THE EFFECT OF BOILING ON THE pH, ELECTRICAL CONDUCTIVITY AND LACTOSE CONTENT OF COW MILK

Mihaela OSTAN[1], I. GOGOAŞĂ[1], Olga-Alina RADA[1], B. BAUL[1], Mihaela FERICEAN[1], Mihaela CAZACU[1], Mihaela PETCU[1], Iuliana CREŢESCU[2]

[1]***Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara***
[2]***"Victor Babeş" University of Medicine and Pharmacy from Timisoara***
mihaela_ostan@yahoo.com

Abstract. *The most important milk components are proteins, lactose, fat and minerals. Electrical conductivity is a biophysical parameter that can be used for assessing the quality of milk. The aim of the present paper is to study the effect of boiling on the pH, electrical conductivity and lactose content, as well as to evaluate the correlations among these parameters. For this reason, 5 samples of fresh milk were taken from healthy cows, and then subjected to heat treatment by boiling. The pH was determined by a digital pH meter OP-211/2, connected with a combined electrode of the type OP-0808P; electrical conductivity was measured with an OK 112 conductometer, and lactose was determined with a MilkoScan S54B.*

The results were processed statistically with ANOVA and are presented as averages ± SD (standard deviation). The results reveal a decrease of the pH from 6.58±0.0841 to 6.54±0.0735, as an effect of boiling, and an increase of the lactose content from 5.07±0.1551 to 5.30±0.2927. It is also worth noting that negative correlation was found between the lactose content and electrical conductivity (r = -0. 6400) in fresh milk and (r= -0.4215) in boiled milk.

Key words: *cow milk, boiling, pH, lactose*

INTRODUCTION

Milk can be considered a fat emulsion in an aqueous solution containing many other substances, some in colloidal form (protein substances) and others in dissolved state (lactose, minerals, water soluble vitamins and enzymes) [3].

Milk and milk products are excellent quality foods, providing high nutritional value [1, 7, 9]. Lactose is the major carbohydrate of milk, occuring at 4.5 - 4.9% level [9].

The normal pH values of cow's milk range between 6.3and 6.8 [2, 6, 8].

Electrical conductivity (G) is a biophysical parameter that can be used for assessing the quality of milk.

Milk can undergo different changes during its preparation (boiling and microwaving) or processing, which may include moderate or severe heat treatment that can lead to undesirable changes [3,4, 5].

The aim of the present paper is to study the effect of boiling on the pH, electrical conductivity and lactose content, as well as to evaluate the correlations among these parameters.

MATERIAL AND METHODS

The research material was represented by 5 milk samples of 700 mL each, collected in milk containers from healthy cows raised in the University Farm, in the month of March 2015. Immediately after milking, the samples were transported to the laboratory for analysis.

The milk was divided in two portions; the second portion was boiled. The first portion was analysed as fresh samples and for the boiled milk the analysis commenced after cooling.

Ten samples were analysed: 5 samples of fresh milk and 5 samples of boiled milk.

The evaluation of changes in the lactose content of the milk samples was performed using the instrument MilkoScan S54B, which works in infrared spectrometry. The pH was determined by a digital pH meter OP-211/2, connected with a combined electrode of the type OP-0808P; electrical conductivity was measured with an OK 112 conductometer in the Biophysics laboratory at "Victor Babeş" University of Medicine and Pharmacy from Timisoara.

The results were processed statistically with ANOVA and XLSTAT 2015.1 software programme and they are presented as averages ± SD (standard deviation).Student test was used for the statistical evaluation, $p<0.05$ was considered as significant.

RESULTS AND DISCUSSIONS

Table 1 shows the percentage (average ±SD) of the chemical composition of cow milk. Table 2 shows the correlations between physico - chemical characteristics of milk.

Table 1.

