JAP&T
TPA-Timişoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2018, *24* (4), 224-229

Journal of Agroalimentary Processes and Technologies

Cow's cheese as mineralizing food

A. M. Ivana[1], M.1. Adamescu[1], L. Radu[1], Liana Maria Alda[1*]

[1]Banat`s University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, Faculty of Food Engineering, Calea Aradului 119, Timisoara 300645, Romania.

Abstract

The paper presents the results obtained in the determination of essential minerals from cow's cheese and the estimation of the mineral intake of this food in the recommended daily diet. The total concentrations of K, Ca, Mg, Zn, Fe, Cu and Mn from cow cheese samples from the Banat - Romania area were determined by atomic spectrometry. Average concentrations of the cheese samples analyzed elements: 4650 ± 305 mg/kg Ca, 425 ± 29.4 mg/kg Mg, 1220 ± 131 mg/kg K, 8.72 ± 1.2 mg/kg Fe, 21.0 ± 3.14 mgkg Zn, 0.87 ± 0.25 mg/kg Cu and 1.08 ± 0.28 mg/kg Mn allowed the calculation of the coverage of the zinc mineral required for 100 grams consumption of this food. Under the present experiment, a daily consumption of 100 g of cow cheese can provide: 46.50 % of the Ca requirement, 3.30 % of the K requirement, 10.63 % of the Mg requirement, 19.09 % of the Zn requirement, 10.90 % of the Fe requirement, 9.67 % of the Cu requirement and 2.70% of the Mn requirement for men, respectively 46.50 % of the Ca requirement, 3.30 % of the K requirement, 13.28 % of the Mg requirement, 26.25 % of the Zn requirement, 4.84 % of the Fe requirement, 9.67 % of the Cu requirement and 3.44% of the Mn requirement for women. Under these conditions, it can be argued that the assortment of cheese taken in the experiment can be considered as an additional source of Ca and Zn, but also of Mg, Cu and Fe, for both genders.

Keywords: essential elements, cow's cheese, mineral intake.

1. Introduction

Cheese is an important dairy product with high nutritional value due to its substantial contribution to human health, which is a rich source of essential nutrients such as proteins, bioactive peptides, amino acids, fats, fatty acids, vitamins and minerals [1, 2, 3]. A diet rich in cheese is associated with resistance to various diseases such as diabetes, obesity, cardiovascular disease, osteoporosis and cancer, and the emphasis they have on [1, 4].

It is known that a high number of types of cheese can be classified according to the milk used in making, the consistency, the fat content, the fermentation, the appearance, etc., differ in flavor as well as some bioactive components [1], which are mainly created during fermentation, proteolysis and lipolysis during the different stages of the ripening process when the main ingredients lactose, protein and fat are broken down by fermentation, proteolysis and lipolysis [5]. The average composition of different types of cheese (fresh, soft, semi-hard, hard and extra-hard cheese) varies widely between 300-700 g/kg water, 110-290 g/kg protein, 80-330 g/kg fats, 0.00-30 g/kg lactose, 60-80 g/kg minerals + vitamins [1]. The chemical composition, respectively the nutritional value of the various assortments of cheese, varies according to the milk origin (eg, the species and breed), breeding conditions (eg, feeding and management), and cheese-making technology (eg coagulation process, addition of salt, period) [6]. All milk samples contains the same type of constituents but in varying amounts. For example, the crude cow's milk composition in U.S.A. is 87.5% water, 4.9% lactose (carbohydrate), 3.4% fat, 3.3% protein, and

Corresponding author: *e-mail:* Essam.ahmed@agr.kfs.edu.eg

0.7% minerals (ash) 3.3% protein and 0.7% minerals (ash) [7].

Brined cheese is a type of cheese obtained from cow, buffalo, sheep or goat milk which is part of the category of traditional cheese-cheese ripened in brine, which has the characteristic to be ripened and stored in brine until their consumption [8]. Cheeses can be very similar, but also quite different in terms of the protocols of obtaining, the composition and the organoleptic and mechanical properties, etc. Due to their diversity, the cheeses can be divided into cheeses, the curds of which are not subjected to any heat treatment, which may be collectively called (white brined cheeses) and cheeses whose curds are subject to various heat treatments, which will be discussed briefly under the head (miscellaneous brined cheeses) [8].

