Characteristics of Raw Milk from Vending Machines in the Transylvania region, Romania

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RESEARCH ARTICLE

Abstract
Milk is a source of proteins, lipids, vitamins and minerals and its quality can be assessed according to hygienic, nutritional, technological and sensory parameters. The main parameters are: somatic cells count, total number of germs, fat content, protein, lactose, nonfat dry matter, pH. The aim of this study was to analyze and compare the characteristics of raw milk from vending machines in a period that includes the July-August summer months and comply qualitative standards: European Regulations 853/2004 and 854/2004 and National Veterinary and Food Safety Authority of Romania (A.N.S.V.S.A.) no. 111/2008 and no. 55/2010. Samples were collected simultaneously from 3 vending machines during a 2-year period, while the ambient temperature at the time of collection varied between 23...31 °C at the time of collection from vending machines. The following parameters were determined: total plate count (TPC), the somatic cell count (SCC), and the content of fat, protein, lactose, casein. All data were analyzed with R Studio software. Graphic analysis of results was performed with "vegan" package, based on both influence of year and automatic vending machine and related to NTG values.

Keywords: raw milk, protein, somatic cells, total number of germs, vending machines.

INTRODUCTION
High-quality milk production is a primary factor for the safety and quality of dairy products (Silanikove et al., 2006). Due to the beneficial effects and nutrients contained in raw milk, its consumption has increase (Oliver et al., 2009). Following the analysis of the nutritional characteristics of milk, it can be associated with a multi-functional food product. Being a source of proteins, lipids, minerals and vitamins and due to the existence of numerous bio-active molecules, the consumption of milk or its derivatives has beneficial properties (Guimont et al., 1997). Raw milk composition is significantly associated with several farming conditions (management, cow breed, basic fodder during summer, milk collection (Nikoloudaki et al., 2021). Cows like other animals, carry various biological substances and is colonized by bacterial species (Piras et al., 2020) than cause raw milk problems. Contamination of raw milk with microorganisms can be done during milking, transport, storage and processing, which is a serious hazard of milk and dairy products quality and safety (Du et al., 2020). Food safety involves monitoring zoonotic infections as one of the main aspects that are caused by specific pathogens or their toxins as well as the presence of undesirable substances in the diet of animals or the inappropriate use of antimicrobial or chemical agents (Silanikove et al., 2006). Milk quality assessment can be done according to hygienic, nutritional, technological and sensory parameters. Usually,
the main parameters that are monitored in dairy farms are: somatic cells count (SCC), total plate count (TPC), nutritional composition, antimicrobial or chemical agent’s residues, adulteration practices; temperature, flavour, taste and appearance are also important (Park et al., 2013).

Raw milk composition is significantly associated with several farming conditions (management, cow breed, basic fodder during summer, milk collection) (Nikoloudaki et al., 2021). Cows are large animals that carry various biological substances, namely a large number of bacteria and genes (Piras et al., 2020) that can cause raw milk problems. Contamination of raw milk with microorganisms can be done during milking, transport, storage and processing, which is a serious hazard of milk and dairy products quality and safety (Du et al., 2020).

Food safety involves monitoring zoonotic infections as one of the main aspects that are caused by specific pathogens or their toxins as well as the presence of undesirable substances in the diet of animals or the inappropriate use of antimicrobial or chemical agents (Silanikove et al., 2006). Milk quality assessment can be done according to hygienic, nutritional, technological and sensory parameters. Usually, the main parameters that are monitored in dairy farms are: somatic cells count (SCC), bacterial counts, nutritional composition, antimicrobial or chemical agent’s residues, adulteration practices; temperature, flavour, taste and appearance are also important (Park et al., 2013).

The Romanian milk market allows direct sales of milk based on local regulations, which are in accordance with the European Regulation which specifies the quality requirements for the total number of germs, somatic cells, fat content, and lactose. Raw milk sold in local markets or in vending machines must come from healthy animals that have not suffered from diseases that can be transmitted to humans through milk (Ștețca et al., 2014). The price for 1 liter of milk sold in Romanian stores is between 0.91 to 1.42 euros. This price depends on the fat content (between 1.5 to 3.5%) and the processor. The milk sold in the vending machines is unprocessed and the price is 0.61 euros for 1 liter, being more attractive to the consumer.

The automatic milking system (AMS) is used in most farms and the growing demands of the cow’s milk market require an increase in the use of these systems compared to the conventional system. In addition to the high yields and low labor costs, AMS also leads to a cost decrease per liter of milk produced (de Koning et al., 2004).

