Determination of Calcium and Magnesium Content Following the Natural Brine Adding in Some Dairy Products

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Abstract

Our study aimed to determine and quantify the calcium and magnesium addition given by natural brine used in the processing of two dairy products. The research has been made on brine samples (natural and conventional) and commercially processed dairy (telemea and cheese) in the south-west Oriental Carpathian Mountains. We determined the calcium and magnesium content of the studied milk by two comparative methods (Perkin Elmer ICP device and complexometric method) together with other basic physical and chemical parameters: dry matter/humidity (steamer drying method), fat (butirometric method), sodium chloride (Mohr method) and pH (with an electronic pH meter). We also investigated the preferences of two consumer groups through tastings, for salted/unsalted cheese and cheese salted with natural/conventional brine. Data analysis revealed that calcium as well as magnesium content are significantly higher in Cheese ($p=0.008$) and natural brine ($p=0.009$) added in Telemea ($p=0.10$). In the consumer preferences, results have shown a predominance for salted Cheese (90.3%), followed by Cheese prepared in natural brine (69.2%). We concluded that, natural, mineral rich brine resulted to be mostly relevant and can increase the biological and sensory qualities of dairy products for a lower processing price.

Keywords: *brine, cheese, ICP, complexometrie, calcium, magnesium*

INTRODUCTION

Milk and dairy products occupy an important role in the human diet, serving as a major source for nutritional and biological active elements. Predominant elements in their composition are the macronutrients (proteins, lipids, carbohydrates) alongside with micronutrients (minerals and vitamins) that represent a smaller but essential component for sustaining the body's vital functions (Vahčić *et al.*, 2010).

The mineral fraction of milk is composed by macro elements (Ca, Mg, Na, K, P, Cl) and oligoelements (Fe, Cu, Zn, Se), distributed differently among the liquid and fatty phases of milk. The most part of calcium is found in the liquid phase, associated mostly (65%) with casein. Calcium, magnesium and zinc concentration of

milk is relatively constant, variation along the lactation pathway are insignificant (Haug *et al.*, 2007).

Minerals are present in every category of milk and dairy product, their content being influenced by processing. Calcium content depends upon the acidifying stage of processing and the acidifying stage along with the evacuation step, determine a fall of calcium content in cheese. It is considered that calcium content rises along the following dairy products: milk, fermented milk, cottage cheese, soft cheese, semi hard cheese and hard cheese (Gaucheron, 2011).

Besides the assured nutritional and biological value, the consumers needs for sensorial satisfaction and safety have to be met as well, that depend mostly on biochemical processes

and manufacturing technology. Their accuracy is mostly responsible for a superior final product in taste, aroma, texture and aspect (Ognean *et al.*, 2012; Someșan *et al.*, 2013).

Starting from these facts, milk processing in safe conditions has become a major preoccupation for today's society, due to the profound effects that food and diet have over the consumer's state of health. There is a tendency to promote sodium poor food due to the fact that there is evidence sustaining that a salty diet increases the risk for cardiovascular and renal disease (He and MacGregor, 2010, 2011). Moreover, it is demonstrated that a sodium poor diet is the most efficient measure to improve public health status (Asaria *et al.*, 2007).

Due to these studies that prioritize consumer health, the dairy industry is confronting a major challenge as it is known that salt is of grave importance in forming the savor and product safety of cheese (Johnson *et al.*, 2009). Small decreases (10 up to 25%) of salt content in cheese are accepted by consumers (Lawrence *et al.*, 2009), but a greater decrease in salt lowers consumer preferences (Ganesan and Brown, 2014). All these facts constitute basic arguments for maintaining essential characteristics and food safety of a certain product, in especially dairy.

The presented arguments justify the present study of evaluating and quantifying calcium and magnesium content and the influence of natural brine in the process of obtaining dairy products in a sub Carpathian mountain region.

MATERIALS AND METHODS

Between October 2014 and March 2015, two batches of processed dairy products have been taken into study (Cheese and Telemea) with two batches of brine (natural and conventional) collected from a processing plant in the south-west Oriental Carpathian Mountains. This plant processes milk obtained in conditions of the sub Carpathian mountain region, where indigenous cattle breeds are held in traditional and commercial farming conditions. The predominant breed in this area is Romanian Spotted breed and its mixes that, through a long lasting selection developed lines with a great capacity to adapt to the local conditions. These proved resistant to disease and well adapted to the climate and the mountain region. The feed of these cows consist mainly of

grazing in the summer and dry feed (hay) from this region, during the winter, with the addition of concentrates (maize and hulls).

