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Effect of added calcium compounds on the yield and quality of goat acid-curd cheese

SUMMARY

Goat's milk, as a raw material for the production of acid-curd cheese, differs from cow's milk. The goat's milk casein curd has a very delicate structure, is easy to brittle, which may also reduce the yield of cheese and cause losses of dry matter components, in particular proteins. Acid-curd cheeses, due to their production technology, are characterized by a much lower calcium content than the cheeses produced by the rennet coagulation method. Increasing the level of calcium in the acid-curd cheese could be achieved by the modification of the technological process or addition of mineral compounds. A method of increasing the degree of protein utilization in acid-curd cheese is the heat processing of calcium enriched milk and coagulation of proteins using the acid method. The process of protein interaction with calcium may affect the degree of retention of the milk components to the curd and affect their physicochemical, sensory and nutritional properties.

The aim of the study was to determine the possibility of using six different calcium compounds in doses of 5, 10, 15 and 20 mg Ca 100 g^{-1} for the integration of casein with whey proteins in the production of acid-curd goat cheese with the use of heat processing of calcium enriched milk method, in two production seasons. Moreover, there were indicated calcium compounds which had the best effect on the cheese yield, organoleptic characteristics, texture, and chemical composition, including the content of micro- and macroelements, in acid-curd goat cheese. An additional aim of this study was to evaluate the quality of fermented milk and acid whey obtained during the production of acid-curd cheese and the influence of the production season and the type of calcium compound and its dose. The obtained results were worked out statistically and one-way, two-way and three-way analysis of ANOVA variance was performed. Moreover, the simple correlation coefficient was calculated.

The obtained results showed that raw goat's milk collected in the spring-summer season differed in microbiological and hygienic quality and chemical composition, including micro- and macroelements, from the milk from autumn season. Richer source of dry matter components was autumn's milk, which confirmed the effect of the production season on the quality of milk.

According to the type of calcium compound introduced into a goat's milk, the pH value after pasteurization process was changed into acidic (calcium chloride, gluconate and

lactate) or alkaline (citrate, bisglycinate and calcium carbonate), compared to the control milk sample. However, calcium compounds in doses of 0-40 mg 100 g^{-1} milk did not lower the thermal stability of goat's milk proteins and the pasteurization process could be carried out at the temperature 90°C/15 s, which enables to their safe use in the processing of goat's milk.

The addition of higher doses of calcium to goat's milk (10 mg Ca 100 g^{-1} and more) in the form of various calcium compounds influenced the acidity, texture and syneresis of the fermented milk. However, the use of a lower dose of calcium (5 mg Ca 100 g^{-1}) in the form of bisglycinate and gluconate, did not significantly affect the quality of the goat acid gel. The addition of calcium bisglycinate in a dose of 20 mg Ca 100 g^{-1} milk reduced most the syneresis of goat's acid gel and it was shown that the whey leakage was reduced by 7.85 - 11.08% compared to the control fermented milk.

The milk's production season and the addition of chloride, citrate, gluconate, lactate and calcium carbonate significantly increased the hardness of the acid gel and acid-curd cheese. Increasing the dose of calcium in the form of all compounds increased springiness of the fermented milk gel. Only the acid-curd goat cheese with the addition of calcium bisglycinate had a worse shape recovery ability. Furthermore, the higher concentration of micro- and macroelements in autumn goat's milk resulted in a significantly higher level of mineral compounds in the acid-curd cheese from the autumn season, compared to the spring-summer season. The addition of calcium gluconate to goat's milk increased the cheese yield most intensively, especially in comparison with the control acid-curd cheese. Moreover, there was shown a positive effect of the addition of calcium chloride and citrate on the level of protein retention from milk to acid-curd cheese. The addition of increasing doses of calcium into goat's milk in the form of all calcium compounds caused an increase in the fat content of the acid-curd cheese. The addition of citrate and calcium lactate to milk was the most efficient method of limiting fat migration to whey.

The interpretation of the overall acceptability of the control and calcium-added acid-curd cheeses showed excellent and very good scores. Moreover, there were not found good, sufficient or bad scores in the evaluation of the acid-curd cheese, which is an optimistic prospect for the use of these compounds in the production of acid-curd goat cheese.

The higher concentration of calcium and phosphorus in autumn goat's milk resulted in a higher level of these macroelements in cheese from the autumn season, compared to the spring-summer season. Increasing the dose of calcium added into milk in the form of six calcium compounds increased the content of calcium and phosphorus in the acid-curd cheese. The addition of 20 mg Ca 100 g-1 of milk in the form of gluconate resulted in acid-curd

cheese with the highest content of calcium and phosphorus. However, the increase in calcium content in acid-curd cheese from milk with gluconate addition, was only 8.93 - 12.78%, while introducing of citrate and bisglycinate (20 mg Ca 100 g^{-1} milk) into the milk increased calcium content in cheese by 15.00 - 22.00%, compared to the control acid-curd cheese. It was showed that autumn acid-curd cheese had a higher level of manganese, molybdenum and selenium, compared to cheese from the spring-summer production season.

The addition of increasing doses of calcium into milk in the form of six calcium compounds increased significantly the content of this macroelement in a whey. The highest migration of calcium from milk to whey was determined in whey from the production of acid-curd cheese from the spring-summer season with the addition of 20 mg Ca 100 g^{-1} in the form of calcium carbonate. The type of calcium compound, production season and the interactions of all three analyzed factors (season, compound type, a dose of calcium) had a significant impact on the content of calcium in whey.

An indication of a calcium compound that was the most preferred additive which affected the quality of acid-curd cheese from goat milk is a major challenge due to the number of evaluated parameters in acid-curd cheese. In general evaluation, the yield, chemical composition and organoleptic characteristics of the curd were most favorably influenced by the addition of calcium citrate and gluconate, especially compared to the commonly used calcium chloride.

Conducted research showed that for the integration of casein with whey proteins in the production of goat's acid-curd cheese with the heat processing of calcium enriched milk method, other calcium compounds than chloride can also be used. The obtained results have an applicative aspect and might play a major role in the designing of new functional products from goat's milk.