Considering that the quality parameters of fresh milk are in accordance with the European Regulation, the study follows at the qualitative changes that may occur in the milk sold by vending machines to consumers. The later are regulated by the standards developed by the National Veterinary and Food Safety Authority of Romania (A.N.S.V.S.A.) no. 111/2008 and no. 55/2010. These standards specify the total number of germs (maximum 100,000 / ml) and the number of somatic cells (400,000 / ml) for milk without antibiotic traces coming from healthy animals that do not suffer from diseases that can be transmitted to people through milk (Ștețca et al., 2014; ISO 13366-2, 2006).

Romanian farmers will have to comply with European quality, hygiene and food safety standards in order to sell or process raw milk to people (Raducu et al., 2016). These are provided by Regulations (CR) of the European Parliament and of the Council no. Regulation (EC) no. 853/2004 establishing specific hygiene rules for food of animal origin (Antunac et al., 1997). At cow farms in Romania, the quality of milk is still one of the most important problems with regard to hygienic parameters.

Total number of germs must be less than 100,000 at 30° Celsius per milliliter according to European Regulations 853/2004 and 854/2004 (ISO 13366-2, 2006; Raducu et al., 2016). Determination of the total number of germs from the samples taken indicate that conditions of poor milking hygiene or non-treatment of diseases of the mammary gland led to an increase in their value over 400,000 / ml limit value that is provided by European Regulations (Ștețca et al., 2014; Raducu et al., 2016).

Other indicators that have been analyzed are fat content in milk (whose value was between 3.5-4.5%), protein (3.0-3.5%) and lactose (4.0-4.5%) (Raducu et al., 2016).

The present study aims to verify the milking hygiene and composition of milk sold through vending machines and also represents the hygiene and composition of milk in the entire chain from farms, through milk dispensers to consumers. For analysis, milk samples were taken from dispensers in high temperature conditions in the middle of the days, specific to the summer period, in order to establish whether the ambient temperature affects the sensory parameters and microbial growth during sampling. Parameters which were considered and analyzed are the following: fat, protein, lactose, nonfat dry matter, pH, milk freezing point, the number of germ and somatic cells.

MATERIALS AND METHODS

During the end of July and the beginning of August in 2019 and in the same period in 2020, for 10 days each year, qualified personnel collected 90 samples/year of 200 milliliters raw milk from 3 vending machines. The vending machines are fed with raw milk from 3 different farms: one from Cluj County, one from Alba County and one from Sălaj County. All vending machines were equipped with milk refrigeration systems, at 4-6 °C. The samples were collected in special sterile containers, of 250 milliliters capacity, and storage at 4 °C during transport at Milk Quality Foundation in Cluj-Napoca.
Milk sampling was performed every day between 12.00-13.00 hours, ambient temperature at sampling time varied from 23 to 31 °C. The samples were maintained at the 4 °C until the time of analysis.

The chemical composition of the samples, fat, protein, lactose, casein, somatic cell count (SCC), total number of germs (NTG) were determined using CombiFoss™ FT+, an equipment combining MilkoScan™ FT+ and Fossomatic™ FC (FOSS, Denmark) ISO 9622:2013 (ISO 9622, 2013) MilkoScan analyse the chemical composition of the milk by infrared light measurement (Infra-Red Spectrophotometry principle). The analysis takes about 30 s. The detection of somatic cell count (SCC) in milk uses flow cytometry by Fossomatic™ FC.

Somatic cell counting was performed by mixing a very thin sample of milk with a fluorescent dye. This allows only one somatic cell to pass at a time. All samples were analyzed in triplicate.

All data were analyzed with R Studio software (RStudio Team., 2019), version 1.1.463, based on several packages adapted for each test. Package“psych” (Revelle W., 2018) was used for descriptive statistics, and completed by ANOVA and Least Significant Differences (LSD) tests from Statistical Procedures for Agricultural Research (de Mendiburu F., 2020). These results were extracted for evaluation of differences between variants. Graphic analysis of results was performed with “vegan” package (Oksanen et al., 2019), based on both influence of year and automatic vending machine and related to NTG values.