Cow brined cheese, cow's cheese, is part of white brined cheeses but has characteristic nutritional and organoleptic properties. The composition and nutritional characteristics of the cow's cheese are mainly determined by the milk used to make it [8]. The average composition of cow's milk is 3.6% fat, 4.7% lactose, 3.2% protein, 60 kcal/100 mL energy, 122 mg/100 g calcium, 119 mg/100 g phosphorus, 126 IU vitamin A and 2.3 IU vitamin D [9]. The gross cow's milk composition in the U.S. is 87.5% water, 4.9% lactose (carbohydrate), 3.4% fat, 3.3% protein and 0.7% ash [7]. The mineral content of milk depends on many factors, such as: genetic characteristics, lactation stage, pedoclimatic conditions, fodder type, etc. [10, 11]. The bibliographic references reveal that cow's milk contain large amounts of macro elements (Na, K, Ca, Mg, Cl, P) and large amounts of microelements (Fe, Cu, Zn, Mn, Cr, Se) concentration [7, 9, 12, 13, 14], determined by a series of genetic factors, lactation stage, pedoclimatic conditions, fodder type, etc. [11].

Increased concentrations of these essential minerals present in cow's milk are found in cow's cheese, the final product obtained by processing it. Therefore, cow's cheese is a food with an important mineral input, determined mainly by the mineral profile of the milk and by the practices used during processing [15]. The literature data is poor in providing informations on the distribution of mineral elements in cow's cheese [2, 16, 17, 18, 19, 20, 21].

Analyzing the chemical composition, the mineral content and the cholesterol levels of some regular and reduced-fat white brined cheeses and strained yoghurt, D. A. Jaoude *et al.* [16] found that the basic nutrients, cholesterol and mineral content of white brined cheeses show different values, depending on the type of cheese. For example, Akkawi, Halloumi and Braided (mujaddal) - firm/semi hard cheeses have the following nutritional characteristics: 46.6 9 (in Braided, full-fat) - 54.3 (in Akkawi, full-fat)% moisture; 3.3 (in Akkawi, full-fat) - 22.7 (in Halloumi, full-fat)% fats; 16.9 (in Akkawi, low-fat) - 23.6 (in Braided, full-fat)% protein; 5.0 (in Halloumi, full-fat) - 13.1 (in Braided, low-fat) % ash; 0.3 (in Braided, full-fat) - 1.1 (in Akkawi, low-fat)% lactose; 331.5 (in Braided, low-fat) - 69.3 (in Halloumi, full-fat) mg/100g for cholesterol. Concentrations of macro and microelements in these cheeses are as follows: 51.1 (in Halloumi, low-fat) - 60 (Braided, full-fat) mg/100 g - for K; 333 (in Braided, full-fat) - 478 (Braided, low-fat) mg/100g - for P; 1019 (in Halloumi, low-fat) - 5012 (in Braided, low-fat) mg/100 g - for Na; 34 (in Akkawi, full-fat) - 170 (in Braided, low-fat) mg/100g - for Mg; 320 (in Braided, full-fat) - 757 (in Halloumi, low-fat) mg/100g - for Ca; 4.0 (in Akkawi full-fat, Halloumi full and low-fat) -9 (in Braided, low-fat) mg/100 g - for Zn.

Similar results have also been obtained by W. A Mustafa *et al.* [17], who analysed the chemical composition of Jibna-beida produced from cow milk at a small scale-level in Dueim city, the largest market of Jibna-beida in Sudan. The results show that the cheese varieties obtained from cow's milk show significant amounts of protein (14.17 - 15.73%), fat (18.92 - 22.27%) and total mineral substances (3.77 - 5.60%). The concentration of the essential minerals is obviously unequal, their concentration limits being within the following limits: 0 - 0.13±0.006 mg/100g Mn, 0.34±0.029 mg/100g Fe, 0.40±0.006 - 0.55±0.017 mg/100g Pb, 5.39±0.341 - 7.90 ± 0.445 mg/kg Zn, 189±10.790 - 315±8.083 mg/kg Na, 49.33±1.853 - 79.00±4.041 mg/100g K, 398±16.166 - 521±13.279 mg/kg Ca and 91.12±0.136 - 108.00±2.309 mg/100g P.

