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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 ^{0}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 soft-ware. 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.

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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 (Ştefca 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 (Ştefca 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 (Ştefca 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 ^{0}C. The samples were collected in special sterile containers, of 250 milliliters capacity, and storage at 4 ^{0}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 ^{0}C. The samples were maintained at the 4 ^{0}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.

Parameter	Year			Vending machine			Year *x* Vending machine		
	F	*p.val*	r	F	*p.val*	r	F	*p.val*	r
Dry matter	0.02	*0.898*	0.01	3.68	*0.032*	-0.15	7.63	*0.001*	0.00
Fat	24.89	*p<0,01*	0.45*	1.39	*0.259*	-0.06	19.38	*p<0.01*	0.45*
Lactose	0.54	*0.465*	-0.09	5.74	*0.005*	-0.39*	0.09	*0.915*	-0.12
Protein	3.05	0.086	0.20	0.27	0.767	-0.06	10.58	*p<0.01*	0.19
pH	1.62	0.208	0.16	2.59	0.085	-0.29*	0.04	0.959	0.14
NTG	5.63	0.021	0.21	5.18	0.009	-0.53*	2.28	0.111	0.17
NSC	4.43	0.040	0.27*	20.62	*p<0,01*	-0.37*	0.51	0.600	0.24

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

Year	Vending machine	Dry matter (g/100g)	Fat (g/100g)	Lactose (g/100g)	Protein (g/100g)
2019	D1	8.87±0.02^{bc}	3.76±0.06^{b}	4.74±0.01^{a}	3.36±0.01^{c}
	D2	8.89±0.03^{bc}	3.85±0.04^{b}	4.67±0.02^{bc}	3.45±0.01^{a}
	D3	8.92±0.02^{ab}	3.43±0.02^{c}	4.67±0.02^{bc}	3.39±0.01^{bc}
2020	D1	8.98±0.03^{a}	3.82±0.03^{b}	4.72±0.03^{ab}	3.49±0.04^{a}
	D2	8.82±0.02^{c}	3.85±0.06^{b}	4.67±0.02^{bc}	3.37±0.02^{c}

	D3	8.87±0.02^{bc}	4.08±0.10^{a}	4.65±0.03^{c}	3.44±0.02^{ab}

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.

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

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

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

	Fat	Lactose	Protein	pH	NSC	NTG
Dry matter	-0.08	0.32*	0.38*	0.43*	0.40*	0.06
Fat		-0.20	0.27*	0.13	0.14	0.08
Lactose			-0.02	0.45*	0.33*	0.29*
Protein				-0.04	0.22	0.10
pH					0.41*	0.28*
NSC						0.44*

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

Two PCA approaches were used to explore de differences between raw milk quality due to the interaction between year and vending machines. First PCA ordination (Figure 1) present 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.

