RESEARCHES ON PHYSICOCHEMICAL CHARACTERISTICS IN RAW COW MILK

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Abstract: Milk is the nutritional fluid secreted by the mammary gland. The cow's milk contains significant amounts of carbohydrate (approx. 4.6%), fat approx. 4.3%) and protein (approx. 3.3%) and also represents an important source of calcium. Water is the main constituent of milk and much milk processing is designed to remove water from milk or reduce the moisture content of the product. Proteins are an extremely important class of naturally occurring compounds that are essential to all life processes. They perform a variety of functions in living organisms ranging from providing structure to reproduction. Milk proteins represent one of the greatest contributions of milk to human nutrition.

Milk is not only a source of nutrient lactation, but also the product that provides the body a wide spectrum of bioactive components, with multiple physiological activities in the gastrointestinal tract.

Keywords: Milk, water, nutrition.

Introduction

Milk is the nutritional fluid secreted by the mammary gland. The cow's milk contains significant amounts of carbohydrate (approx. 4.6%), fat approx. 4.3%) and protein (approx. 3.3%) and also represents an important source of calcium (Banu, C., 2007; Walstra, P. et al., 2008). Water is the main constituent of milk and much milk processing is designed to remove water from milk or reduce the moisture content of the product (Walstra, P. et al., 2008). Proteins are an extremely important class of naturally occurring compounds that are essential to all life processes. They perform a variety of functions in living organisms ranging from providing structure to reproduction. Milk proteins represent one of the greatest contributions of milk to human nutrition. Proteins are polymers of amino acids. Only 20 different amino acids occur, regularly in proteins. Fats supply the body with a concentrated source of energy: oxidation of fat in the body yields 9 calories/g. Milk fat acts as a solvent for the fat-soluble vitamins A, D, E and K and also supplies essential fatty acids (linoleic, linolenic and arachidonic). Lactose is the major carbohydrate fraction in milk. It is made up of two sugars, glucose and galactose. The average lactose content of milk varies between 4.7 and 4.9%, though milk from individual cows may vary more. Mastitis reduces lactose secretion.

Milk is not only a source of nutrient lactation, but also the product that provides the body a wide spectrum of bioactive components, with multiple physiological activities in the gastrointestinal tract. These activities are the consequences of the improvements of nutrient absorption, inhibition of enzymes, modulation of the immune system and protecting against pathogenic bacteria. Many of these bioactive substances are for storage and optimization of gastrointestinal health.

The term "gastrointestinal health" involves a lot of issues, many of them being interdependent. The structure, the integrity and functioning of the intestinal mucosa,

mucosal barrier that protects the body from invading bacteria and viruses, is dependent on the supply of essential nutrients. Therefore, nutrients are needed not only in the diet, but attendance must also be effectively absorbed through the cell membrane. Milk proteins that facilitate the absorption of essential nutrients are α-and β-casein, lactoferrin, protein which binds vitamin B12. Through the formation of fosfopeptidos from the digestion of casein, the use of calcium improves.

Also, the bioactive milk proteins can inhibit bacterial growth through retention of nutrients that are essential for the multiplication of bacteria. It has been demonstrated that the lactoferrin inhibits the development of harmful bacteria (for example E. coli), by binding the iron so tightly that they cannot gain access to it (Clare, D. A., 2000).

The antimicrobial activity of the milk is mainly attributed to immunoglobulin and other proteins: lysozyme, lactoperoxidase and lactoferrin. More recently, other whey protein, such as α-lactalbumin and β-lactoglubulin were also considered as potential precursors of bactericidal fragments. Similarly, antibacterial fragments were derived from α, β-and κ-casein. These peptides proved to be active against a broad spectrum of pathogenic microorganisms (for example Escherichia, Helicobacter, Listeria, Salmonella şi Staphylococcus), yeasts and filamentous fungi (Haque, E., 2008).

Chemical composition, i.e. the quality of cow milk may be affected by a number of factors such as: genetic factors, environmental factors, lactation stage, state of health, age, season, the manner and type of nutrition , the manner of milking, the number of lactation, and finally on the individual itself etc. (Tratnik L. J., 1998; . Kuchtik J., 2008) stability the stage of lactation also had a highly significant effect on all milk properties under study and on the rennet curdling quality.

Milk fat was the only milk ingredient measured for milk payment, but nowadays the payment criteria also include protein quantities, total microorganism count and somatic cell count in 1 mL, with compulsory determination of freshness.

Chemical composition and hygiene quality is of the greatest importance in public health, processing technology and the quality of milk products (Dobranić, V., 2008). The hygienic quality main indicators for fresh cow's milk are the total number of microorganisms and the somatic cell count (SCC) (Čačić Z., 2003; Atasever, S.2012; Atasever, S., 2013). The somatic cell count in the milk is closely connected to dairy gland inflammation, so the somatic cell count is acknowledged as an international standard in milk quality (Dobranić , V., et al., 2008; Harmon R. J., 2001).

Milk composition and factors affecting their variation throughout the lactation and relationships between milk yield and milk composition were studied in dairy cattle (Ng-Kwai-Hang K.F.,et al., 1984; Schutz M.M., et al.,1990; . Stanton T. L. et al., 1992).