RESULTS AND DISCUSSIONS

Based on the ANOVA test, the percentage of fat in raw milk can be observed depending on the year (Table 1). Dry matter and lactose analyzed from the samples taken from the vending machine show values that are influenced by the feed (Descalzo et al., 2012; Portnoy et al., 2021) and milking conditions of the year in question. For NTG and SCC values a significant influence have year indicated by vending machines. Analyzing the values obtained from the perspective of the interaction year x vending machine, only dry matter, fat and protein are influenced by both factors. This aspect sustains the differences between the 2 years analyzed and the origin of milk. Correlations among experimental parameters of raw milk show a different influence of the analyzed year on the values obtained associated with the milk vending machines. Fat and NSC is highly correlated with year, and lactose, pH, NSC and NTG are correlated with milk provenance. Fat is the only parameter that is significantly correlated with both year and milk provenance.

Table 1. Influence of year associated with the vending machine on dry matter, fat and lactose from raw milk.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Year</th>
<th>Vending machine</th>
<th>Year x Vending machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td>F</td>
<td>p.val</td>
<td>r</td>
</tr>
<tr>
<td>Fat</td>
<td>0.02</td>
<td>0.898</td>
<td>0.01</td>
</tr>
<tr>
<td>Lactose</td>
<td>0.54</td>
<td>0.465</td>
<td>-0.09</td>
</tr>
<tr>
<td>Protein</td>
<td>3.05</td>
<td>0.086</td>
<td>0.20</td>
</tr>
<tr>
<td>pH</td>
<td>1.62</td>
<td>0.208</td>
<td>0.16</td>
</tr>
<tr>
<td>NTG</td>
<td>5.63</td>
<td>0.021</td>
<td>0.21</td>
</tr>
<tr>
<td>NSC</td>
<td>4.43</td>
<td>0.040</td>
<td>0.27*</td>
</tr>
</tbody>
</table>

Note: Year – 2019, 2020; r – correlation coefficient (values with * are significant at p<0.05); NTG – total number of germs; NSC – number of somatic cells; Significance levels: p<0.001 ***; p<0.01 **; p<0.05 *; p>0.05 n.s.

The significant variations of the resulting dry matter values are analyzed from the point of view of the year and associated with the milk machine (Table 2). The highest value of this parameter was registered in 2020 at vending machine 1, significantly higher than the other two vending machines in the same year. This value was significantly higher than the same vending machine and the second one in 2019.

Table 2. Differences in dry matter, fat and lactose caused by year and vending machine.

<table>
<thead>
<tr>
<th>Year</th>
<th>Vending machine</th>
<th>Dry matter (g/100g)</th>
<th>Fat (g/100g)</th>
<th>Lactose (g/100g)</th>
<th>Protein (g/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>D1</td>
<td>8.87±0.02&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.76±0.06&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.74±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.36±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>D2</td>
<td>8.89±0.03&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.85±0.04&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.67±0.02&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>3.45±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>D3</td>
<td>8.92±0.02&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>3.43±0.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.67±0.02&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>3.39±0.01&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>2020</td>
<td>D1</td>
<td>8.98±0.03&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.82±0.03&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.72±0.03&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>3.49±0.04&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>D2</td>
<td>8.82±0.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.85±0.06&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.67±0.02&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>3.37±0.02&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
The only supplier from which the distributed milk exceeded the value of 4% as fat content was the one with the vending machine marked with D3 from the 2020 year (Table 2). This value was significantly higher than all other observations. In the conducted study, it was found that the milk suppliers for vending machines D1 and D2 deliver milk with a constant fat percentage, and in the case of the one with D3, the fat percentage recorded the lowest value in 2019 (3.43%). Lactose had smaller variations in the analyzed periods at all machines. It was found that this was stable in both years analyzed at the D2 machine, and the highest value was found at the D1 machine (4.74%). The protein content of raw milk recorded large variations that were found at all suppliers. The causes would be the feeding of animals with acidic and low-quality fodder or different breeds of animals with specific genetic potential.

The highest value (3.49%) was observed in 2020 in the milk supplied through D1 and in 2019 the maximum value was provided by the milk supplied in D2 (3.45%). As an observation, it is noted that for the milk supplier for the D1 vending machine, in 2019 the value is the lowest (3.36%) and for the D2 vending machine supplier, the value of 3.37% in 2020 may suggest that there could have been animal feeding samples, which shows a very high change in the quality of both milk sources: a decrease in D2 and an increase in D1.

pH is a parameter with low variations caused by year and milk source (Table 3). The only significant difference is registered between D3 (2019) and V1 (2020). A different trend is observed in the case of NTG, which shows large variations between variants. There were registered two values over 620 NTG in year 2020 (D1 and D2) and one values over 550 in 2019 (D1). An interesting case is V2 in 2019, when NTG value is only 185.20, the lowest value observed in the entire experiment. This shows an almost 350 NTG increase from one year to another. The only vending machine which maintains NTG at reduce values is D3, with an increase of only 70 units from one year to another. NSC shows a trend of variation between the ones observed at pH and NTG. The highest values are registered at D1 in both years, significantly higher than the other two vending machines. Both D2 and D3 have similar values in 2019 and 2020, with no significant differences between them.