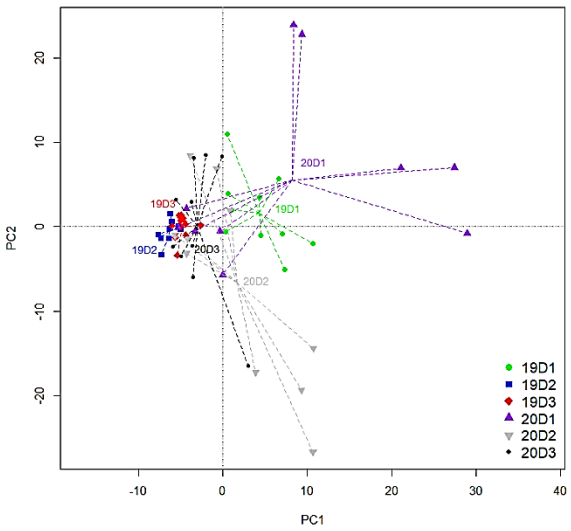
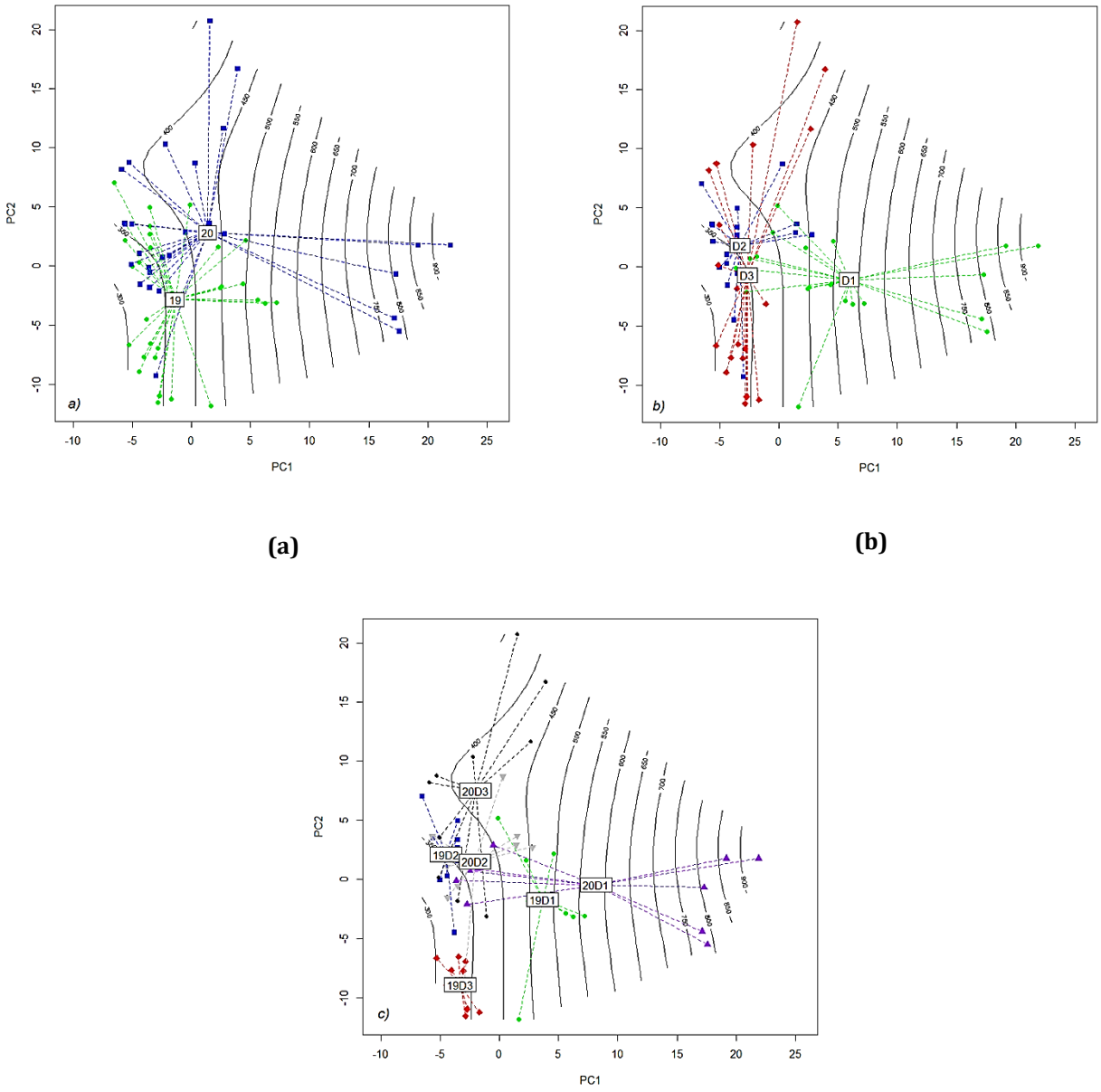


Figure 1. PCA of raw milk parameters as defined by experimental factors. First numbers represent the year: 19–2019, 20–2020. D1, D2 and D3 represent the vending machines.

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.



(a) **(b)**

(c)

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 ^{0}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 (Velea 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 (Dobranić 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 ^{0}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).

