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ВЛИЯНИЕ НА СТАРТЕРНИТЕ КУЛТУРИ ВЪРХУ ДИНАМИКАТА НА pH И SH В ПРОИЗВОДСТВОТО НА БЯЛО САЛАМУРЕНО СИРЕНЕ

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THE IMPACT OF STARTER CULTURES ON pH AND SH DYNAMICS IN THE PROCESS OF WHITE BRINED CHEESE PRODUCTION

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Abstract

White brined cheeseisa specific dairy product for Balkan Peninsula countries, Mediterranean, North Africa, Eastern Europe and some parts of Asia. The survey was conducted in 2015 ata dairy industry laboratory in R. of Macedonia. In this research workthe influence of three different starter cultures of three white brined cheese variants (A, B, C) has been examined regarding the pH and SH dynamics.The starter culture in variant A (SMCH - 5) contained following bacteria strains: *Lb. bulgaricus, Str. thermophilus* and *Lb. acidophilus*. In the variant B (Choozit Feta A) the follow bacteria strains were included: *Lac. lactis*ssp. *lactis*, *Lac. lactis* ssp. *cremoris,Str. thermophilus, Lb. bulgaricus*and *Lb. helveticus.* The variant C (MOTC 092 EE) was a combination of the strains: *Lac. lactis* ssp. *lactis, Str. thermophilus, Lb. bulgaricus, Lb. helveticus*and *Lb. casei*. The impact of the above mentioned three different starter cultureswas determined overthe pH and SH during the process of ripening of the white brined cheese.

Key words: white – brined cheese, starter cultures,pH, SH, dynamic.

Introduction

White brined cheese has a great tradition in R. Macedonia and is usually produced from cow milk. The increased consumption of white brined cheese contributes to the necessity to be produced in almost all dairy facilities in industrial way: milk pasteurization, adding ingredients (calcium chloride, color, rennent.), and also the addition of starter cultures for continuous milk acid fermentation.

According to El Soda at al. (2003), the use of commercial starter cultures in an industrial way of cheese production is necessary for obtaining a final product with a standard identifiable feature.

The most important function of the starter cultures is the production of lactic acid and the release of enzymes during the fermentation process of white brined cheese (Leroy and de Vuyst, 2004).

Material and methods

As for this research the whitebrined cheese was manufactured from pasteurized cow milk in a local dairy plant “Milkom" - v. Nogaevci, Gradsko, R. Macedonia. Regarding the production the raw milk was supplied from Gradsko region in Macedonia. The chemical composition of the milk used for the manufacturing of white cheese was 12.13% total solids, 3.70% fat, 3.21% protein, 0.67% ash, and 4.55% lactose. The pH of the milk was 6.49 and it was pasteurized at 72°C for 15 seconds and cooled at 34°C. The curding was done at temperature of 34 ^{o}C.First the following starter cultures were added: for white brined cheese-Variant A- SMCH – 5, for white brined cheese-Variant B- Choozit Feta A and for white brined cheese Variant C - MOTC 092 EE. Then the $CaCl_2$ 0.02% and blego color 10 ml/100 liters milk was added. The cow milk was coagulated with chymosin rennet (Chymax Extra Powder 1, 5 g/100 l milk) completed in 45 min. Further on, the curd was cut in cubes of 1 cm3, resting for 5 minutes and afterwards pressed in cheese mold for 3 hours. Cheese blocks were placed in tinned cans filled with brine solution of 8g NaCl/100g. During the ripening period of 30 days the cheese was held at 15-17°C, and then kept at 2-4°C. (Figure 1 White-brined cheese technology).

Figure 1:Modified protocol of white cheese production (Ozcan at al.2012)

Raw milk

↓

Filtration and pasteurization (72^{0}C/15 sec),

↓

Cooling till 35^{0}C

↓

Addition of $CaCl_2$ (0, 02%), blego color (10 ml/100 liters milk) and inoculation with starter cultures (SMCH – 5(Var.A), Choozit Feta A(Var.B) and MOTC 092 EE(Var.C)

↓

Rennetingwith Chymax Extra Powder(1, 5 g/100 l milk) at 34^{o}C,completed in45 min

↓

Cutting the curd (the coagulum is cut into cubes of 1cm^{3})

↓

Pressing the cheese and curd in cheese mold and whey draining (2, 5-3 h)

↓

Adding salt at titrable acidity of 72^{o}SH

↓

The pressed curd is cut in cubes

↓

Packaging (cheese blocks placed in tinned cans filled with brine solution of 8g NaCl/100g)

↓

Ripening (15-17 ^{0}C/30 days)

↓

Storage (2-4 ^{0}C)

In order to determine their influence on pH and SH in white brined cheese three different types of starter cultures were used. There were three variants of cheese produced which differ by starter cultures used in production process (Var. A - SMCH – 5,product by LB Lactis – Bulgaria, Var. B- Choozit Feta A- product by Danisco - Denmark and Var.C MOTC 092 EE (produced by Sacco Clerici).