The main objectives of this study were to obtain information with respect to the changes in physical and chemical components of raw milk collected from cattle bred in farms and households by age, i.e. lactating period.

Materials and methods

Raw materials

The material used in the conduct of the study was raw milk collected in the Western part of Romania. The raw milk was collected for analysis from two sources, one from the livestock farm (S1) and the other was from individual household (S2). The samples were taken from the morning milk, the quantity taken being of 500 mL. The

samples were accompanied by an information document containing the following data collection: The number of source and milk sample; Identification number of cattle; Date and time of collection of the milk; The age and the period of lactation of cattle. The samples were brought into the laboratory to determine the max. 45 minutes from the performing of milking.

Determination of physical - chemical analysis

The milk samples were collected during the months of January-June 2013 and they have been analyzed in terms of density, fat, total dry substance, acidity, lactose content. The physicochemical determinations were carried out in the laboratories of the Faculty of Animal Science and Biotechnologies. Evaluation of changes in the chemical composition of the milk samples was determining using the instrument MilkoScan® S54B, which works in infrared spectrometry. The measuring device prints the results after every measuring. The results are shown as percentages. The density and the acidity of the milk was determined by standard methods (Căpriţă R. 2002; Caprita, R. Etal., 2005).

Statistical analysis

All determinations were processed statistically with XLSTAT 7.5.2 by Principal Component Analysis (PCA). The values of the parameters are expressed as the mean (standard error and deviation standard) at confidence interval of 95%. To verify the relation between physicochemical characteristics and physiological factors, the following method of interpreting the Pearson correlation coefficients was used [17]: very strong association for a correlation of 0.7 or higher; substantial association for a correlation of 0.5 or higher; moderate association for a correlation of 0.3 or higher; low association for a correlation of 0.1 or higher. A p-value <0.05 was considered statistically significant.

Results and discussions

The results of the calculations have been centralized in Table 1.

Table 1. The physicochemical quality characteristics for milk samples are collected from source S1 and source S2.

	Density, (g/mc)	**Fat, (%)**	**DM, (%)**	**Acidity, (ºT)**	**Lactose, (mg %)**	**Lacting period (month)**	**Age, (years)**
Milk from the livestock farm (S1)							
Mean±SD	1.029±0.003	4.94±0.98	13.31±1,65	20.53±1.87	5.66±1.09	4.19±1.52	4.42±0.15
Minimum	1.02	2.7	9.6	18	3.6	2	4.2
Maximum	1.035	6.4	15.3	24	7	7	4.7
Milk from individual household (S2)							
Mean±SD	1.031±0.002	3.59±0.80	12.38±0.66	18.66±1.73	5.86±0.99	4.19±1.52	4.42±0.15
Minimum	1.027	2	11.1	14.5	4.3	2	4.2
Maximum	1.035	4.4	13.4	22	8	7	4.7

SD-standard deviation

Analyzing the results obtained during the study, it is found that the lowest density is recorded by samples of milk from source S1 followed by the samples derived

from source S2. Also, the high in fat content is most often from milk samples from source S1. The total dry substance shows high values in milk samples from source S1, with maximum 15.2% and the lowest values were recorded at the same source, 9.6%. Of note is that milk from S2 contains the highest lactose content of 8%.

In order to effectively determine the quality characteristics studied in the samples of milk, an evolution of the characteristics dependent on the season was undertaken. Thus, it was interpreted statistically each sample separately during the analysis period.

From the analysis of the change in the physicochemical components, it is found that source S1 of milk presents a high content of fat in particular in the months of March-June. Moreover, the fat does not record significant variations in the March-June period, the values being relatively constant with the exception of sample 7 when the fat had the lowest value (2.7%).

This aspect is noted on the same sample and content of lactose and total dry substance. Table 2 and Fig. 1 present the correlation between physicochemical characteristics with age and the period of lactation for milk samples from source S1.

Table 2. The Pearson correlation matrix among the dependent variables with lactating period and age for samples of milk from the livestock farm (S1).

	Density, g/cmc	**Fat, g%**	**SUT, %**	**Acidity, °T**	**Lactose, mg%**	**Lacting period**	**Age**
Density, g/cmc	1	-0.065	0.488	-0.103	**0.626**	0.407	0.407
Fat, g%	-0.065	1	**0.801**	-0.237	0.167	**0.540**	**0.540**
SUT, %	0.488	**0.801**	1	-0.299	0.484	**0.659**	**0.659**
Acidity, °T	-0.103	-0.237	-0.299	1	**-0.691**	**-0.497**	**0.497**
Lactose, mg%	**0.626**	0.167	0.484	**-0.691**	1	**0.614**	**0.614**
Lacting period	0.407	**0.540**	**0.659**	**-0.497**	**0.614**	1	**1.000**
Age	0.407	**0.540**	**0.659**	**-0.497**	**0.614**	**1.000**	1

In bold, significant values (except diagonal) at the level of significance alpha = 0,050 (two-tailed test)

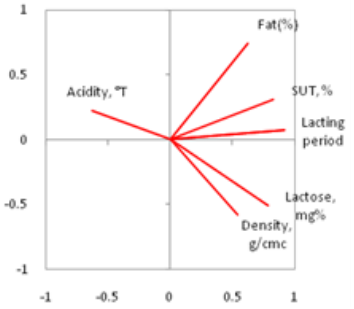

Fig. 1. Biplot graphic of the principal components for the dependent variables with lactating period and age for samples of milk from the livestock farm (S1)

Among the variables studied, it appears that the dry substance correlates highly significantly positively (r = 0.801) with milk fat. The same aspect is observed between the variables and the dry substance lactose, the correlation coefficient r = 0.484 indicates significant positive correlation.