Table 3. Differences in pH, NTG and NSC caused by year and vending machine

<table>
<thead>
<tr>
<th>Year</th>
<th>Vending machine</th>
<th>pH</th>
<th>NTG/mL x 1000</th>
<th>NSC/mL x 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>D1</td>
<td>6.58±0.01ab</td>
<td>553.90±66.25ab</td>
<td>752.10±36.74a</td>
</tr>
<tr>
<td></td>
<td>D2</td>
<td>6.55±0.03ab</td>
<td>185.20±9.90c</td>
<td>336.00±17.85b</td>
</tr>
<tr>
<td></td>
<td>D3</td>
<td>6.51±0.03b</td>
<td>232.10±13.78c</td>
<td>397.10±16.62b</td>
</tr>
<tr>
<td>2020</td>
<td>D1</td>
<td>6.62±0.03a</td>
<td>625.20±163.28a</td>
<td>981.50±178.51a</td>
</tr>
<tr>
<td></td>
<td>D2</td>
<td>6.57±0.03ab</td>
<td>627.80±155.22a</td>
<td>460.70±51.85b</td>
</tr>
<tr>
<td></td>
<td>D3</td>
<td>6.55±0.05ab</td>
<td>302.20±71.58bc</td>
<td>463.20±58.13b</td>
</tr>
</tbody>
</table>

Note: Values presented in the table are the means of parameters ± standard error. Means followed by different letters indicate differences at $p < 0.05$ according to LSD test.

Raw milk parameters show different levels of correlations, which explain the variations observed between variants (Table 4). Dry matter is highly correlated with lactose and protein levels, and both with pH and NSC. Also, between fat and protein exist a significant correlation. Lactose is linked with the variations of pH, NSC and NTG, the last two parameters being correlated also with pH values. NSC and NTG shows a significant correlation coefficient.

Table 4. Interrelations between raw milk parameters

<table>
<thead>
<tr>
<th></th>
<th>Fat</th>
<th>Lactose</th>
<th>Protein</th>
<th>pH</th>
<th>NSC</th>
<th>NTG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td>-0.08</td>
<td>0.32*</td>
<td>0.38*</td>
<td>0.43*</td>
<td>0.40*</td>
<td>0.06</td>
</tr>
<tr>
<td>Fat</td>
<td>-0.20</td>
<td>0.27*</td>
<td>0.13</td>
<td>0.14</td>
<td>0.14</td>
<td>0.08</td>
</tr>
<tr>
<td>Lactose</td>
<td>-0.02</td>
<td>0.45*</td>
<td>0.33*</td>
<td>0.29*</td>
<td>0.29*</td>
<td>0.28*</td>
</tr>
<tr>
<td>Protein</td>
<td>-0.04</td>
<td>0.22</td>
<td>0.41*</td>
<td>0.28*</td>
<td>0.44*</td>
<td>0.44*</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NSC</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Note: correlation values with * are significant at $p<0.05$.

Two PCA approaches were used to explore the differences between raw milk quality due to the interaction between year and vending machines. First PCA ordination (Figure 1) presents the assemblage of all raw milk
parameters regarding to the arrangement produced by year and vending machines. The first PCA axis explain 72.09% of variance while second axis explain 27.91%, which assure the overall variance. Both D2 and D3 share a common place on the ordination and have low variations, which maintain the idea that the milk provided maintain its quality during summer and the global value of parameters are similar.

