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STUDY REGARDING THE QUALITY OF MILK FROM COWS REARED ON THE REDIU FARM

Mihaela IVANCIA[1], Marius Gheorghe DOLIȘ[1], Carmen Giorgeta NICOLAE[2], Marius Giorgi USTUROI[1], Roxana Nicoleta RAȚU[1*]

[1],,Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine of Iași, 3,MihailSadoveanu Alley, Iași, Romania
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Bucharest, Romania

Corresponding author email: roxana.ratu@gmail.com

Abstract

Assuring of raw material with superior quality, have particular importance because on this depends the obtaining of superior quality products as well as a realization of a superior capitalization index of raw material. Qualitative reception of milk was daily effectuated, through three control periods, as follows: 1st period: 23.12.2017 – 6.01.2018, 2nd period: 24.02 – 10.03.2018, 3rd period: 7 – 21.04.2018; gathering samples on which were determined: fat, protein titer, acidity, density as well as somatic cells. Statistical analysis of the main physical-chemical features show differences between those three control periods regarding milk fat content, modifications which reflected also on density. So, milk gathered in the first period recorded a mean value of 4.23±0.02%. For milk gathered in the second period, fat content had a lower value (4.03±0.03%) due to a change in cows' nourishment from preserved fodders to green ones. Milk analyzed in the third period, suffered some qualitative and quantitative modifications; animals recorded a higher milk production in comparison with the winter season, but fat content was lower. Generally, we could say that milk obtained at Rediu Farm, was in accord with the norms stipulated into quality standards.

Key words*: milk, quality, fat content, minerals.*

INTRODUCTION

Success in dairy cows farming due to the multiple factors related to animal husbandry technologies, company management and hygienic and veterinary prophylactic measures (Carlsson et. al., 1995).

Certain main objectives are to be followed in cows farming, such as: better exteriorizing of animals' genetic potential into the main product, maximizing the cows' productive longevity, turning their yield into efficient production, improving the nutritional quality of the milk and decreasing the production costs (Heck et. al., 2009).

Milk is a natural product with a complex chemical composition, secreted in the mammary gland on the basis of carbohydrates, proteins, vitamins, and minerals extracted from the circulating blood and converted into specific milk nutrients by the cells in the udder epithelium. (Pereira, 2014).

According to Codex Alimentarius (CODEX STAN, 1999), milk is defined as the product secreted by the mammary gland of one or more healthy, well rested and appropriately fed cows, obtained through a complete and hygienic milking.

Nutritionally, milk is considered one of the most important food matters in rational human nutrition, due to its complex chemical composition and to its biological value (Matte et. al., 2014).

Milk chemical composition could be influenced by both genetic and environmental factors (Miller et. al., 1970; Ujică and Maciuc, 2000; Bernabucci et. al., 2002).

Most of the dry matter in milk is represented by nitrogenous substances, most of them (95%) being proteins and 5% being non-protean nitrogenous compounds (Bille et. al., 2009; Harding, 1995).

The milk protein comprises casein (70 -80%) and serum (whey) proteins, such as lactalbumin and lactoglobulin (3.5% of the whole nitrogen in milk and 12% of that in colostrum) (Harding, 1995). The milk also comprises proteo-peptones (4 - 5%), such as creatine, creatinine,

urea, uric acid, and guanidine. These ones originate in blood and are part of the lipid goblets membranes in milk, as glycoproteins (Imran et. al., 2008; Ozrenk and Inci, 2008).
The fat in milk is synthesized in the mammary gland and is the milk compound presenting the highest variability as the proportion (3 – 5.4%) (Amitot et. al., 2002; Michalski et. al., 2005).
Lactose is the main milk carbohydrate, also synthesized by the mammary epithelium, starting from blood originating glucose (Norberg, 2005).
Most of the minerals in milk are found up to 0.7% and contain chlorides, phosphates and calcium citrates (Kittivachra, 2007).
The Ca/P ratio is quite relevant technologically because it interacts directly with the milk coagulation behavior (Blewu and Aiyegbusi, 2004).
Milk enzymes have an endogenous origin (bloodstream) (Andrews, 1992; Brew, 2003; Calore and Vingola, 2002).
Vitamins content is also important in milk, especially for the newborn and is strongly influenced by the diet of the lactating female (Schrodes, 1982; Florence, 2010).
Providing high-quality milk, as raw matter in the food industry is essential in order to guaranty the manufacturing of products presenting superior quality and high conversion efficiency (Borkova and Snaselova, 2005).

