

Fat is directly dependent on milk fat that can vary with certain on milk fat that can vary with certain manufacturers. Milk tests have shown that values move within boundaries 3,69-3,92, with the mean value of 3,84. The amount of cheese that is obtained from a certain amount of milk depends on milk fat and casein. From 100 l of milk is obtained 20,83kg of cheese with 19% of milk fat. The required milk fat for the production of full fat cheese with 45-50% of fats should be about 3,5-4% which depends on the technology itself. Therefore, special attention must be paid to the process of production. Milk must also have a certain degree of acidity, that is must possesses certain maturity, because only the milk of normal maturity gives the pear to be processed properly. Maturity impacts on:

1. Milk coagulation rate;
2. Hardness of pear;
3. Consistency of pear;
4. Speed of whey extraction.

The necessary acidity of milk for making feta moves within the limits of 6,8-7,8°SH. Based on physical-chemical testing it has been established that the milk used for feta has acidity 7°SH, taken as a mean value. In order to achieve the desired acidity, the milk is left at $T = 30-33^{\circ}\text{C}$ for 60 minutes. The milk concentrate must be pasteurized, and a large number of microorganisms are destroyed in that way. Removing mechanical impurities has a great practical significance because they carry a biological impurity with them. The composition of minerals in cheese plays an important role in organoleptic characteristics and texture of cheese. Concentrate homogenization is applied for the uniform distribution of fat to obtain uniform pear fat. In homogenized concentrate is added a culture of *Streptococcus lactis* to a provide a normal microflora. The dilution of the homogenized concentrate is performed under the effect of hymozin and lactic acid on casein. The action of the rennet depends on the

acidity of the concentrate, because when the acidity is increased, the effect of the rennet decreased. The process of ripening is carried out at a temperature of 14-16°C during 2-3 weeks. The aim of ripening is to obtain cheese with normal quality and good physical, chemical and microbiological parameters.

5. CONCLUSIONS

Based on the experimental work, the results obtained, the discussion and the literature data, the following conclusions can be made:

1. The quality of cow's milk used to produce feta is satisfactory because it possesses all the qualities of quality milk.
2. The quality of the feta depends on the quality of the milk, concentrate obtained by ultrafiltration and way of producing feta cheese.
3. In the production of feta, it is necessary to constantly keep an account of temperature pasteurization of milk and ultrafiltration, quantity and quality of pasteurized and unpasteurized milk and rennet, temperature of raising and ripening feta cheese.
4. The quality of the obtained feta fully meets all the norms prescribed by the rules because it possesses all the qualities of quality soft cheese.
5. This way of making it possible to get a feta in a quick and easy manner while preserving the quality of milk and all valuable ingredients.
6. The results of physical-chemical tests of milk showed:
 - that the average milk acidity value in producing feta is 7°SH;
 - that the average milk fat value in producing feta is 3,84%;
 - that the average specific milk weight value is 1,0286 g/l;
 - that the average value of dry matter is 11,98%;
 - that the average value of dry matter without fat is 8,14%;
 - that there are not carbonates in milk;
 - that alcoholic test is negative – milk not grub;
 - that milk is bacteriological correctly.
7. The results of feta testing showed:
 - after ultrafiltration, milk acidity increased for 9,6°SH;
 - pH value increases for 0,1;
 - dry matter increases for 23,02%;
 - after a month and half of ripening feta there are increases of % fat milk, milk acidity, % fat milk in dry matter and % salts; and there are decreases of pH value, % of moisture and % dry matter.

6. REFERENCES

- [1] Proizvodnja sira na tradicionalan način, Prof.spec. Zlatan Glišić (2010).
- [2] Proizvodnja mleka i mlečnih proizvoda, Dr.Jovan Đorđević, Dr. Radosav Stefanović.
- [3] Principi membranske filtracije sa primenom u tehnologiji mleka, Dr. Dragoljub Đ. Gavrić (1995).
- [4] Tehnologija mleka i sirastva, Predrag Puđa.
- [5] <http://www.tehnologijahrane.com>.
- [6] Pravilnik o kvalitetu i drugim zahtevima za mleko i mlečne proizvode, kompozitne mlečne proizvode i starter kulture („Sl. list SRJ“ , br. 26/2002 i „ Sl. list SCG“ br. 56/2003 – dr.pravilnik, 4/2004 – dr.pravilnik 5/2004 i „Sl.glasnik RS“ , br. 21/2009 – dr.pravilnik i 33/2010 – dr.pravilnik).