Effect of boiling on the physico - chemical parameter averages (±SD)

	pH	G [mS]	Lactose [g %]
Fresh milk	6.58±0.0841	5.37±0.2343	5.07±0.1551
Boiled milk	6.54±0.0735	5.73±0.2843	5.30±0.2927

pH is a measure of the acidity or basicity of a solution. It is defined as the co logarithm of the activity of dissolved hydrogen ions (H+). The results reveal a decrease of the pH from 6.58±0.0841 to 6.54±0.0735, as an effect of boiling. Another finding of the present study is an increase in the lactose content from 5.07±0.1551 to 5.30±0.2927. Electrical conductivity is the property of a substance to transport electrical charges. In a pure solution, conductivity is a function of the ionic concentration. In a heterogeneous system, such as milk, the fats and the colloidal dispersed substances obstruct the ions in their migration and decrease the conductivity. The electrical conductivity is due to the presence of sodium, potassium and chloride ions in milk [4, 9].

At the temperature of 25 ^{0}C, electrical conductivity of milk varies from 5.1miliSiemens [mS] to 5.70mS for fresh milk and from 5.33 mS to 6.10mS.

Table 2.

Pearson correlation matrix between physico-chemical characteristics of milk

Correlation matrix (Pearson (n)):						
Variables	pH	G	Lactose	pH boiled	G boiled	Lactose boied
pH	**1**	-0.489	0.670	**0.954**	-0.515	0.685
G	-0.489	**1**	-0.640	-0.586	**0.978**	-0.502

Lactose	0.670	-0.640	**1**	0.689	-0.510	0.855
pH boiled	**0.954**	-0.586	0.689	**1**	-0.612	0.810
G boiled	-0.515	**0.978**	-0.510	-0.612	**1**	-0.421
Lactose boiled	0.685	-0.502	0.855	0.810	-0.421	**1**
Values in bold are different from 0 with a significance level alpha=0.05						

We observed a positive correlation between the lactose content and the pH (r=0.670) for fresh milk and r= 0.810 for boiled milk samples.

Figure 1 presents the PCA analysis of the pH, electrical conductivity and lactose content of milk samples.

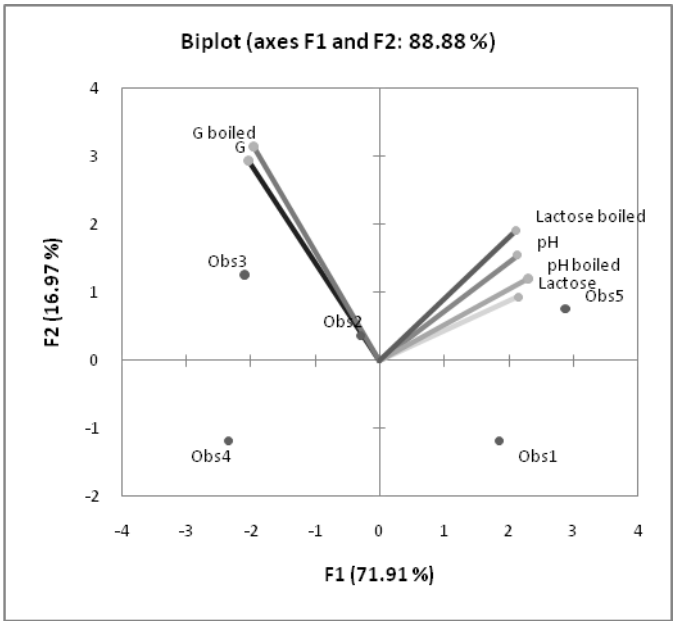

Figure 1. Principal Component Analysis (PCA) of variables

From the correlation matrix (Table 2) and Figure 1 we can observe that there is a negative correlation between the concentration of lactose and electrical conductivity of milk, while between the concentration of lactose and pH there is a positive correlation.

This work confirms the existence of significant differences as result of boiling on pH and conductivity of caw milk is very significant (pH – p-value (two-tailed) =0.002, G- p-value (two-tailed) =0.020and lactose-p-value (two-tailed) =0.014.

CONCLUSIONS

The results showed a decrease of the pH as result of boiling from 6.58±0.0841 to 6.54±0.0735. Between lactose concentration and the electrical conductivity of milk there is a negative correlation (r = - 0.640) while between pH and lactose concentration there is a positive correlative relation (r = 0.670).

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