MATERIALS AND METHODS

Qualitative reception of raw matter milk was organized daily throughout three control timeframes: period I, 23.12.2017 - 6.01.2018; period II, 24.02 - 10.03.2018; period III, 7 - 21.04.2018.
Daily analytical assessments were carried on the sampled milk, in order to measure the raw matter density (g/cm3), acidity (˚T), total lipids (%), total proteins (%) and casein content (%).
By the end of each control period the samples were investigated for their content in crude ash (total minerals) and of certain subsequent macro elements such as Ca (mg/L), Mg (mg/L), Na (mg/L) and K (mg/L).
Milk density was measured using a thermolactodensitometer. This physical trait represents the ratio between the milk mass at +20˚C and the mass of the same water volume at a +4˚C temperature (SR 143:2008; SR 2418:2008).
Milk acidity was assessed via the Thörner method – neutralizing of organic acids with NaOH (0.1N) titration, using phenolphthalein as witness pigment (SR 2418:2008; SR 143:2008).
Total lipids content was quantified by the acid-butyrometric Gerber method (digestion of milk proteins with sulfuric acid followed by separation of lipids via centrifugation, under the influence of isoamyl alcohol and 65˚C temperature) (ISO 2446:2009; ISO 3433:2009 STAS 6352-1:1988).
Total protein content was measured through the Schúrltz titrimetric method: milk treatment with formaldehyde that locks the protein amino groups, followed by NaOH (0.143N) titration of the free carboxyl groups resulting in a direct value of protein percentage (Merliță et. al., 2018; Rațu et al., 2017).
Crude ash content was assessed via incinerating at 550ºC, in a Super Therm C311 oven after prior combustion with a Bunsen funnel, until samples ceased to smoke according to AOAC, No. 945.46 (2005).
The macro element's contents - Ca, Mg, Na and K - were quantified via atomic absorption spectrometry. The Atomic Absorption Spectroscopy (AAS) is an analytic technique widely used in research studies, which aim to determine inorganic ions in solution. The determination is both qualitative and quantitative. This method is based on the quantification of the energy released by an atom when it passes from an excited state to the ground state (Carroll et al., 2006; Summer et al., 2009).
Collected data were subjected to statistical computation, using the ANOVA one-way algorithm included in MsExcel, to calculate the descriptive statistics (mean, standard error) and find out whether there were significant differences and upgraded with PostHoc Daniel's XL Toolbox version 4.01 (http://xltoolbox.sf.net), to identify the differences (Radu-Rusu et. al., 2014).

RESULTS AND DISCUSSIONS

Certain differences with different degrees of statistical significance were found between the

average values of the physical and chemical milk traits measured in the three control periods. Thus, for the total lipids content, the average value was 4.26±0.02% in the first period (P_1), 4.03±0.03% in the second period (P_2) and 3.91±0.02% in the third period (P_3). Highly significant differences were identified for all three comparisons. The P_1 vs $P_2$and P_2 vs P_3 comparisons were found statistically significant ($P < 0.05$), while the P1 vs. P3 comparison was found as highly significant ($P < 0.001$) (Table 1). According to the quality standards, the milk fat content should not be less than 3.2%. All the samples analyzed by us, surpassing this concentration (Figure 1).