The fact that cow brined cheese is a food rich in essential minerals is also confirmed by M. Barać *et al.* [18], which found that traditional white brined cheeses analyzed: Zlatar cheese, Sjenica cheese and Homolje cheese contain high amounts of macroelements, which in a study on the fatty acid profiles and mineral content of Serbian traditional white brined cheeses (mg/100 g of lyophilized

cheese): 821.0 (Homolje cheese) - 1422.3 (Sjenica cheese) Ca, 729.2 (Homolje cheese) - 1375.5 (Sjenica cheese) P, 124.5 (Homolje cheese) - 290.4 (Sjenica cheese) K, 1570 (Sjenica cheese) - 4040 (Zlatar cheese) Na, 23.20 (Homolje cheese) - 34.78 (Sjenica Cheese) Mg and microelements (μg/100 g of lyophilized cheese): 5.81 (Homolje chees) – 8.08 (Sjenica cheese) Fe, 20.73 (Homolje Cheese) - 47.11 (Sjenica cheese) Zn, 0.544 (Zlatar cheese) - 0.73 (Sjenica cheese) Mn, 0.13 (Zlatar cheese) – 1.16 (Sjenica Cheese) Cu, 0.48 (Sjenica cheese) - 1.33 (Zlatar cheese) Co, 0.57 (Zlatar cheese) - 0.90 (Sjenica cheese) Cr, 0.199 (Sjenica cheese) - 0.25 (Homolje cheese) Ni. Finally, the authors of this study clearly highlighted the significant importance of white brined cheese in healthy human diet.

From the above it can be stated that the nutritional value of the cheese is given by the nature and the content of essential minerals: Ca, Mg, K, P, Zn, Fe, Cu, Mn, Se etc. which enter into the composition of this food value. Therefore, the interest in knowing the mineral profile in cow's cheese and assessing its mineral intake is fully justified.

The present experiment aims to determine the total concentrations of K, Ca, Mg, Zn, Fe, Cu and Mn from the sample of cow's cheeses from different profile stores in Timisoara - Romania and assess the mineral input of this food, Ca, Mg, K, Fe, Zn, Cu and Mn needed in the recommended daily diet.

2. Materials and Methods

2.1. Materials

To achieve the proposed objective, samples of cow's cheese were sampled, from which the 5 average samples of 10 ± 0.0002 g were prepared for each analysis.

2.2. Reagents

Nitric acid Merck, 65% (p = 1.39 g/cm^3) to prepare the nitric acid solution 0.5 N; Multi-element concentrated standard solution (1g/L) Merck-Germany to prepare working standards in concentrations that cover the concentration interval of elements in the analyzed cow's cheese samples; Distilled water.

2.3. Apparatus

Analytical scale Denve Instrument-Germany, model TP 2014; Thermal regulation calcining oven Nabertherm model 6/11; Thermal regulation electric stove; Flame atomic absorption spectrophotometer Varian 280 FS.

2.4. Procedures

Mineral elements analysis was performed using the atomic absorption spectrometry method using the method described by Rada *et al.*, 2018 [22]. The actual determination of the microelements was carried out in two steps: mineralization of the cheese samples by subsequent calcination followed by the ash dissolution in 0.5 N HNO_3 and the measurement of the absorbance of the mineral elements in the acid solution. The calcination of the cheese samples was carried out in the Nabertherm calcination furnace at 550 °C in two 4-hour increments. The ash resulting from calcination was resumed with 20 mL of 0.5N HNO_3 solution, then evaporated (on the electic hob) to near dryness. The operation was repeated two more times, then quantitatively added to 50 ml using small portions of 15 ml of 0.5 N HNO_3 and distilled water.

Measurement of the absorbent elements of clear solutions (50 ml) was performed using the Varian 280 FS Spectrometer, under the conditions recommended by the machine supplier. Simultaneously with the absorbance measurement of the analyzed samples and under the same working conditions, the absorbances of the calibration solutions were determined. For the certainty of the experimental results, triple samples were used.

