

MONITORING OF THE QUALITY AND SALUBRITY OF RAW MILK SOLD BY VENDING MACHINES IN TIMIȘOARA AND ARAD MUNICIPALITY

MONITORIZAREA CALITĂȚII ȘI SALUBRITĂȚII LAPTELUI CRUD COMERCIALIZAT DE DOZATOARELE AUTOMATE DIN MUNICIPIILE TIMIȘOARA ȘI ARAD

Adriana MORAR^{1),*},
Alexandra BAN-CUCERZAN¹⁾,
V. HERMAN¹⁾, S. POPA¹⁾, K. IMRE¹⁾

ABSTRACT | REZUMAT

There has been a growing consumer demand lately for raw, unprocessed products, which are often considered healthier. Whole raw milk is an extremely nutritious product for the consumer if the components are found in appropriate proportions. The study took place between March 17 and June 3, 2021, and consisted of analysing a total of 38 samples of raw cow's milk. The samples were collected from vending machines in Timișoara and Arad. The determinations on raw milk were performed to assess the quality of milk, respectively the assessment of integrity by physico-chemical determinations of the following parameters: fat, protein, lactose, dry matter and cryoscopic point. Acidity was determined to assess the freshness of the milk. The salubrity indicators determined were: total number of germs (TNG) and the number of somatic cells (SCC). The aim of this paper was to screen the quality and health of milk sold at milk vending machines in Timișoara, to provide authorities and consumers with a real picture of the health of milk offered for sale. The results obtained from the physico-chemical determinations showed significant variations of the components, the largest variation being recorded in the percentage of fat. Non-compliances were also reported regarding the salubrity of the milk with all samples exceeding the maximum admitted level for the total number of germs and up to 48% of non-compliant samples for the number of somatic cells. Exceeding the maximum allowed values in terms of the TNG and the SCC reveals hygienic deficiencies, but also the health of the animals on the farms that supply the milk dispensers.

Keywords: unprocessed products, TNG, SCC, milk vending machines, milk

În ultimul timp a existat o cerere crescândă a consumatorilor pentru produse crude, neprelucrate, care sunt adesea considerate mai sănătoase. Laptele crud integral este un produs extrem de nutritiv pentru consumator dacă componentele se găsesc în proporții adecvate. Acest studiu a avut loc în perioada 17 martie - 3 iunie 2021 și a constatat în analiza unui total de 38 de probe de lapte crud de vacă. Probele au fost colectate de la automatele din Timișoara și Arad. Determinările privind laptele crud au fost efectuate pentru a evalua calitatea laptelui, respectiv evaluarea integrității prin determinări fizico-chimice ale următorilor parametri: grăsimi, proteine, lactoză, substanță uscată și punct crioscopic. Aciditatea a fost determinată pentru a evalua prospețimea laptelui. Indicatorii de salubritate determinați au fost: numărul total de germeni (TNG) și numărul de celule somatice (SCC). Scopul acestei lucrări a fost de a examina calitatea și sănătatea laptelui vândut la automatele de lapte din Timișoara, pentru a oferi autorităților și consumatorilor o imagine reală a stării de sănătate a laptelui oferit spre vânzare. Rezultatele obținute la determinările fizico-chimice au arătat variații semnificative ale componentelor, cea mai mare variație înregistrându-se la procentul de grăsimi. Au fost raportate, de asemenea, neconformități cu privire la salubritatea laptelui, toate probele depășind nivelul maxim admis pentru NTG și până la 48% din probe au înregistrat neconformități în ceea ce privește SCC. Depășirea valorilor maxime admise în ceea ce privește NTG și SCC relevă deficiențe de igienă, dar și sănătatea animalelor din fermele care alimentează dozatoarele de lapte.

Cuvinte cheie: produse crude, TNG, SCC, automate de lapte, lapte

There has been a growing consumer demand lately for raw, unprocessed products, which are often considered healthier. In many European countries, the sale of raw milk directly from the farm, through milk vending

machines, has become a fairly common method of marketing (7).

The direct sale of some food products (for example milk, eggs, honey) by limiting the quantity that can be subjected to this type of trade has been regulated, in our country, from a sanitary-veterinary point of view since 2010. As a result, more and more farmers are resorting to this system of selling milk, through which they can get a much higher price for the sold product.