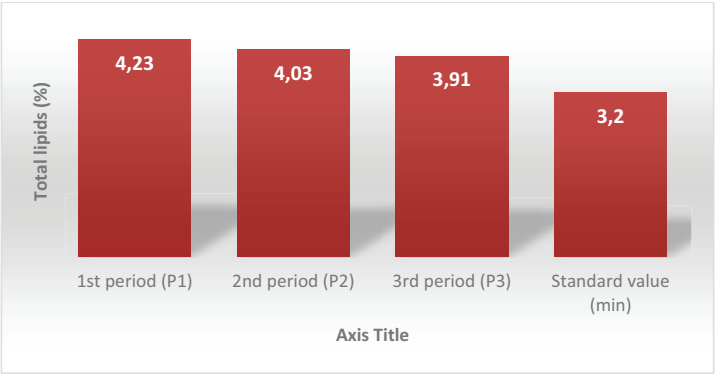

Figure 1. Total lipids content (%)

Milk titratable acidity reached 17.68±0.09˚T in P1 samples, 18.39±0.08˚T in P2 ones and 18.66±0.09˚T in P3 milk, with no statistical differences occurring between the three moments of analysis.

The total proteins assessment did not reveal statistical significance between the samples, while the average values reached 3.37±0.03% in P1, 3.34±0.02% in P2 and 3.31±0.02% in P3 samples (Table 1).

Table 1. Means (± SD) for the chemical composition of raw milk

Quality parameters	1st period (P1)	2nd period (P2)	3rd period (P3)	ANOVA computation and analysis		
				Compared period	P value	Significance
Total lipids (%)	4.23±0.02	4.03±0.03	3.91±0.02	P1 vs.P2	0.0024	***(P<0.001)
				P1 vs. P3	0.0029	***(P<0.001)
				P2 vs. P3	0.0022	***(P<0.001)
Density (g/cm^3)	1.0299±0.0001	1.0287±0.0001	1.0282±0.0001	P1 vs.P2	0.0153	*(P <0.05)
				P1 vs. P3	0.0003	***(P<0.001)
				P2 vs. P3	0.0192	*(P <0.05)
Acidity (˚T)	17.68±0.09	18.39±0.08	18.66±0.09	P1 vs.P2	0.4480	ns (P >0.05)
				P1 vs. P3	0.2386	ns (P >0.05)
				P2 vs. P3	0.6313	ns (P >0.05)
Total proteins (%)	3.37±0.03	3.34±0.02	3.31±0.02	P1 vs.P2	0.4908	ns (P >0.05)
				P1 vs. P3	0.0914	ns (P >0.05)
				P2 vs. P3	0.2867	ns (P >0.05)

ANOVA within rows: ns=not significant ($P > 0.05$); *=significant($0.01 < P < 0.05$), **=distinguished significant ($0.001 < P < 0.01$); ***=highly significant ($P < 0.001$)

The analysis of the crude ash content indicated 0.722±0.005% in P1 samples, 0.726±0.001% in P2 and 0.734±0.007% in P3, while the differences between these average values did not pass the statistical significance threshold.

Compared to blood, milk contains more K, Ca and P, and less Na and Cl, due to the Na-K pump that regulates osmotic pressure between the cytoplasm of blood cells and cytoplasm of epithelial cells that secrete milk. At the same

time, Ca is transported from the basal membrane to cytosol and onward into the Golgi apparatus of the alveolar cells in the mammary glands to be incorporated into casein micelles (Paulina and Bencini, 2004).

Serial dilutions were made from total ash in order to quantify the major mineral elements in milk.

The Ca content reached 1.194±0.001 mg/L in P1, 1.193±0.001 mg/L in P2 and 1.193±0.001 mg/L in P3 (Table 2) samples.

Calcium is named also "the mineral of milk" (Cashman, 2006) and close values to our findings were measured by Soliman (2005), which reported a Ca content of 1.19 mg/L, while Zamberlin et al. (2012) identified 1.07 – 1.33 mg Ca/L cow milk.

In milk, all of these macro-elements are distributed differently into soluble and insoluble fractions (essentially casein micelles). Potassium, sodium, and chloride ions are essentially soluble, while calcium, inorganic phosphate, and magnesium are partly bound to the casein micelles, therefore mostly insoluble (Guancheron, 2012).