3. Results and Discussions

The experimental results obtained in the analysis of the essential elements of the cheese samples taken in the experiment are presented in Table 1.

As can be seen from Table 1, the distribution of the analyzed mineral elements presents a high degree of unevenness, depending on the nature of the element and the origin of the sample.

The best represented among the analyzed elements are the macroelements, their weight representing about 99% of the total analyzed elements. Out of these, the best represented is calcium, determined concentrations between 4310-5050 mg/kg, followed by K and Mg, which were identified within lower concentration ranges between 1050-1370 mg/kg and 385-455 mg/kg.

Microelements were identified in concentrations much lower than macroelements, with their mean concentrations ranging from 0.62±0.27 - 21.0±3.14

mg/kg. These values do not in any way minimize the importance of these essential bio-elements, which even in very small concentrations have particularly important roles in the proper functioning of the body. Among the trace elements, Zn was demined at the highest concentrations (16.03 - 24.00 mg/kg), followed by Fe, which was determined in sensitively reduced concentrations of Zn (7.02 - 9.81 mg/kg). Cu and Mn are the least represented microelements in all samples of the analyzed cheese, their concentration limits presenting close values: 0.54 - 1.13 and 0.44 - 1.08 mg/kg, respectively.

Table 1. The distribution of some esential elements in cow's cheese

Specification	Mineral content, mg/kg						
	Ca	Mg	K	Fe	Zn	Cu	Mn
Minim values	4310	385	1050	7.02	16.03	0,54	0.44
Maximun values	5050	455	1370	9.81	24.00	1,13	1.08
Average	*4650± 305*	*425± 29,4*	*1220± 131*	*8,72± 1,22*	*21,00± 3,14*	*0,87± 0,25*	*0,62± 0.27*

Table 2. Mineral supply in the recommended daily diet corresponding to 100 g of cow's cheese

People range	Mineral supply (%)						
	K	Ca	Mg	Fe	Zn	Cu	Mn
Men aged, 19-50	3.30	46.50	10.63	10.90	19.9	9.67	2.70
Women aged, 19-50	3.30	46.50	13.28	4.84	26.25	9.67	3.44

Comparing the experimental results obtained by the authors of this study with the results obtained by other researchers, no significant differences can be observed in the analysis of similar cheeses [18].

From the above it can be argued that the analyzed cow cheese shows increased content of macroelements and appreciable microelements, their distribution having the following decreasing trend: Ca (4650 mg/kg)> K (1220 mg/kg)> Mg (425 mg/kg) >> Zn (21.00 mg/kg)> Fe (8.72 mg/kg) >> Cu (0.87 mg/kg) ≅ Mn (0,62 mg/kg).

The average concentrations of the mineral elements determined in the cheese samples taken in the experiment (Table 1) suggest the idea of using this food as an additional source rich in such essential minerals, namely the use of cow's cheese as an additional source of Ca, Mg, K, Fe, Zn, Cu and Mn. To assess the mineral supply of the analyzed cow cheese, and to determine the degree of coverage of the required daily intake of Ca, Mg, K, Fe, Zn, Cu and Mn, we took into account the individual values of the required microelements in the recommended daily intake in men and women aged 19-50 (3700 mg K for men and women, 1000 mg Ca for men and women, 400 mg Mg for men and 320 mg Mg for women, 8 mg Fe for men and 18 mg Fe for women, 11 mg Zn for men and 8 mg Zn for women, 0.9 mg Cu for men and women, 2.3 mg Mn for men and 1.8 mg Mn for women) [23] and the amount of caw cheese consumed.

Mineral intake in the recommended daily intake corresponding to each microelement was calculated with the relation:

$$MI\,[\%] = \frac{c}{m} \cdot 100$$

were: MI – mineral supply, c –mg of element in the 100 g of cow cheese, m – mg of element recommended/day

In our experiment, a consumption of 100 g of cow cheese corresponding to a quantity of 465 mg of Ca, 42.5 mg of Mg, 122 mg of K, 0.872 mg of Fe, 2.1mg of Zn, 0.012 mg of Cu and 0.062 mg of Mn, represents a considerable percentage of the mineral necessary daily intake. (Table 2 below).