1) Banat's University of Agricultural Science and Veterinary Medicine "King Michael I of Romania"

Faculty of Veterinary Medicine, Timișoara, Romania

*) Corresponding author: alexandra_cucerzan@yahoo.com

Whole raw milk is an extremely nutritious product for the consumer if the components are found in appropriate proportions. At the same time, this product may be dangerous to the consumer through the microorganisms or the residues of antimicrobial substances it may contain, if the requirements of European legislation are not complied with (14).

A recent review article (2) summarizing the scientific achievement of the study of the occurrence of food-borne pathogenic bacteria in different food matrices, and other scientific papers achieved in the field of food safety (9, 10, 12, 13) in the last decade, underlined the necessity of the continuous monitoring of the quality and salubrity of food products, including raw milk. In this regard, until now, there is no published scientific report about the monitoring of the hygienic quality and biological safety of the raw milk, produced by the western Romanian cattle farms and intended for direct sale through milk vending machines. The present survey was undertaken to fulfil this major scientific gap.

MATERIALS AND METHODS

The study took place between March 17 and June 3, 2021, and consisted in analysing a total of 38 samples of raw cow's milk. The samples were collected from vending machines in Timișoara and Arad.

The determinations on raw milk were performed to assess the quality of milk, respectively the assessment of integrity by physio-chemical determinations of the following parameters: fat, protein, lactose, dry matter, and cryoscopic point. Acidity was determined to assess the freshness of the milk. The salubrity indicators determined were: total number of germs (TNG) and the number of somatic cells (SCC).

The Lactoscope Rapid Analyzer (Delta Instruments, Drachten, the Netherlands) was used to quickly determine protein, fat, lactose, and total dry matter. The working method is simple, fast, does not require heating the sample, but only its homogenization and insertion under the pipette of the device. As a principle of this method, the milk sample is analysed by infrared spectrometry. An infrared beam passes through the sample and is then read by the analyser, and the results are compared with the preset curves, establishing the chemical composition of the analysed milk (8).

The cryoscopic point of the milk was determined using the CryoStar device (Delta Instruments, Drachten, the Netherlands). The appliance is put into operation about 20 minutes before the start of the determinations, in order to ensure the cooling of the liquid in the cooling bath. From each sample of carefully homogenised milk, in order to avoid entrainment of air, a volume of 2-2.5 ml is taken, which is transferred to one test tube of the apparatus. For correctness, from each test to be analysed, 2 determinations are performed, and the final re-

sult consists of the average of the values obtained. Usually, the result is rounded to 3 decimal places (the device displays 4 decimal places) (11).

The determination of the total number of germs was performed according to ISO 6887-5:2020 (17) and ISO 4833-1:2013 (16).

The estimation of the number of somatic cells in milk was performed by a method, which involves the automatic counting of the DNA of somatic cells. This quick method uses the NucleoCounter SCC system (Chemo Metec, Denmark) (18).

Determination of milk acidity was assessed through the Thorner method according to STAS 6353- 75.

RESULTS AND DISCUSSIONS

The results obtained from the physico-chemical determinations of the milk taken from the different automatic milk dispensers recorded different values of quality and sanitation. Significant variations were obtained in the cold period, respectively in the warmer period of the year (see Tables 1 and 2).

During the study period, the milk samples collected showed a variable chemical composition from one dispenser to another, and from one month to another, although most of the milk samples came from the same producer. The fat percentage of the analysed milk samples varied between 2.40-5.82%, with an average of 4.33%. These variations are largely due to inadequate homogenization in the milk dispenser, where the fat accumulates on the surface, and the last milk samples from the appliance will have a higher percentage of fat.

The average value of the percentage of protein was 3.64%, with a minimum limit of 3.36% and a maximum of 3.82%. The milk-specific reducing diglucose, namely lactose, recorded values between 4.65-4.98%, with an average value of 4.80%. Of all the components, lactose recorded the smallest variation, The dry matter had an average value of 13.55%, the limits being between 11.56-15.02%. The cryoscopic point varied within tight limits, the values of this indicator were 0.51-0.53°C and the average being 0.52%. The acidity was within the allowed limits, the resulting average was 19.3°T.

The results of the analyses obtained when determining the sanitation indices, respectively the total number of germs (TNG) and the number of somatic cells for the 19 dispensers in March and June are presented in Table 3 and Table 4, respectively.