The Mg content reached 115.8±0.374 mg/L in P1 samples, 116±0.707mg/L in P2 samples and 116.4±0.509mg/L in P3 samples.

Magnesium is a ubiquitous food mineral. Milk is a good source of Mg with an average content of 117 mg/L (De Marchi et. al., 2014).

The average Na content was of 529.6±0.50 mg/L in P1, 528.8±0.374 mg/L in P2 and 528.2±0.663mg/L in P3 milk samples.

Sodium is a monovalent cation mainly located in extracellular fluids.

If compared to other major minerals, its concentration in bovine milk is relatively low, with an average of 531 mg/L (De Marchi et. al., 2014).

Table 2. The mineral content of milk

Quality parameters	1st period (P1)	2nd period (P2)	3rd period (P3)	ANOVA computation and analysis		
				Compared period	P value	Significance
Crude ash (%)	0.722±0.005	0.726±0.001	0.734±0.007	P1 vs.P2	0.6195	ns (P >0.05)
				P1 vs. P3	0.2165	ns (P >0.05)
				P2 vs. P3	0.3773	ns (P >0.05)
Calcium (Ca) (mg/L)	1.194±0.001	1.193±0.001	1.193±0.001	P1 vs.P2	0.7690	ns (P >0.05)
				P1 vs. P3	0.6181	ns (P >0.05)
				P2 vs. P3	0.8066	ns (P >0.05)
Magnesium (Mg) (mg/L)	115.8±0.374	116.1±0.707	116.4±0.509	P1 vs.P2	0.8088	ns (P >0.05)
				P1 vs. P3	0.3705	ns (P >0.05)
				P2 vs. P3	0.6585	ns (P >0.05)
Sodium (Na) (mg/L)	529.6±0.509	528.8±0.374	528.2±0.663	P1 vs.P2	0.2415	ns (P >0.05)
				P1 vs. P3	0.1328	ns (P >0.05)
				P2 vs. P3	0.4534	ns (P >0.05)
Potassium (K) (mg/L)	1.539±0.003	1.540±0.003	1.539±0.005	P1 vs.P2	0.6938	ns (P >0.05)
				P1 vs. P3	0.6665	ns (P >0.05)
				P2 vs. P3	0.3465	ns (P >0.05)

ANOVA within rows: ns=not significant (P > 0.05); *=significant(0.01 <P <0.05), **=distinguished significant (0.001 < P<0.01); ***=highly significant (P <0.001)

The average K content reached 1.539±0.003 mg/L in the milk collected in P1, 1.540±0.003 mg/L in P2 milk and 1.539±0.005 mg/L in P3 samples (Table 2).

Potassium is one of the most important intracellular cations, but in a lower concentration is present also in the extracellular fluids. Potassium is found in cow milk, mainly in the aqueous phase, with an average concentration of 1.550 mg/L (De Marchi et al., 2014).

All the differences concerning the contents of the macro element in the milk sampled in the three control moments were not statistically (P >0.05) significant (Table 2).

CONCLUSIONS

The analyses run in our study revealed that the proximate composition of milk modifies upon season. The most significant differences

occurred for total lipids content and for milk density.

So, for example, the milk collected in the 1st period (P1) has the highest lipid content (4.25±0.02%). The milk collected in the 2nd period recorded a fat content was less than 0.2% compared to that of P1. For the milk collected in the 3rd period, the fat content was less than 0.32% compared to that of P1 and 0.12 compared to that of P2.

Acidity and density of analyzed milk were also inside the values indicated by SR 2418.

Despite the fact that the crude ash content and the individual analyzed macro-elements contents were different between the control moments, they did not differ significantly from the statistical point of view, hence the lack of seasonality influence on these quality traits.

So, for calcium content, the mean obtained by us had values between 1.193–1.194 mg/L. Magnesium content was 115.8±0.374 mg/L for milk collected in the 1st period, 116±0.707 mg/L for the for milk collected in the 2nd period and 116.4±0.509 mg/L for milk collected in the 3rd period. Content in sodium varied between 528.2±0.663 mg/L and 529.6±0.509 mg/L.

