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DINAMICS OF RIPPENING OF CHEESE, TYPE CHEDDAR

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Abstract

The aim of the study was to determine the dynamics and period of maturation in terms of used rennet enzymes and starter cultures, and their influence on the cheese quality.

During the research, was investigated the influence of some proteolytic enzymes as rennet enzymes and *Lactobacillus casei*, as auxiliary starter culture on the rate of proteolytic breakdown in cheese ripening, type Cheddar. Were produced and followed four varieties of cheese produced according to procedure and technology of production of Kosikowski [1].

Variants were monitored during the 90 days of ripening, with three repetitions and were analyzed in terms of chemical composition, in the Institute of Animal Science, Laboratory for milk and milk products quality.

From the results, the mean value of the contents of total nitrogen at the end of ripening (90 days) ranged from 3,741% - 3,914%. The process of maturing, was monitored through the content of soluble nitrogen, which ranged from 0.745-0.753% and a deeper changes of proteolysis in soluble nitrogen content of 0.915% (var. 2) and 0.948% (var. 4). Through the results of the primary nitrogenous materials that ranged from 0.429% -0.514% nitrogen and secondary materials from 0.332% -0.434%, we get a realistic picture that Cheddar is a cheese with prolonged and profound proteolysis.

***Key words**: Cheddar cheese, ripening, nitrogen materials*

1. Introduction

During the production of this type of cheese in areas with colder climate, for better production of lactic acid under the influence of lactic acid bacteria starter, you need to run heated cheese curd. For some types of cheese that is made by squashy cheese runny with hot water, for achieving the optimum temperature for activity of lactic acid bacteria (cheese such as Gouda). The same effect is achieved by removing the entire whey and collecting the curd in blocks in order to maintain the temperature of the curd, and to develop good acidification. Later these blocks are called "cheddars" after Cheddar place in England where this type of cheese was produced for the first time, while the procedure is called cheddarisation.

Soon this type of cheese spreads through many countries around the world (Hansen [5]). Today, the major producers of this type of cheese are: USA, UK, Canada, New Zealand, Australia, Ireland and other smaller producers of the same type. Although the cheese carry the same name, according to Kosikowski [1], the quality of Cheddar produced in England, was not the same as that produced in other countries. According to him the English Cheddar was with crumbling consistency and with more stressed intensive and sour taste and a higher concentration of salt. While Cheddar produced in the United States, was more cohesive and had smooth-wax texture with unify flavor and taste.

An important step in the process of producing cheese-type Cheddar, according to Kosikowski [1], is cheddarisation. This step makes Cheddar be distinguished from other types of cheese, for its organoleptic and structural characteristics, according to which cheese is considered as number one in the world. In fact, the specific technology of producing this type of cheese, gives it characteristically physical and chemical properties. Without hesitation, this cheese is a product to which is given the most attention from technological aspect and the most usable in the world. Nowadays in our country, there is an interest for this dairy product on the market, as interesting, competitive and economically acceptable.

2. Materials and Methods

As a feedstock for the production of this type of cheese cow's milk from the farm "Di-Si" in area of Skopje was used, where it was processed in its own mini-dairy plant. During the survey different types of squashy cheese were used and also starter crops, whereas it had produced the following four types:

– Type 1 - production using squashy cheese Chy-Max and the main starter crop FD-DVS R-704,

– Type 2 - production using squashy Chy-Max and the main starter crop FD-DVS R-704 and subsidiary starter crop of L. casei 01-nu-trish.

– Type 3 - production with the use of microbiological squashy cheese Hanillase starter and main crop FD-DVS R-704.

– Type 4 - production using the microbiological squashy cheese Hanillase starter and main crop FD-DVS R-704 and subsidiary starter crop of *L. casei* 01-nu-trish.

These types were sent during the 90 days of ripening, with three repetitions and were analyzed in terms of chemical combination in the milk laboratory at the Institute of Animal Science, Skopje.

As subsidiary raw materials which were used during the survey were:

- Squashy cheese powder CHY-MAX Powder Extra, measuring 2080 IMCU/g, pure chymosin obtained by recombination way *Aspergillus niger var. awamori*.
- Squashy cheese powder, Hanillase L 2235 2080 measuring IMCU/g, which represents a protease from *Rhizomucor miehei*.
- Main pure starter crop FD-DVS R-704 (*Lactoccocus lactis ssp. lactis*, *Lactococcus lactis ssp. cremoris*).
- Subsidiary starter crop *L. casei* 01-nu-trish (*Lactobacillus casei*).