Janahar (Janahar et al., 2021) analyzed the effect of temperature on milk processing and found that, up to 35 ^{0}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

1. Albenzio, M.; Caroprese, M. Differential Leucocyte Count for Ewe Milk with Low and High Somatic Cell Count. J. Dairy Res. 2011, 78 (1), 43–48. https://doi.org/10.1017/S0022029910000798
2. Albenzio, M.; Figliola, L.; Caroprese, M.; Marino, R.; Sevi, A.; Santillo, A. Somatic Cell Count in Sheep Milk. Small Rumin. Res. 2019, 176, 24–30. https://doi.org/10.1016/j.smallrumres.2019.05.013
3. Antunac, N.; Lukač-Havranek, J.; Samaržija, D. Somatske Stanice i Njihov Utjecaj; Croatian Dairy Union, 1997; Vol. 47
4. Barreto, M. L. de J.; Rangel, A. H. do N.; Spyrides, M. H. C.; Júnior, D. M. L.; Oliveira, G. S. de; Lima, F. F. de. Stages of Lacta-tion and Order for Delivery in Quality and Composition of Dairy Cattle. 2013. Journal Veterinaria e Zootecnia, 20(2), Supl.1, 163-164
5. Berge, A., Baars, T. (2020). Raw milk producers with high levels of hygiene and safety. Epidemiology and Infection, 148, E14. doi:10.1017/S0950268820000060
6. C. Piras, V. Greco, E. Gugliandolo, A. Soggiu, B. Tilocca, L. Bonizzi, et al., Raw Cow Milk Bacterial Consortium as Bioindicator of Circulating Anti-Microbial Resistance (AMR), Animals 2020 Vol. 10 Issue 12 Pages 2378, Accession Number: doi:10.3390/ani10122378, https://www.mdpi.com/2076-2615/10/12/2378
7. de Koning, K.; Rodenburg J.; Automatic Milking: State of the Art in Europe and North America. In Automatic Milking—A Better Understanding, Meijering A.; Hogeveen H.; de Koning C.J.A.M. (Eds.), Wageningen Academic Publishers, Wa-geningen, the Netherlands, 2004, pp. 27-37
8. de Mendiburu, F.: Statistical Procedures for Agricultural Research. 2020, R package version 1.3-2. https://CRAN.R-project.org/package=agricolae
9. Descalzo, A. M.; Rossetti, L.; Paez, R.; Grigioni, G.; Garcia, P. T.; Costabel, L.; Negri, L.; Antonacci, L.; Salado, E.; Bretschnei-der, G.; Gagliostro, G.; Comeron, E.; Taver, M. A. Differential Characteristics of Milk Produced in Grazing Systems and Their Impact on Dairy Products. In Milk Production - Advanced Genetic Traits, Cellular Mechanism, Animal Management and Health; InTech, 2012. https://doi.org/10.5772/50760