As can be seen from Table 2, the values obtained in assessing the cow cheese's mineral intake, the percentage of coverage of the daily mineral requirement, show different values depending on the consumer and the amount of element contained in the mass of the cheese consumed.

Under the present experiment, a daily consumption of 100 g of cow's cheese provides much of the daily mineral requirement, as follows:

- 46.50% of the Ca requirements, 3.30% of the K requirements, 10.63% of the Mg requirements, 19.09% of the Zn requirements, 10.90% of the Fe, 9.67% of the Cu and 2.70% of the Mn requirements - for Men;
- 46.50% of the Ca requirement, 3.30% of the K requirement, 13.28% of the requirement Mg, 26.25 of the Zn requirement, 4.84 of the Fe requirement, 9.67% of the Cu requirement and 3.44 of the Mn requirements - for Women.

Under these conditions, it can be argued that the assortment of cheese taken in the experiment can be considered as an additional source of Ca and Zn, but also of Mg, Cu and Fe.

4. Conclusion

The native cow cheese in the study contains important amounts of essential minerals: Ca (4650 mg/kg), K (1220 mg/kg), Mg (425 mg/kg), Zn (21.00 mg/mg/kg), Cu (0.87 mg/kg) and Mn (0.62 mg/kg).

Under the conditions presented in this study a consumption of 100 g of cheese provides an important percentage of the daily mineral requirement, as follows: 46.50% Ca, 19.09% Zn, 10.90% Fe, 10.63% Mg, 9.67% Cu, 3.30% K, 2.70% of Mn - for men and 46.50% Ca, 26.25% Zn, 13.28% Mg, 9.67% Cu, 4.84% Fe, 3.44% Mn, 3.30% K - for women.

Our experiment shows that cow 'cheese analyzed can be a supplementary source of Ca and Zn, but also of Mg, Cu and Fe, for both gendres.

It is hoped that the experimental results obtained could be used to distinguish between traditional cow cheeses from another types of cheeses: sheep, goat etc.

Acknowledgments: PNCDI III 2015-2020 – ID 368 institutional development project:"Ensuring excellence in R&D within USAMVBT" from the institutional performance subprogram 1.2, development of the R&D national system program 1.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

References

1. Walther B., Schmid A., Sieber R., Wehrmüller K., Cheese in nutrition and health, *Dairy Sci. Technol*., **2008**, *88*., 389 – 405
2. Nour El Diam, M.S.A., El Zubeir Ibtisam, E.M., Chemical Composition of Processed Cheese Using Sudanese White Cheese, *Research Journal of Animal and Veterinary Sciences*, **2010**, *5*, 31-37.
3. Levkov V. , Stafilov T., Pacinovsk N., Bačeva K., Mateva N., Gjorgovska N., Eftimova E., Kostadinov T., Content of major and trace elements in raw ewes' milk used for production of traditional white brined cheese, Slovak J. Anim. Sci., **2017**, *50*, 7–14
4. Murphy K.J., Crichton G.E., Dyer K.A., Coates A.M., Pettman T.L., Milte C., Thorp AA, Berry NM, Buckley JD, Noakes M, Howe PR, Dairy Foods and Dairy Protein Consumption Is Inversely Related to Markers of Adiposity in Obese Men and Women, *Nutrient*s, **2013**, *5*(11), 4665-4684.
5. Molimard P., Spinnler H.E., Review: compounds involved in the flavor of surface mold-ripened cheeses: origins and properties, *J. Dairy Sci*., 1996, *79*(2), 169 -184.
6. Manuelian C.L., Currò S., Penasa M., Cassandro M., De Marchi M., Characterization of major and trace minerals, fatty acid composition, and cholesterol content of Protected Designation of Origin cheeses, *J Dairy Sci.*, **2017**, *100*(5), 3384-3395
7. Cadar O., Tănaselia C., Miclean M., Levei E., Șenilă M., Șenilă L., Analysis of Minor and Trace Elements in Cow, Goat and Sheep Milk in the NW Part of Romania, *ProEnvironment*, **2016**, *9*, 87 – 90.
8. Alichanidis E., Polychroniadou A., Characteristics of major traditional regional cheese varieties of East-Mediterranean countries: a review, *Dairy Sci. Technol*. **2008**, *88*, 495–510.
9. Paula C., Pereira Ph.D., Milk nutritional composition and its role in human health, *Nutrition*, **2014**, *30*, 619–627
10. Mourad G., Guess B., Medjekal S., Review Composition and nutritional value of raw milk, *Biological Sciences and Pharmaceutical Research*, **2014**, *2*(10), 115 – 122.
11. González-Martín I., Hernández-Hierro J. M., Revilla I., Vivar-Quintana A., Lobos-Ortega I. and González-Pérez C., Changes in the Mineral Content in Cheeses of Different Compositions during 6 Months of Ripening, *Czech J. Food Sci*., **2009**, *27*, S11-S18 Special Issue.