The second PCA approach explore the dispersion of raw milk parameters based on the partition imposed by each factor separately (Figure 2, a, b) and their interaction (Figure 2, c), all related to the NTG parameter values. Our experiment revealed that year 2019 is characterized by a lower dispersion of raw milk parameters than 2020 (Figure 2, a). For this year, the large majority of values of NTG were placed within 300-450, so this parameter has a reduced impact on the quality of raw milk. All parameters were in this case more stable, and the center is placed near 350 NTG. As an opposite, the year 2020 shows large fluctuations of milk parameters, with the center moved to 400-450 NTG. A lot of samples are placed under the value of 400 NTG, but there are also some samples over 750 NTG. This aspect sustains the importance of raw milk origin, and the difference in quality imposed by it. In order to assess the difference, a vending machine partition PCA (Figure 2, b) was performed in order to explore the partition of samples. The most stable vending machine is D2, which maintain a low dispersion of samples and a reduced number of samples that cross over 400 NTG limit. The quality of raw milk in this case shows reduced fluctuations and all samples are near to the center. The vending machine D3 shows similar values of NTG, but a much larger dispersion across 350-450 NTG lines. This indicates the reduced homogeneity of raw milk parameters and a non-uniform change of them from one period to another. The vending machine D1 shows the most reduced stability of raw milk parameters, and the largest dispersion of samples in the ordinate graph. Less than half of samples are positioned near to the mathematical center of D1, which indicate both large fluctuations in the overall quality of milk and the lack of uniformity in the changes of each parameter. In order to fully explore the changes produced both by year and milk origin, a third PCA (Figure 2, c) was performed. The vending machine D1 have large fluctuations in both years, with a more stable fluctuation in 2019 and a very large one in 2020, when high differences in NTG were associated with the quality of milk. For the other two vending machines (D2 and D3), 2019 was the year when the milk quality suffers the lowest amplitude of fluctuations and the parameters modify uniformly form one period to another. As an opposite, in 2020, both vending machines showed a larger dispersion and a reduced homogeneity of changes in raw milk parameters.

![Figure 1. PCA of raw milk parameters as defined by experimental factors. First numbers represent the year: 19–2019, 20–2020. D1, D2 and D3 represent the vending machines.](image-url)
Figure 2. Partial PCA of raw milk parameters as defined by experimental factors and related to NTG values. a) the separation imposed by year; b) the separation imposed by vending machine; c) the separation imposed by the interaction year x vending machine. First numbers represent the year: 19–2019, 20–2020. D1, D2 and D3 represent the vending machines.

The global interest in raw milk is developed by both consumers and processors of this product. The health of production animals directly influences human health. Consumers cannot evaluate the safety of raw milk solely on the basis of organoleptic qualities (taste, smell, appearance) and must trust the best practice procedures that farmers must adopt to increase food safety (Berge et al., 2020). Bacteriological tests of raw milk indicate compliance with milking hygiene and also the safety of raw milk.

The risk assessment for the sale of milk by vending machines was done in several European countries. In Italy, monitoring of raw milk sold through vending machines has indicated higher health risks (Giacometti et al., 2015; Giacometti et al., 2017).

A study conducted in Croatia on the physio-chemical composition and parameters of milk sold by vending machines calls into question the suitability of raw milk consumption when sold through dispensers (Mikulec et al., 2019). This study indicates that the optimal storage temperature in vending machines for 24 h is +4 °C with a
variation of ± 2°C. And in this case, it is recommended that raw milk must be boiled prior to consumption and to avoid the consumption of non-thermally treated milk.

In Slovenia, a study was carried out on compliance with the quality standards of milk production for sale through milk vending machines (Janzekovic et al., 2012). It was concluded that milk production from farms is in accordance with hygienic norms and can be marketed to consumers through dispensers if the temperature of storage and marketing did not exceed 7 °C and the rest of the parameters are in accordance with European rules and regulations.

The price of milk sold through vending machines is lower than that sold in packaging on store shelves. The selling price of milk is also set by the following parameters such as: fat content, protein, lactose, NTG, casein and NSC. Among them, one of the main indicators of the hygienic quality of milk is NTG (Veđa et al., 2012; Baretto et al., 2013).

The high number of germs above the 100,000/ml increase the possibilities of developing a bacterial infection (Nagahata et al., 1987) and affecting the physio-chemical composition, taste and its nutritional value (Albenzio et al., 2011; Norman et al., 2011).

The health status of animals is represented by the number of somatic cells (SCC) which is also a standard for the qualitative evaluation of milk (Albenzio et al., 2019). Determining the quality of milk and cow health monitoring can be performed quickly and accurately by measuring the CCS (Gao et al., 2020).