10. Dobranić, V.; Njari, B.; Samardžija, M.; Mioković, B.; Resanović, R. The Influence of the Season on the Chemical Composition and the Somatic Cell Count of Bulk Tank Cow's Milk. Vet. Arh. 2008, 78 (3), 235–242
11. Du B., L. Meng, H. Liu, N. Zheng, Y. Zhang, X. Guo, et al., Impacts of Milking and Housing Environment on Milk Microbiota, Animals 2020 Vol. 10 Issue 12 Pages 2339, doi:10.3390/ani10122339, https://www.mdpi.com/2076-2615/10/12/2339
12. Gao, F., Wang, J., Ge, Y., & Lu, S., A vision based instrument for measuring milk somatic cell count. Measurement Science and Technology, 2020, https://doi.org/10.1088/1361-6501/ab9f44
13. Giacometti F et al. (2015) Human campylobacteriosis related to the consumption of raw milk sold by vending machines in Italy: quantitative risk assessment based on official controls over four years. Preventive Veterinary Medicine 121, 151–158
14. Giacometti F et al. (2015) Quantitative risk assessment of human salmonellosis and listeriosis related to the consumption of raw milk in Italy. Journal of Food Protection 78, 13–21
15. Giacometti F et al. (2017) Paediatric HUS cases related to the consumption of raw milk sold by vending machines in Italy: quantitative risk assessment based on Escherichia coli O157 official controls over 7 years. Zoonoses and Public Health 64, 505–516
16. Guimont, C.; Marchall, E.; Girardet, J. M.; Linden, G. Biologically Active Factors in Bovine Milk and Dairy Byproducts: Influence on Cell Culture. Crit. Rev. Food Sci. Nutr. 1997, 37 (4), 393–410. https://doi.org/10.1080/10408399709527780
17. Harmon R. J.; Somatic cell counts: A primer. 40th Annual Meeting. Proceedings National Mastitis Council. Arlington, USA, 2001; p. 9
18. ISO - ISO 13366-2:2006 - Milk — Enumeration of somatic cells — Part 2: Guidance on the operation of fluoro-opto-electronic counters https://www.iso.org/standard/40260.html (accessed Aug 20, 2020)
19. ISO - ISO 9622:2013 - Milk and liquid milk products — Guidelines for the application of mid-infrared spectrometry https://www.iso.org/standard/56874.html (accessed Aug 20, 2020)
20. Janahar Jerish Joyner, Alice Marciniak, V.M. Balasubramaniam, Rafael Jimenez-Flores, Edmund Ting, Effects of pressure, shear, temperature, and their interactions on selected milk quality attributes, Journal of Dairy Science, Volume 104, Issue 2,2021, Pages 1531-1547, ISSN 0022-0302, https://doi.org/10.3168/jds.2020-19081.https://www.sciencedirect.com/science/article/pii/S0022030220310298
21. Janzekovic, M., Janzekovic, I., Brus, M., Mursec, B, Quality of raw milk in different series of milk deliveries at milk – dispensers, DAAAM INTERNATIONAL SCIENTIFIC BOOK 2012 pp. 379-388 CHAPTER 32, DOI: 10.2507/daaam.scibook.2012.32
22. Li, N.; Richoux, R.; Boutinaud, M.; Martin, P.; Gagnaire, V. Role of Somatic Cells on Dairy Processes and Products: A Review. Dairy Science and Technology. Springer-Verlag France November 1, 2014, pp 517–538. https://doi.org/10.1007/s13594-014-0176-3
23. Mikulec, N., Špoljarić, J., Zamberlin, Š., Krga, M., Radeljević, B., Plavljanić, D., Antunac, N. (2019). The investigation of suitability of raw milk consumption from vending machines in Croatia. Journal of Central European Agriculture, 20(4), 1076–1088. doi:10.5513/jcea01/20.4.2277
24. Nagahata, H.; Saito, S.; Noda, H. Changes in N-Acetyl-B-D-Glucosaminidase and B-Glucuronidase Activities in Milk during Bovine Mastitis. Can. J. Vet. Res. 1987, 51 (1), 126–134
25. Nagy, P.; Faye, B.; Marko, O.; Thomas, S.; Wernery, U.; Juhasz, J. Microbiological Quality and Somatic Cell Count in Bulk Milk of Dromedary Camels (Camelus Dromedarius): Descriptive Statistics, Correlations, and Factors of Variation. J. Dairy Sci. 2013, 96 (9), 5625–5640. https://doi.org/10.3168/jds.2013-6990
26. Ng-Kwai-Hang, K. F.; Hayes, J. F.; Moxley, J. E.; Monardes, H. G. Variability of Test-Day Milk Production and Composition and Relation of Somatic Cell Counts with Yield and Compositional Changes of Bovine Milk. J. Dairy Sci. 1984, 67 (2), 361–366. https://doi.org/10.3168/jds.S0022-0302(84)81309-0
27. Nikoloudaki, O., Lemos Junior, W.J.F., Borruso, L., Campanaro, S., De Angelis, M., Vogel, R.F., Di Cagno, R. and Gobbetti, M. (2021), How multiple farming conditions correlate with the composition of the raw cow's milk lactic microbiome. Environ Microbiol, 23: 1702-1716. https://doi.org/10.1111/1462-2920.15407
28. Norman, H. D.; Lombard, J. E.; Wright, J. R.; Kopral, C. A.; Rodriguez, J. M.; Miller, R. H. Consequence of Alternative Standards for Bulk Tank Somatic Cell Count of Dairy Herds in the United States. J. Dairy Sci. 2011, 94 (12), 6243–6256. https://doi.org/10.3168/jds.2011-4645
29. Oksanen, J.; Blanchet, F.G.; Friendly, M.; Kindt, R.; Legendre, P; McGlinn, D.; . . . Wagner, H. vegan: Community Ecology Package. 2019, Retrieved from https://CRAN.R-project.org/package=vegan
30. Oliver, S. P.; Boor, K. J.; Murphy, S. C.; Murinda, S. E. Food Safety Hazards Associated with Consumption of Raw Milk. Foodborne Pathogens and Disease. Mary Ann Liebert, Inc. 140 Huguenot Street, 3rd Floor New Rochelle, NY 10801 USA September 1, 2009, pp 793–806. https://doi.org/10.1089/fpd.2009.0302
31. Park, Y. W.; Albenzio, M.; Sevi, A.; Haenlein, G. F. W. Milk Quality Standards and Controls. In Milk and Dairy Products in Human Nutrition; John Wiley & Sons: Oxford, 2013; pp 261–287. https://doi.org/10.1002/9781118534168.ch13