12. Slačanac V., Hardi J., Lučan M., Koceva Komlenić D., Krstanović V., Jukić M., Concentration of nutritional important minerals in Croatian goat and cow milk and some dairy products made of these, *Croat. J. Food Sci. Technol*,. **2011**, *3*(1), 21-25.
13. Spiteri R., Attard E., Determination of Major and Minor Elements in Maltese Sheep, Goat and Cow Milk Using Microwave Plasma-Atomic Emission Spectrophotometry, *Journal of Agricultural Science*, **2017**, *99*(8), 43-50.
14. Zamberlin Š., Antunac N., Havranek J., Samaržija D., Mineral elements in milk and dairy products, *Mljekarstvo*, **2012**, *62*(2), 111-125
15. Arafa M. S. Meshref, Walaa A. Moselhy, Nour El-Houda Y. Hassan, Heavy metals and trace elements levels in milk and milk products, *Food Measure*, **2014**, *8*, 381–388.
16. Abou Jaoude D., Olabi A., El Ouyoun Najm N., Malek A., Saadeh C., Baydoun E., Toufeili I., Chemical composition, mineral content and cholesterol levels of some regular and reduced-fat white brined cheeses and strained yogurt (Labneh), *Dairy Sci. Technol.*, **2010**, *90*, 699–706.
17. Mustafa W. A., Sulieman A. M. E., Abdelgadir W. S., Elkhalifa E. A., Chemical Composition of the White Cheese Produced at Household Level in Dueim Area, White Nile State, Sudan, *J Food Nutr Disor*, **2013**, *2*(2), 1-5.
18. Barać M., Kresojević M., Špirović-Trifunović B., Pešić M., Vučić T., Kostić A., Despotović D., Fatty acid profiles and mineral content of Serbian traditional white brined cheeses, *Mljekarstvo*, **2018**, *68*(1), 37-45.
19. Fresno J. M., Prieto B., Urdiales R., Sarmiento R. M., Carballo J., Mineral content of some Spanish cheese varieties. Differentiation by source of milk and by variety from their content of main and trace elements, *Journal of the Scence of food and Agricukture*, **1995**, *69*(3), 339-345.
20. Shaymaa S. Bakry, Mohamed A. Mohran, Nanis H. Gomah and EHAB A. Y. Essawy, Gross Composition of Milk and Dairy Products Produced in Assiut Villages, *Assiut J. of Agric. Sci.*, **2013**, *42*(3), 34-46
21. González Martín I., Hernandez-Hierro J. M. , Revilla ,I. Vivar-Quintana A. M., Ortega I. L., González-Pérez C., Determination of the Mineral Composition (Ca, P, Mg, K, Na) in Cheeses (Cow's Ewe's and Goat's) with Different Ripening Times Using Near Infrared Spectroscopy (NIRs) with a Fibre-Optic Probe, *Czech Journal of Food Sciences*, **2009**, *27*, S113
22. Rada M., Berbecea A., Alda L. M., Cozma A., Zippenfening S. E., Nemeş O. F., Alda S., Gogoaşă I., Preliminary research regarding the mineral intake of walnut kernel, *Proceedings of the International Conference on Life sciences*, First Edition July 2018, Filodiritto Publisher, Bologna (Italy), 921- 928.
23. http://www.nationalacademies.org/hmd/~/media/Files/Activity%20Files/Nutrition/DRI-Tables/5Summary%20TableTables%2014.pdf?la=en