The number of SCC contained in milk is a topic of discussion in the milk production and processing sectors. Somatic cells are of endogenous origin, being epithelial leukocytes and erythrocytes (Ng-Kwai-Hang et al., 1984). The increase in the number of leukocytes is a response to bacterial infection, tissue damage being a measure of defense against infection (Nagahata et al., 1987). The organism reacts with a defense mechanism against irritating agents with an increased cell count (especially polymorph nuclear leukocytes), so their increased number in any of the udder quarters shows disturbed secretion (Ng-Kwai-Hang et al., 1984). Depending on the season and the lactation period, the number of somatic cells in milk varies (Nagy et al., 2013) and increases the possibility of bacterial infections. The SCC in the milk samples of healthy cows that do not have mastitis is usually lower than 100,000/ml, while most cows have somatic cell count lower than 100,000/ml (Dobranic et al., 2008; Harmon R., 2001). A somatic cell counts higher than 200,000/ml is a mastitis indicator (Harmon R., 2001). In this case the most of somatic cells are neutrophils.

EU legislation (Regulation no. 853/2004/EC) requires for raw cow milk a maximum limit of 400,000 SCC/mL. Increasing the number of SCC in milk (Li et al., 2014) above the upper limit causes changes in production, changes in nutritional value and physical and chemical changes in milk.

Milk, like other functional foods, in addition to their nutritional level, has health benefits. Interest in food with health benefits has greatly increased with the tendency of people to consume healthy products and stimulated the development of these products in the food market. Also, experimental models are validated to confirm these health benefits (Descalzo et al., 2012).

These concerns and numerous technological changes over recent years justify reevaluation of several factors that might affect quantification of percentage of fat, percentage of protein, and SCC. Almost all the analyzes for each of the components measured in this study revealed some changes due to the way of feeding, milking, cooling, storage and transport before feeding the vending machines with raw milk. European Regulation EC 853/2004 (Regulation EC No 853, 2004) establishes specific hygiene rules for food of animal origin. Milking installations, used equipment, cooling tanks, transport tanks, qualified personnel and other equipment must be operated in such a way as to limit the risk of milk contamination. During transport the cold chain must be maintained and on arrival at the establishment of destination, the temperature of milk must not to be more than 6 °C.

NTG in the composition of raw cow milk provides information regarding the hygienic conditions, handling and transportation. Correlations between the total number of germs, number of somatic cells and milk composition show the milking hygiene, processing factors, price of milk and lead to measures to be taken to prevent diseases. Bacterial infection of the dairy gland represents the main source of somatic cell count increase in milk, and the total count is an internationally accepted parameter in the evaluation of udder health status. With the increase of the somatic cell count above 400,000/ml, the milk is altered, and the consequences are manifested in lower secretion, alterations in chemical composition and physical, bacteriologic and technologic characteristics of the milk (Antunac et al., 1997).

Jahanar (Jahanar et al., 2021) analyzed the effect of temperature on milk processing and found that, up to 35 °C, process temperature did not have any effect on particle size, viscosity, creaming or pH. Parmar (Parmar et al., 2020) analyzed the relationship between temperature and density, noting that the density of milk decreases with temperature rise and the higher the fat content of milk, the more density varies with increasing temperature.

**CONCLUSIONS**

Fat and NSC is highly correlated with year, and lactose, pH, NSC and NTG are correlated with milk provenance. Fat is the only parameter that is significantly correlated with both year and milk provenance. Maintaining the quality parameters of raw milk in accordance with the European Regulation should not be influenced by summer
temperatures. The retail prices of the liter of milk sold through three vending machines compared to the retail price of processed milk in stores is lower, for the buyer for whom this detail is important can lead to the development of this type of distribution, especially since the product has a known origin.

In Romania, farmers who supply milk for vending machines are obliged by law to take samples for the analysis of milk parameters after each milking. The control of vending machines should be done by the authorities to limit the supply of non-compliant milk. The buyer does not have the possibility to check the quality of the milk supplied by these machines and in no way to know the limits of the parameters of the milk sold. The farmer who feeds the machine can only inform the buyer about the parameters of the milk supplied through the dispenser.

The quality of raw milk sold through vending machines is shown by analyzing the main parameters such as somatic cells count, total number of germs, fat content, protein, lactose, nonfat dry matter, pH. The quality variations observed in the periods considered to be with the highest temperatures of the analyzed years, lead to the conclusion that the quality parameters of raw milk are in accordance with the requirements of European Regulations EC 853/2004 and regular microbiological controls of raw milk assess the safety of the product and reduce the food safety risks.

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Conflicts of Interest
The authors declare no conflict of interest.

REFERENCES
3. Antunac, N.; Lukač-Havranek, J.; Samaržija, D. Somatske Stanice i Njihov Utjecaj; Croatian Dairy Union, 1997; Vol. 47