In March, an average value of the total number of germs of 332,176 CFU /ml was obtained, the lowest value recorded was 101,600 CFU /ml, and the highest value was 825,500 CFU /ml (Fig. 1). Although in March the average temperatures in the Municipality of Timișoara and Arad remained low, all the samples collected during this period exceeded the maximum allowed value of the total number of germs (max. 100,000 CFU /ml).

Table 1

Physico-chemical values of raw milk samples collected in March

Crt. No.	Location	Fat %	Protein %	Lactose %	D.M. %	Cryoscopic point (°C)	Acidity (°T)
1	Piața Verde	4.42	3.63	4.81	13.62	0.52	19
2	Str. Sfinții Apostoli	4.63	3.80	4.80	13.98	0.51	19
3	Piața Dacia	4.65	3.78	4.79	13.98	0.53	19
4	Dumbrăvița	4.61	3.78	4.80	13.94	0.53	19
5	Piața, zona Lipovei	4.36	3.62	4.82	13.56	0.52	20
6	Badea Cârțan	4.65	3.80	4.76	13.96	0.53	20
7	Profi, Calea Șagului	4.64	3.77	4.79	13.96	0.53	19
8	Str. Simion Bărnuțiu	4.68	3.80	4.80	14.02	0.53	19
9	Piața Doina	4.78	3.77	4.79	14.10	0.53	20
10	Profi AEM	4.71	3.81	4.77	14.04	0.53	19
11	Zona Soarelui	4.32	3.73	4.79	13.59	0.53	19
12	Profi, Printul Turcesc	4.67	3.80	4.79	14.01	0.53	19
13	Kaufland, Circumvalațiunii	4.25	3.62	4.84	13.47	0.53	19
14	Str. Mureș, Agil	4.66	3.82	4.78	14.00	0.53	20
15	Sala Olimpia	4.66	3.79	4.77	13.98	0.53	20
16	Profi, Str. Cluj	4.60	3.76	4.76	13.90	0.52	20
17	Arad, Piața Catedralei	4.00	3.46	4.91	13.13	0.53	19
18	Arad, Str. Stefan cel Mare	2.72	3.47	4.96	11.89	0.51	20
19	Arad, Piața Miorița	4.21	3.54	4.86	13.37	0.53	19

Legend: D.M. - dry matter

Table 2

Physico-chemical values of raw milk samples collected in June

Crt. No.	Location	Fat %	Protein %	Lactose %	D.M. %	Cryoscopic point (°C)	Acidity (°T)
1	Piața Verde	2.40	3.56	4.82	11.56	0.53	19
2	Str. Sfinții Apostoli	4.66	3.63	4.80	13.85	0.52	19
3	Piața Dacia	4.17	3.50	4.85	13.27	0.53	19
4	Dumbrăvița	4.06	3.50	4.85	13.42	0.53	20
5	Piața, zona Lipovei	4.31	3.50	4.85	13.42	0.53	20
6	Badea Cârțan	4.66	3.60	4.78	13.81	0.52	20
7	Profi, Calea Șagului	4.35	3.60	4.76	13.48	0.53	19
8	Str. Simion Bărnuțiu	4.43	3.62	4.78	13.60	0.52	19
9	Piața Doina	4.23	3.41	4.65	13.09	0.53	19
10	Profi AEM	4.41	3.64	4.78	13.59	0.52	20
11	Zona Soarelui	4.58	3.64	4.76	13.74	0.52	19
12	Profi, Printul Turcesc	4.37	3.63	4.78	13.54	0.53	19
13	Kaufland, Circumvalațiunii	4.59	3.63	4.78	13.75	0.53	19
14	Str. Mureș, Agil	4.37	3.63	4.79	13.56	0.53	19
15	Sala Olimpia	3.81	3.36	4.89	12.82	0.53	19
16	Profi, Str. Cluj	2.87	3.46	4.98	12.05	0.53	20
17	Arad, Piața Catedralei	3.85	3.40	4.95	12.95	0.52	19
18	Arad, Str. Stefan cel Mare	4.66	3.74	4.76	13.90	0.53	19
19	Arad, Piața Miorița	5.82	3.74	4.68	15.02	0.53	20

Legend: D.M. - dry matter

In June, the values showed an even greater variation, so the lowest value was 215,900 CFU / ml, and the highest was 1,905,000 CFU / ml, with an average of 611,179 CFU / ml. Similar to March, all 19 samples exceeded the maximum allowed value.