The pH of milk and cheese samples was measured using a digital pH meter (digital pH meter, model MP120FK Mettler Toledo, Greifensee, Switzerland). SH was measured according to Soxlet Henkel method.

The determination of pH and SH of white brined cheese was examined on the 1st day, 10th day, 30th day and the 60th day.Further on, the standard statistical method (Najchevska, 2002) was used for statistical presentation of the analyzed data as well as the F-test for analysis of the variance in tested cheese variants.

Results and discussion

Active acidity (pH) is defined as concentration of hydrogen ions. This parameter according Baltadzhieva (1993) has a control function and reflects the buffering capacity of the cheese. By increasing the concentration of hydrogen or hydroxyl ions to some extent, active acidity is not changed. The pH value of the cheese is most affected by phosphates, carbonates, citrates, casein, albumin and globulins. The dynamics of the active acidity in tested variants of cheese is shown in Table 1,2 and 3 and Figure 2.

In this survey the pHvalues at the first day after production of the three variants of cow's brined cheeses were as followed: 4.93 (Var. A); 4.95 (Var.C) and 5.01 (Var. B). The content of starter cultures is so important for the dynamics of the active acidity.

According to Baltazdieva (2004**)** the most important bacteria for fermentation process in brined cheese production is Str. Lactis. This bacterium has role to make hydrolytic degradation of cheese paracasein. In further stages of ripening particularly important is bacterium Lac. Casei. While yogurt culture composed of Str. thermophilus and Lac. bulgaricus practically does not participate in the ripening process because they develop at temperatures above 15^0C and salt concentration between 6 to 8%.

The activity of starter cultures and the decrease of pH is expressed on the 10th day when the pH was 4.66 (Var. A); 4.71 (Var. B) and 4.69 (Var. C). After the 10th day came to accumulation of lactic acid with the transformation of lactose which has negative affects on the bacteria. That's the reason for decreasing the process of acidification and autolysis on lactic acid bacteria cells.

The value of active acidity after period of one month fermentation was similar for each variant white brined cheese: 4.50 (Var. A); 4.54 (Var.B) and 4.52 (Var. C).

Table 1.*Dynamics of active acidity (pH) of white brined cheese*-Variant A

Variant A (SMCH - 5)				
Day	1 day	10 day	30 day	60 day
x̄	4,93	4,66	4,50	4,42
Min	4,87	4,61	4,44	4,40
Max	5,02	4,71	4,55	4,45
Sd	0,058	0,045	0,051	0,019
Cv	1,174	0,972	1,133	0,423

Table 2 Dynamics of active acidity (pH) of white brined cheese -Variant B

Variant B (Choozit Feta A)				
Day	1 day	10 day	30 day	60 day
x̄	5,01	4,71	4,54	4,48
Min	4,91	4,68	4,48	4,43
Max	5,09	4,75	4,61	4,52
Sd	0,082	0,032	0,049	0,042
Cv	1,628	0,688	1,090	0,934

Table 3.*Dynamics of active acidity (pH)* of white brined cheese -Variant C

Variant C (MOTC 092 EE)				
Day	1 day	10 day	30 day	60 day
x̄	4,95	4,69	4,52	4,45
Min	4,88	4,60	4,43	4,41
Max	5,04	4,75	4,60	4,50
Sd	0,060	0,060	0,067	0,036
Cv	1,207	1,275	1,482	0,805

The further reduction of active acidity level was with lower dynamics. At 60-th day the lowest pH value was determined in variant A (4.42), then the variant C (4.45), while the highest pH was measured in variant B (4.48).

The obtained data for pH of white brined cheese in this survey are in corellation with the results by Chobanova Vasilevska (2007)where were noticed variations of pH from4.50 to 4.80, and also by Ostojić andMesner (1978) where was determinedan average of pH 4.44. According to Presilski(2004)the pHof traditional Macedonian white brined cheese is in range between 4.04 to 5.05.Similar results to ours werealso presented by Talevski (2011). In his surveythree variants of white brined cheese with three different starter cultures were produced. The pH of white brined cheeses were between 4,54to 4,62.

Figure 2.Dynamics of the active acidity (pH) in white brined cheese

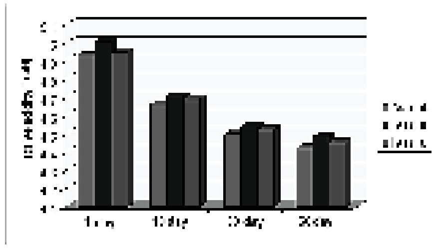


Table4. Analysis of variance for the active acidity (pH) in white brined cheese

Source of variation	Sum of squares (SQ)	Degree of freedom (DF)	Variance	F-value
Total	0,0231	14		*4,25
Between groups	0,00958	2	0,00479	
In groups	0,01352	12	0,001126	

ns- not statistically significant;* significance level $p<0.05$;** significance level $p<0.01$

$F_{0.05}$=3,74за p<0,05; $F_{0.01}$=6,51 за p<0,01

Starter cultures have minimal influence on pH value of white brined cheese at level p<0,05which can be noticed with positive Fisher test (table 4).