Research started by identifying cheese types and integrating them into product standards according to today's legislation requirements and those set by the processing plant. Therefore, based on the evaluations made, it has been set, that the two types of dairy, Cheese and Telemea are obtained using a traditional method, specific to the region taken into study. The particularity of this method is that it uses natural occurring brine as the region has a salt deposit.

The Cheese type taken into study has a 54% DM (dry matter) content and is obtained from standardized raw milk with a fat/protein ratio of 0.96 and coagulated with chymosin. The process includes: maturation at a pH of 4.9-5.2, followed by slicing and boiling (74-78°C) in a natural brine bath of 6-8%, finally drained, packed and deposited at 2-8°C.

The tested Telemea type contains 40% DM and is obtained from standardized milk with a fat/protein ratio of 0.87, pasteurized (85°C for 3 minutes) and coagulated with chymosin and added lactic acid and calcium chloride. The process includes: slicing the curd and maintaining it in natural brine of 14-16%, for 7-14 days, at 2-8°C; draining, packing and depositing at 2-8°C.

At this point we would like to mention, that to be able to quantify the impact of natural brine, we also used conventional brine for this study (made of water and salt) at the same concentration in NaCl as the natural one. Initially the salt concentration of the brine (natural and conventional) was 24% that was later diluted with water according to the concentration used in the production process (6-8% and 14-16% respectively).

Every month two samples of every batch were collected to be analyzed in the laboratory. A total number of 48 tests have been made, 12 for every sample. These were tested for physical and chemical properties, calcium and magnesium quantification (with Perkin Elmer ICP device and complexonometry) along with other basic parameters: dry matter/humidity (steamer drying method), fat (butirometric method), sodium chlorine (Mohr method) and pH (with an electronic pH-meter).

Research continued with tastings to inquire consumer preferences of two groups for the

following types of cheese: salted cheese/unsalted cheese and cheese salted with natural brine/cheese salted with conventional brine, respectively.

Obtained data has been statistically analyzed with GraphPad InStat 3 ($p=0.05$ representing a significant result) and Fisher test.

RESULTS AND DISCUSSION

Calcium and magnesium content revealed variations among the two types of dairy products and the two types of brine, linked to product type and inorganic component.

Calcium and magnesium evolution in types of dairy revealed a mean level of 855 mg/100g of calcium in Cheese 605.8 mg/100g in Telemea, the differences between the two types are statistically significant ($p=0.008$). Comparative analysis of these values showed 294.2 mg greater calcium content in Cheese as in Telemea (Fig. 1). As for mean magnesium values, results have showed a mean value of 40.02 mg/100g for cheese and 64.3 mg/100g for Telemea (Fig. 2). By comparing these results, a higher magnesium level of 24.28 mg in Telemea as compared to Cheese has been revealed, without any statistically significant correlation among the set values ($p=0.10$).

Calcium and magnesium evolution in types of brine indicated a mean calcium level of 529 mg/L in natural brine and 87.7 mg/L in conventional brine, the differences being statistically significant ($p=0.009$). These results showed a 414.3 mg/L higher calcium level in natural brine as compared to the conventional type (Fig. 3). The results

of this study revealed 59.7 mg/L magnesium content of magnesium in natural brine and 30.4 mg/L in the conventional one (Fig. 4). As results indicated, natural brine contains 29.3 mg/L more magnesium than the conventional brine, the correlation between the values having a statistical significance ($p=0.04$).

NaCl and pH results showed a NaCl content of 24% (240 g/L) for both types of brine and a pH value of 6.59 in natural brine and 6.94 for conventional brine respectively.

The data obtained from the comparative determination of calcium levels in unsalted and salted (with natural brine) Cheese revealed some differences between the two types. Unsalted cheese has had a mean calcium content of 766 mg/100g, whereas salted Cheese has had a mean calcium content of 780 mg/100g, with statistically significant differences ($p=0.87$). As for magnesium levels of the two types of cheese, results indicated a mean magnesium level of 25.8 mg/L for unsalted Cheese and 26.1 mg/L for salted cheese, with statistically insignificant differences ($p=0.73$).