The TNG variations recorded at the 19 dispensers in the two study periods are shown in Fig. 1.

Regarding the TNG, in March the average values were 319,263 cells / ml, ranging between 211,000 – 421,000 cells / ml. From the collected samples. 21% (4/19. C.I. 95% 8-43%) were non-compliant, exceeding the maximum allowed value (400,000 cells / ml).

In June, the SCC had an average of 319,105 cells / ml, 26% (5/19, CI 95% 11-48%) of samples exceed the maximum permissible value.

The increase in the SCC leads to the appearance of biochemical changes in the composition of milk, representing at the same time a danger to the consumer (1, 5). The SCC in cow's milk is an indicator of the health of the mammary gland and the quality of milk being connected with the cellular immune response following an inflammatory process (6).

The comparison of the analyses performed for the 38 milk samples in the 2 months of study indicates that the

Table 3

The results of the analyses obtained when determining the milk salubrity indices in March

Crt. No.	Location	TNG (CFU/ml)	SCC (SCC/ml)
1	Piața Verde	260.350	418.000
2	Str. Sfinții Apostoli	203.200	285.000
3	Piața Dacia	279.400	379.000
4	Dumbrăvița	133.350	211.000
5	Piața. zona Lipovei	533.400	333.000
6	Badea Cârțan	482.600	245.000
7	Profi. Calea Șagului	228.600	356.000
8	Str. Simion Bărnuțiu	152.400	254.000
9	Piața Doina	190.500	278.000
10	Profi AEM	215.900	298.000
11	Zona Soarelui	177.800	324.000
12	Profi. Prințul Turcesc	330.200	309.000
13	Kaufland. Circumvalațiunii	298.400	299.000
14	Str. Mureș. Agil	406.400	411.000
15	Sala Olimpia	825.500	407.000
16	Profi. Str. Cluj	685.800	421.000
17	Arad. Piața Catedralei	234.950	313.000
18	Arad. Str Stefan cel Mare	571.000	270.000
19	Arad. Piața Miorița	101.600	255.000

Table 4

The results of the analyses obtained when determining the milk salubrity indices in June

Crt. No.	Location	TNG (CFU/ml)	SCC (SCC/ml)
1	Piața Verde	215.900	377.000
2	Str. Sfinții Apostoli	431.800	402.000
3	Piața Dacia	762.000	355.000
4	Dumbrăvița	844.550	302.000
5	Piața. zona Lipovei	222.250	415.000
6	Badea Cârțan	292.100	211.000
7	Profi. Calea Șagului	342.900	241.000
8	Str. Simion Bărnuțiu	330.200	330.000
9	Piața Doina	215.900	345.000
10	Profi AEM	317.500	422.000
11	Zona Soarelui	1.968.500	314.000
12	Profi. Prințul Turcesc	298.400	258.000
13	Kaufland. Circumvalațiunii	1.270.000	251.000
14	Str. Mureș. Agil	304.800	219.000
15	Sala Olimpia	222.250	297.000
16	Profi. Str. Cluj	900.000	267.000
17	Arad. Piața Catedralei	336.550	256.000
18	Arad. Str. Stefan cel Mare	431.800	341.000
19	Arad. Piața Miorița	1.905.000	460.000

milk that reaches the dispensers does not come from a single farm.

In our country, in accordance with the Romanian National Order no. 55/2010 (15) the marketing of the raw milk by milk vending machines is one of the most frequently encountered direct sale activity. In this regard, from the primary production units, the obtained raw milk, within the food chain, it reaches directly on the consumer's table, via vending machines. However, as has been previously demonstrated, there are several predisposing, determining and favouring factors at the farm level, associated with the occurrence of feeding origin occult (4) or water origin zoonotic (3) diseases, which can significantly influence the quality of raw milk.

The percentage of non-compliant samples recorded demonstrates major deficiencies in milking hygiene be-

ing associated with the evolution of subclinical mastitis in cows on farms supplying milk dispensers.

CONCLUSIONS

Milk sold through direct sales to dairy vending machines is not always a safe alternative with real benefits for consumers, taking into account the safety of the product and its nutritional values.