The dynamics of the titratable acidity in three varieties of cheese is shown in Table 5,6 and 7, and Figure 3. The starting values in tested variants were: 51,20 ^{o}SH (var. A); 48,40 ^{o}SH (var. B) 50,40 ^{o}SH (var. C). These results for titratable acidity were quite similar with results presented by Tratnikat al. (2000) for feta cheese obtainedfrom full fat and partly skimmed milk

On the tenth day of production a continuous increase of titratable acidity in all variants were noticed. The minimum value at that point of measurement was established in white brined cheese (variant B) produced from Choozit Feta A (69,20^{o}SH), while the maximum reached the white brined cheese (variant A) produced from SMCH - 5 (72 ^{o}SH).

After 30 days fermentation period, the titratable acidity values of three variants white brined cheese were as follows: 79,20^{o}SH (Variant A); 76,40 ^{o}SH (Variant B) and 77,60 ^{o}SH (Variant C).In that stage of fermentation, the increase of titratable acidity is mostly affected by Lactobacillus which are tolerant to low pH and high salt concentration. According to Núñez (1978), at the initial stage prevailing streptococci, but due to the high salt concentration and the inhibitory action of the active acidity comes to their extinction and its place is taken by Lactobacillus.These results approximating the optimal acidity in this period noted by Stojiljkovic (2007) indicating that the cheesetitratable acidity in 20-25 days should be 62-74 ^{o}SH.Higher titratable acidity causesfriableand sour cheese, while the lower acidity has the opportunity to get to faster deterioration due to lack of lactic acid.

Table 5.*Dynamics of titratable acidity(^{o}SH)*
in white brined cheese -Variant A

Variant A (SMCH - 5)				
Day	1 day	10 day	30 day	60 day
$\bar{x}$	51,20	72	79,20	86,40
Min	48	66	76	84
Max	54	74	82	88
Sd	2,280	3,464	2,280	1,673
Cv	4,454	4,811	2,879	1,937

Table 6.*Dynamics of titratable acidity* in white brined cheese -Variant B

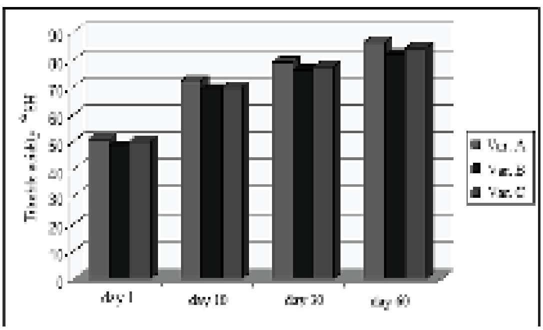
Variant B (Choozit Feta A)				
Day	1 day	10 day	30 day	60 day
x̄	48,40	69,20	76,40	82
Min	46	64	74	80
Max	52	74	78	84
Sd	2,191	3,633	1,673	1,414
Cv	4,527	5,250	2,190	1,725

Table 7. *Dynamics of titratable acidity* in white brined cheese -Variant C

Variant C (MOTC 092 EE)				
Day	1 day	10 day	30 day	60 day
x̄	50,40	70	77,60	84,40
Min	48	68	74	82
Max	52	74	82	86
Sd	2,191	2,449	3,578	1,673
Cv	4,347	3,499	4,610	1,983

After 30 days fermentation period, the titratable acidity values of three variants white brined cheese were as follows: Variant A 86,40^{0}SH, VariantB - 82 ^{0}SHandVariant C - 84,40 ^{0}SH.According to Kostova(2013),the titrable acidity in white brined cheese is between 80^{o}SHand 96^{o}SH.Our results correspond with the results of Sjenichkoto cheese produced from sheep's milk where titratable acidity had extremes of 57.54 to 97,73^{o}SH.(Ružić Muslić at al., 2011).

Figure3.Dynamics of titrable acidity (^{o}SH) in white brined cheese



At the table above are presented the results of analysis of variance for titratable acidity in three variants of white brined cheese. From the obtained results it is noticed that the starter cultures have significant impact at level p<0,01 and have influence on white brined cheese titrable acidity. Obtained F-value (9.58) was greater than the tabular values of both levels.

Table 10. Analysis of variance of titratable acidity (^{o}SH) in white brined cheese

Source of variation	Sum of squares (SQ)	Degree of freedom (DF)	Variance	F-value
Total	78,934	14		**9,58
Between groups	48,534	2	24,267	
Ingroups	30,40	12	2,533	

ns- not statistically significant;* significance level p<0.05;** significance level p<0.01
$F_{0.05}$=3,74за p<0,05; $F_{0.01}$=6,51 за p<0,01

Conclusion

The starter culturesthat were used in the process of white brined cheese production had a minimal impact on the dynamics of the active and titratable acidity in tested varieties of cheese. The pH values of all three variants of cheese after two months of ripening period were as follow: 4,42 (Var. A), 4,48 (Var. B) and 4,45 (Var. C). The SH values of all three variants of cheese after two months of ripening period were as follow: 86,40 (Var. A), 82(Var. B) and 84,40 (Var. C).

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