The potassium content varied between 1.539±0.003 mg/L and 1.540±0.003 mg/L.

REFERENCES

Amitot, J., Foumier, F., Lebeuf, Y., Paquin, P., Simpson, R. (2002). *Composition, propriétés physicochimiques. Valeur nutritive, qualité technologiques, et techniques d'analyse du lait*. Science et technologie du lait: transformation du lait, Montréal, Canada: Presses internationales polytechnique, 1– 73.

Andrews, A.T. (1992). *Indigenous milk enzymes, phosphatases.* In P.F. Fox (Ed.), Advanced dairy chemistry, Vol. 1, proteins (322–331). London, UK: Elsevier Applied Science.

AOAC (2005). *Official Methods of Analysis of AOAC* International 18th edn., Gaithersburg, MD, USA: Association of Official Analytical Chemists.

Bernabucci, U.N., Lacetera, N., Ronchi, B., Nardone, A. (2002). Effects of the hot season on milk protein fractions in Holstein cows. *Anim. Res*., 51, 25-33.

Bille, P.G., Haradoeb, B.R., Shigwedha, N. (2009). Evaluation of chemical and bacteriological quality of raw milk from neudammdairy farm in Namibia. *African Journal of Food, Agriculture, Nutrition and Development*, 9 (7).

Brew, K. (2003). *a-Lactalbumin*. In P.F. Fox, & P. L. H. McSweeney (Eds.), Advanced dairy chemistry, Vol. 1, proteins (pp. 387–419). New York, USA: Kluwer Academic Publishers–Plenum Press.

Borkova, M., Snaselova, J. (2005). Possibilities of different milk detection in milk and dairy products. A review. *Czech J. Food Sci*., 23, 41-50.

CODEX STAN 206-1999 - GENERAL STANDARD FOR THE USE OF DAIRY TERMS avaible on: http://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCODEX%2BSTAN%2B206-1999%252FCXS_206e.pdf

Carlsson, B.J., Bergstrom, J., Pehrson, B. (1995). Variations with breed, age, season, yield, stage of lactation, and breed in the concentration of urea in bulk milk and individual cow's milk. *Acta Veterinaria Scandinavica*, 36, 245– 254

Carole, L.,V. (2002). *Science et technologie du lait*. Québec, Canada: Fondation de technologie laitière du Québec Inc. Publishing House, 599.

Carroll, S.M., DePeters, E.J., Taylor, S.J., Rosenberg, M., Perez-Monti, H., Capps, V.A. (2006). Milk composition of Holstein, Jersey and Brown Swiss cows in response to increasing levels of dietary fat. *Anim. Feed Sci. Tech*., 131, 451-473.

Cashman, K.D. (2006). Milk minerals (including trace elements) and bone health. *Int. Dairy J*., 16, 1389-1398.

De Marchi, M, Penasa, M., Niero, G., (2014). *Characterization of major mineral contents in milk of four cattle breeds.* Corso di laurea magistrale in Scienze e Tecnologie Animali. Dipartimento di Agronomia Animali Alimenti Risorse Naturali e Ambiente. UNIVERSITÀ DEGLI STUDI DI PADOVA.

Florence, C.L. (2010). *Qualité nutritionnelle du lait de vache et de ses acides gras, voies d'amélioration par l'alimentation.* Ecole nationale vétérinaire d'ALFOR. thèse. Doctorat vétérinaire. P 51.

Gaucheron, F. (Auteur de correspondance) (2012). *Calcium phosphates in dairy products*. In: Heimann, Robert B.,*Calcium Phosphate Structure, Synthesis, Properties, and Applications.* Hauppauge, USA: Nova Science Publishers, 498 p.

Harding, F. (1995). *Milk quality* (1st ed.). London, UK: Chapman and Hall Publishing House.

Heck, H.J.F, Valenberg, J., Dijkstra, A.C.M., Hooijdonk, M. (2009). Seasonal variation in the Dutch bovine raw milk composition. *Journal of Dairy Science*, 92, 4745–4755.