During the research was following dynamic of ripening for four variant of cheese by this parameters: total nitrogen, dissolvable nitrogen, primary and secondary nitrogen materials, according of this methods:

– Total nitrogen and protein content - Kjeldahl,

– Dissolvable nitrogen content - Van Slyke method (Gjorgjevic and Pejic [9]) and

– Primary and secondary nitrogen products (Gjorgjevic and Pejic [9]).

3. Results and Discussion

One of the most important parameters for assessment of the chemical combination of types of cheese is the content of total nitrogen substances.

Table 1. Dynamic of average value of total nitrogen materials (%) during of 90 days ripening for all four types of cheese Cheddar

Period (days)	*Cheddar (var.1)*	*Cheddar (var.2)*	*Cheddar (var.3)*	*Cheddar (var.4)*
1	3.759	3.696	3.690	3.663
15	3.752	3.693	3.696	3.666
30	3.853	3.737	3.704	3.675
45	3.846	3.746	3.707	3.685
60	3.837	3.737	3.718	3.693
75	3.849	3.755	3.718	3.718
90	3.914	3.755	3.741	3.755

Overall, the total nitrogen content of materials for all four types of cheese such Cheddar during mellowing increases. During the test period of 90 days there has been seen an increase of: 0.155% for type 1, 0.059 for type 2, 0.051% for type 3 and 0.092% for type 4. Increasing of the total content of nitrogen substances during ripening due to the reduction of water content in it and concentration of other components. Small negligible declines in total content of nitrogen substances in types 1 and 2 in some stage of testing, due to unchangeable content of water in these phases of testing and small increases in other components of the types of cheese.

Our results for total nitrogen content of the goods are coincide with the results obtained by Thakur *et al*. [4], Kosikowski [1], Sapru *et al*. [3], Hansen [5] and Oommen *et al*. [2], who found the content of total nitrogen goods between 3.610 to 3.920%.

The content of soluble nitrogen substances determines the intensity of the degradation of proteins during ripening. Therefore, defining these values during the test period of 90 days of ripening, determined by the degree of proteolytical degradation of the four types of cheese such Cheddar.

Table 2. Dynamic of average value of soluble nitrogen materials (%) during of ripening for all four types of cheese Cheddar

Period (days)	*Cheddar (varianiant 1)*	*Cheddar (varianiant 2)*	*Cheddar (varianiant 3)*	*Cheddar (varianiant 4)*
1	0.15713	0.18665	0.16494	0.19194
15	0.22624	0.25888	0.25318	0.27312
30	0.30747	0.34679	0.30484	0.36235
45	0.41575	0.45401	0.42111	0.48937
60	0.52298	0.65883	0.52833	0.69207
75	0.65741	0.82347	0.65548	0.85365
90	0.75384	0.91509	0.74558	0.94851

The largest increase in content of soluble nitrogen in the previous stage is set for the type 1, followed by type 4, type 2 and type 3. Highest content of soluble nitrogen containing type 4 that is 0.19467% higher compared to type1; to 0.03342% higher compared to type 2 and 0.20293% higher compared to the type 3.This shows that during the mellowing of types of cheese (90 days), the highest proteolytic degradation according to the results was fixed in type 4, followed by type 2, type 1 and type 3 of the cheese type Cheddar. According to the basis of the data can be noted the content of soluble nitrogen substances are similar for types 1 and 3 or 2 and 4, so it can be concluded that himozine obtained by means of recombination of *Aspergillus niger var. awamori* and protease from *Rhizomucor miehei* have quantitatively similar proteolytic activity.

Our results for the soluble nitrogen content of the goods are coincide with the results obtained by Thakur *et al.* [4], that studying the changes during ripening of cheese such Cheddar using different concentrations of salt and unexplained part of the starter crop got similar values obtained for the content of soluble nitrogen substances for types of cheese.

Dynamic of primary and secondary nitrogen materials

According with Lowrie [7] and Johnson [8], the content of primary nitrogen products depends on intensity and growth and development of lactic acid bacteria, actually of increasing enzyme activity and of used rennet- cheese enzymes.

Table 3. Dynamic of average value of primary nitrogen materials during of whole ripening for all four types of cheese Cheddar

Period (days)	*Cheddar (var. 1)*	*Cheddar (var. 2)*	*Cheddar (var. 3)*	*Cheddar (var. 4)*
1	0.11785	0.13699	0.12586	0.14070
15	0.16160	0.17862	0.18535	0.18283
30	0.19766	0.21494	0.20553	0.21867
45	0.26457	0.26365	0.27242	0.28860
60	0.33281	0.41648	0.33465	0.43103
75	0.39445	0.46908	0.39761	0.48272
90	0.42953	0.51474	0.41273	0.51420

The biggest increase of the content of the primary nitrogen products counter part of whole period of survey was noticed in types 1 and 2 which increase is almost identical and the type 1 and the type 3 followed. It could be fortified that the content of primary nitrogen products depends on intensity and growth and development of diary sour bacteria, actually of increasing enzyme activity and of used squashy cheese enzymes.