The data obtained from the comparative determination of calcium levels in unsalted and salted (with natural brine) Telemea revealed some differences between the two types. The unsalted type has had a mean calcium content 739 mg/100g and salted type a mean calcium content of 927 mg/100g, with statistically insignificant differences ($p=0.04$). The mean magnesium content for the two types of Telemea showed 28.8 mg/L in the unsalted and 43 mg/L in the salted

Fig.1. Mean values of calcium in types of dairy

Fig.2. Mean values of magnesium in types of dairy

Fig.3. Mean values of calcium in brine

type, with statistically significant differences ($p=0.0001$).

Analyzing these results together, it is safe to confirm that calcium and magnesium rich natural brine brings an addition of these minerals to both types dairy products taken into this study. The most important addition of calcium (188 mg/100g) magnesium (14.2 mg/100g) has been made for Telemea. This is explained by the fact that in the case of Telemea a greater concentration (14-16%) of natural brine has been used than in the case of Cheese (6-8%). In addition to this, during the fabrication process of Telemea 2% of calcium chloride has been added, although new studies show that calcium chloride addition (10%) does not result in statistically relevant modifications (McMahon *et al.*, 2014).

According to the Institute of Medicine (1997) and Ross *et al.* (2011), recommended daily dose (RDD) for calcium is 700-1300 mg/day and for magnesium 65-350 mg/day. Viewed in this context, the results of the study showed that a daily intake of 100 g of Cheese or Telemea covers the calcium necessities of an adult for up to 60-70% and in 100% that for magnesium.

Mean salt content values reached 1.48% (14.8 g/kg) for Cheese and 4.76% (47.6 g/kg) for Telemea. These results show that salt content is sufficient (Telemea), even though there have been some difference between dairy types, but this kind of results were communicated by other recent studies as well (Hashem *et al.*, 2014). Even though the importance of salt in obtaining the

Fig.4. Mean values of magnesium in brine

texture and savor of the product has been already demonstrated (Pastorino *et al.*, 2003; Shrestha *et al.*, 2011), the tendency is to reduce the Na content or to replace it with other chlorine salts (K, Mg, Ca) (Johnson *et al.*, 2009), but this has a negative influence upon savor and consumer acceptance (Grummer *et al.*, 2013). Other researchers went further and quantified the effect on the micro flora in dairy when replacing totally or partially NaCl with KCl, but the results have been insignificant (Wachowska, 2011; Ayyash *et al.*, 2012.).

In consumer preferences through comparative tasting of salted and unsalted Cheese, 90.3% (28 out of 31) preferred salted Cheese, the recorded differences have been statistically insignificant ($p=0.07$). Consumer preferences in comparative tasting of salted Cheese with natural brine versus conventional brine, 69.2% (18 out of 26) have chosen natural brine, the differences being also statistically insignificant ($p=0.16$).

Our results indicate that salinity is an important sensorial attribute of food and implicitly dairy products, results that have been published by other researchers as well (McMahon *et al.*, 2014). Even though adequate sodium content is vital for health and savor, its excess is link to the development of hypertension and associated pathologies (Karppanen *et al.*, 2005). Taking this into account, WHO (2006) recommended a decrease in salt intake (under 5g/day) as being one of the most important prevention methods for non-transmissible diseases (Hashem *et al.*, 2014). It has been proven that a sodium rich diet during

adolescents has negative implications on bone tissue development. Plus, the reduced magnesium and calcium retention caused by a sodium rich diet has negative implications on arterial pressure and cardiovascular disease (Palacios *et al.*, 2013).

There are technological limitations in sodium use linked to the processing of food and consumer preferences that forces the food industry to discourage sodium reduction tendencies. Despite all this, mandating sodium reduction in some food categories would make the food industry to come up with a few creative solutions that would allow sodium reduction without compromising food safety and consumer preferences. There is no doubt that sodium reduction will be difficult, but there is also no doubt that reducing sodium levels is essential for the health of the population (Liem *et al.*, 2011).

CONCLUSION

The data obtained showed significantly higher calcium content in Cheese ($p=0.008$) and natural brine ($p=0.009$), and magnesium content in Telemea ($p=0.10$). We have also found out that natural brine has a greater calcium (188 mg/100g) and magnesium (14.2 mg/100g) contribution to Telemea. Consumer preferences are higher for salted Cheese (90.3%) and for cheese salted through natural brine (69.2%). In the end we conclude that, natural, mineral rich brine resulted to be mostly relevant and can increase the biological and sensory qualities of dairy products for a lower processing price.

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