Imran, M., Khan, H., Hassan, S.S., Khan, R. (2008). Physicochemical characteristics of various milk samples available in Pakistan. J. *Zhejiang Univ. Sci*., 9, 546-551.

ISO 2446:2009 – Milk and dairy products

ISO 3433:2009 - Milk and dairy products

Kittivachra, R.R., Sanguandeekul, R., Sakulbumrungsil, R., Phongphanphanee, P. (2007). Factors affecting lactose quantity in raw milk. *Songklanakarin J. Sci. Technol*., 29, 937-943.

Matte, J.J., Britten, M., Girard, C.L. (2014). The importance of milk as a source of vitamin B12 for human nutrition. *Anim. Front*., 4(2), 32–37.

Belewu, M., Aiyegbusi, O. (2004). Comparison of the mineral content and apparent biological value of milk from human, cow and goat. *Journal of Food Technology in Africa*, 7 (1), 9-11.

Michalski, M.C., Briard, V., Michel, F., Tasson, F., Poulain, P. (2005). Size Distribution of Fat Globules in Human Colostrum, Breast Milk and Infant Formula. *J. Dairy Sci*., 88, 1927–1940.

Mierliță, D., Pop, I.M., Lup, F., Simeanu, D., Vicas, Simona Ioana, Simeanu, Cristina (2018). The Fatty Acids Composition and Health Lipid Indices in the Sheep Raw Milk Under a Pasture-Based Dairy System. *Revista de chimie* (Bucharest), 69 (1), 160-165.

Miller, P., Lentz, W.E., Henderson, C.R. (1970). Joint influence of month and age of calving on milk yield of Holstein cows in the Northeastern United States. *J. Dairy Sci*., 53 (3), 351.

Norberg, E. (2005). Electrical conductivity of milk as a phenotypic and genetic indicator of bovine mastitis: A review. *Livest. Prod. Sci*., 96, 129-139.

Ozrenk, E., Inci, S.S. (2008). The effect of seasonal variation on the composition of cow milk in Van Province. *Pakistan J. Nutr*., 7, 161-164

Pereira, P.C. (2014). Milk nutritional composition and its role in human health. *Nutrition*, 30, 619627.

Radu-Rusu, R.M., Usturoi, M.G., Leahu, A., Amariei, S., Radu-Rusu, C.G., Vacaru-Opriş, I. (2014). Chemical features, cholesterol and energy content of table hen eggs from conventional and alternative farming systems. *South African Journal of Animal Science*, 44(1), 33-42.

Rațu, Roxana Nicoleta, Radu Rusu, R.M., Usturoi, M.G. (2018) Physical-chemical quality of the dairy milk gathered from Fleckvieh breed. *Scientific Papers-Animal Science Series*, 69 (23), 130 – 132.

Schrodes, M.J.A. (1982). Effect of oxygen on the keeping quality of milk. I. Oxidized flavor development and oxygen uptake in relation to oxygen availability. *J. Dairy Res*., (49), 407– 424.

SR 143:2008 – Milk and dairy products / Lapte și produse lactate

SR 2418:2008 – Milk, cream, flavored milk / Lapte, smântână, lapte cu arome

SR 143:2008 - Milk, cream, flavored milk / Lapte, smântână, lapte cu arome

Soliman, G.Z. (2005). Comparison of chemical and mineral content of milk from human, cow, buffalo, camel and goat in Egypt. *Egypt J. Hosp. Med*, 21, 116-130.

STAS 6352-1:1988 – Milk and dairy products / Lapte și produse lactate

Summer, A., Franceschi, P., Malacarne, M., Formaggioni, P., Tosi, F., Tedeschi, G., Mariani, P. (2009). Influence of somatic cell count on mineral content and salt equilibria of milk. *Ital. J. Anim. Sci*., 8, 435-437.

Ujică, V., Maciuc, V. (2000). *The genetic evaluation of exterior character in Romanian cattle population Black and white (BNR)*, Interbull meeting, Uppsala, Sweden.