32. Parmar, P., Lopez-Villalobos, N., Tobin, J. T., Murphy, E., Buckley, F., et al., Effect of temperature on raw whole milk density and its potential impact on milk payment in the dairy industry, International Journal of Food Science & Technology, 2020, doi:10.1111/ijfs.14869
33. Portnoy, Matilde, Barbano, David M. Lactose: Use, measurement, and expression of results. Journal of dairy science, 2021, 104.7: 8314-8325, https://doi.org/10.3168/jds.2020-18706
34. Raducu, C.; Miresan, V.; Coroian, A.; Pop, C.; Coroian, C. O.; Cocan, D.; Andronie, L. Study on the milk Quality Parameters in Three Farms from Sălaj County. Bull. Univ. Agric. Sci. Vet. Med. Cluj-Napoca. Anim. Sci. Biotechnol. 2016, 73 (2), 256. https://doi.org/10.15835/buasvmcn-asb:12257
35. Regulation EC. No 853/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific rules for food of animal origin. Official Journal of the European Union L. 2004; 226:22-82. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32004R0853&from=EN (accessed Aug 20, 2020)
36. Revelle, W. psych: Procedures for Psychological, Psychometric, and Personality Research. Evanston, Illinois: Northwestern University. 2018, Retrieved from https://CRAN.R-project.org/package=psych
37. RStudio Team. 2019, RStudio: Integrated Development for R. RStudio, Inc., Boston, MA. URL http://www.rstudio.com/
38. Silanikove, N.; Merin, U.; Leitner, G. Physiological Role of Indigenous Milk Enzymes: An Overview of an Evolving Picture. In International Dairy Journal; Elsevier, 2006; Vol. 16, pp 533–545. https://doi.org/10.1016/j.idairyj.2005.08.015
39. Souza, F. N.; Blagitz, M. G.; Penna, C. F. A. M.; Della Libera, A. M. M. P.; Heinemann, M. B.; Cerqueira, M. M. O. P. Somatic Cell Count in Small Ruminants: Friend or Foe? Small Ruminant Research. Elsevier October 1, 2012, pp 65–75. https://doi.org/10.1016/j.smallrumres.2012.04.005
40. Şteţca, G.; Ilea, A.; Şuteu, L.; Coldea, T. Raw Milk Hygiene at Local Markets and Automatic Milk Dispenser Machines. Bull. UASVM Food Sci. Technol. 2014, 71 (2). https://doi.org/10.15835/buasvmcn-fst:10822
41. Velea C.; Marginean G. Tratat de crestere a bovinelor, Editura Risoprint, 2012.; Volume 1, pp. 145-150. ISBN 978-973-53-0734-9