The raw milk acidity correlates strongly negatively, the Pearson correlation index has the value of r =-0.691, i.e. the lactose content is low to an increase in the acidity of the milk. The period of lactation and age are significantly positively correlated with the fat (r = 0.540), it significantly positively increases with the dry substance (r = 0.659) and it correlates significantly positively with lactose too, the Pearson correlation index is r = 0.614. The acidity correlates not so much negatively with the period of lactation and age. The Pearson correlation index, r =-0.497 indicates that with the rise of the month of lactation, the acidity lowers. A significant influence of the stage of lactation on the chemical composition of milk was established by (Gonzalo, C., 1994; Fuertes, J.A., 1998).

The physicochemical analysis of milk samples obtained from source S2 show average quality characteristics of raw milk, with significant developments of all components. Exception makes the quantity of lactose that has a high value, 8 mg% and 7.2 mg%. The amount of lactose in the milk has reached the maximum of 8 mg% in March 11, and the smallest value of 4.3 mg lactose% determined on 8 March. The fat is located between the limits of 2 and 4.4%. In Table 3 and Fig. 2 it is shown the correlation between physicochemical characteristics with age and the lactation period for milk samples obtained from source S2.

Table 3. The Pearson correlation matrix among the dependent variables and the lactating, respectively the age of the cattle to the milk samples from individual household (S2)

	Density, g/cm³	**Fat, g%**	**SUT, %**	**Acidity, °T**	**Lactose, mg%**	**Lacting period**	**Age**
Density, g/cm³	1	**-0.736**	-0.124	-0.154	0.118	-0.154	-0.154
Fat, g%	**-0.736**	1	**0.763**	0.436	-0.252	0.309	0.309
SUT, %	-0.124	**0.763**	1	0.482	-0.260	0.292	0.292
Acidity, °T	-0.154	0.436	0.482	1	-0.223	0.115	0.115
Lactose, mg%	0.118	-0.252	-0.260	-0.223	1	0.081	0.081
Lacting period	-0.154	0.309	0.292	0.115	0.081	1	**1.000**
Age	-0.154	0.309	0.292	0.115	0.081	**1.000**	1

In bold, significant values (except diagonal) at the level of significance alpha=0,050 (two-tailed test)

The only significant correlation among the studied components is achieved between the dry substance content and the fat content of milk in source S2, the index of correlation r = 0.763 indicates strongly positive correlation. Other correlations are not significant.

Both the age and the period of lactation do not significantly affect the physicochemical components of quality studied in the milk source S2. The change of dry substance and the quantity of lactose might be influenced by the feeding mode of the cattle.

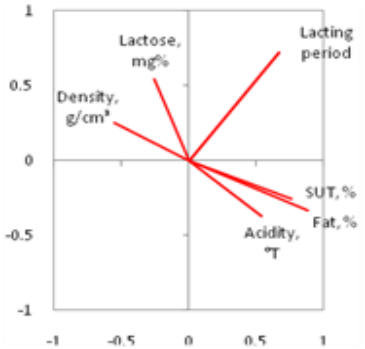

Fig. 2. Biplot graphic of the principal components for the dependent variables and the lactating, respectively the age of the cattle to the milk samples from individual household (S2)

Significant variations of qualitative characteristics of raw milk have been obtained during the winter at all milk samples. A sharper variation to the milk from their own household is noticed. The change in the qualitative characteristics of milk coming from the microfarm is not as evident as in this period, fact explained by constant food rations, specific to the conditions of farm and the genetic fund of the animal from where it comes the milk (mixed breed: Romanian Simmental). Insignificant variations in the qualitative characteristics of the raw milk during the spring-summer can be explained by the introduction of green forage to the cattle feed. Our study shows that the season has a significant influence on the chemical composition of milk and other studies in the specialty literature (Dobranić, V.et al., 2008) but (Tratnik L. J. et al., 1998; Havranek, J., 1996; . Antunac, N. et al., 1997) on the basis of their research, concluded that the season has no influence on the chemical composition of the milk.

Conclusions

In conclusion, the qualitative factors in milk vary significantly during the period of lactation. The lactating period significantly correlates positively with fat (r = 0. 540), with dry substance (r = 0. 659) and lactose (r=0.614). The acidity correlates weakly negatively with the period of lactation and age. The Pearson correlation index, r =-0. 497, indicates that with the rise of the month of lactation, the acidity lowers.

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