Comparing the results of types 1 and 3 regarding types 2 and 4 a little strong imperceptible activity is seen of chymosin formed by recombination way of *Aspergilus niger var. awamori*, against protease got from *Rhyzomucor miehei*.

Table 4. Dynamic of average value of secondary nitrogen materials during of whole ripening for all four types of cheese Cheddar

Period (days)	*Cheddar (var. 1)*	*Cheddar (var.2)*	*Cheddar (var.3)*	*Cheddar (var.4)*
1	0.03928	0.04966	0.03908	0.05124
15	0.06464	0.08026	0.06783	0.09029
30	0.10981	0.13185	0.09931	0.14368
45	0.15118	0.19036	0.14869	0.20077
60	0.19017	0.24235	0.19368	0.26104
75	0.26296	0.35439	0.25787	0.37093
90	0.32431	0.40035	0.33285	0.43431

And again as in previous cases we could fortify that the content of secondary nitrogen products of types 2 and 4 where the diary acid bacteria are applied of *Lactobacillus casei* will be bigger because of the intensity of growth and development of this kind of diary acid bacteria regarding their enzyme activity.

Secondary nitrogen goods are the content of amine nitrogen (little peptides, amino acids, NH_3 and others) formed during proteolytic degradation of squashy cheese. The main "guilty" of production of these goods in squashy cheese are enzymes from diary acid bacteria.

Primary nitrogen products are in the total nitrogen of 15,50% and the participation of secondary nitrogen products in total nitrogen of 9,50%. The exceptions are for smaller results got from our survey for participation of primary nitrogen products in total nitrogen for all four types of cheese from type Cheddar; the little unnoticeable exceptions for participating of secondary nitrogen products in total nitrogen in types 1 and 3 and bigger results for participating of secondary nitrogen products in total nitrogen for types 2 and 4 in relating to the results got from Djordjevic [6].

4. Conclusions

- Based on the values of the dynamics of the protein components during ripening in four types, using different squashy cheese and starter crop is determined the direction and speed of fermentation in the tested varieties.
- From the results of participation of primary and secondary nitrogen degradation products of soluble nitrogen substances, we found that at the end of the period examined, types 1 and 2, which were produced using recombination chymosin obtained by means of Aspergilus niger var. awamori, have a greater "breadth" of the ripening of cheese, than those produced by protease from Rhizomucor miehei. The term "width" of aging, presents a greater presence of primary nitrogen substances. (Gorgevic, [6]). While variants 3 and 4, produced by previous protease have more "depth" of the ripening of cheese, or a greater amount of secondary nitrogen substances, which is typical for this type of hard cheese, in terms of variants obtained using recombinated rennet.
- In types where the applied subsidiary starter crop of pure strains of lactic acid bacteria Lactobacillus casei (type 2 and 4) was observed more proteolysis degradation of protein components and shortened the fermentation period, compared with types where it is not applied.

5. References

[1] Kosikowski F. (1982). *Cheese and Fermented Milk Foods*, Second Edition, New York.

[2] Oommen B.S., Mistry V.V., and Nair M.G. (2000). *Effect of homogenization of cream on composition yield, and functionality of Cheddar cheese made from milk supplemented with ultrafiltered milk*. Lait, 80, 77-91.

[3] Sapru A., Barbano D.M., Yun J.J., Klei L.R., Oltenacu P.A., and Bandler D.K. (1997). *Cheddar cheese: Influence of milking frequency and stage of lactation on composition and yield*. J. Dairy Sci., 80, 437-446.

[4] Thakur M.K., Kirk J.R., and Hedrick T.I. (1975). *Changes during ripening of unsalted Cheddar cheese*. J. Dairy Sci., 58, 175-180.

[5] Hansen C. (2001). *Cheddar Cheese Types*, First Revised Edition.

[6] Djordjevic J. (1960). *Promena belancevina u toku zrenja kaskavalja*. Disertacija, Zemun.

[7] Lowrie R.J. and Lawrence R.C. (1972). *Cheddar cheese flavour. IV. A new hypothesis to account for the development of bitterness*. N.Z.J. Dairy Sci. Technol., 7, 51.

[8] Johnson M.E. (2001). *Cheese Products*. In Applied Dairy Microbiology, Second Edition Revised and Expanded, (E.H. Marth and J.L. Steele ed.), Marcel Dekker, Inc., New York, p. 345-384.

[9] Pejic O., Djordjevic J. (1963). Mlekarski Praktikum, Univerzitet u Beogradu.