The variation of the chemical composition of raw milk can lead to the marketing of products with inconsistent nutritional values. Exceeding the maximum allowed values in terms of the total number of germs and the number of somatic cells reveals hygienic deficiencies, but also the health of the animals on the farms that supply the milk dispensers.

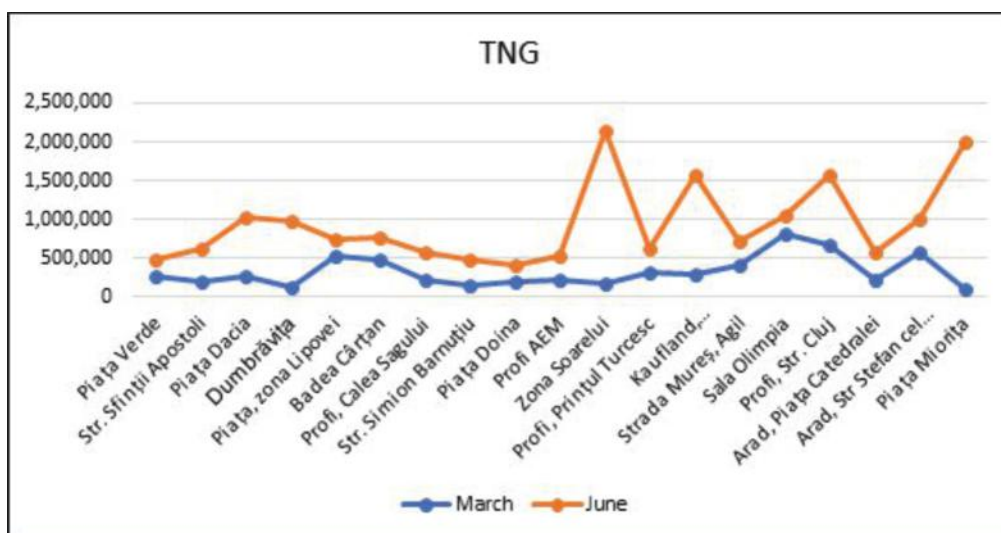


Fig. 1. TNG variation of milk samples by location

REFERENCES

1. Fox, P., McSweeney, P.L.D., (2003), Proteins. Advanced Dairy Chemistry, vol I, 3rd ed., Plenum Publish, NY, USA
2. Imre K., Herman V., Morar A., (2020). Scientific achievements in the study of the occurrence and antimicrobial susceptibility profile of major foodborne pathogenic bacteria in foods and food processing environments in Romania: review of the last decade. Biomed Res Int, 5134764
3. Imre K., Morar A., Ilie M.S., Plutzer J., Imre M., Tîrziu E., Herbei M.V., Dărbăuș G., (2017), Survey of the occurrence and human infective potential of *Giardia duodenalis* and *Cryptosporidium* spp. in wastewater and different surface water sources of Western Romania. Vector Borne Zoonotic Dis, 17(10):685-691.
4. Imre K., Morariu S., Ilie M.S., Imre M., Ferrari N., Genchi C., Dărbăuș G., (2012), Serological survey of *Neospora caninum* infection in cattle herds from western Romania. J Parasitol, 98(3):683-685
5. Lindmark-Mansson H., Branning, C., Paulsson M., (2006), Relationship between somatic cell count, individual leukocyte population and milk components in bovine udder quater milk. Int Dairy J, 16:717-727
6. Mehra R., Obrian B., Connolly J.F., Harrington D., (1999), Seasonal variation in the composition of Irish manufacturing and retail milk. Irish J Agric Food Res, 38:65-74
7. Meunier-Goddik L., Waite-Cusic J., (2019), Consumers acceptance of raw milk and its products, In: *Raw Milk*, (Ed.) Academic Press, Cambridge, MA, USA, 311-350
8. Morar, A., Sala, C., Milovan, G., (2009), Sanitary veterinary control of products of animal origin - practical works, (Ed.) Eurobit, Timisoara, Romania (in Romanian)
9. Sala C., Imre K., Nichita I., David C., Morar A., (2014), Raw milk quality collected in teh western part of Romania. Lucrari Stiintifice - Universitatea de Stiinte Agricole a Banatului Timisoara, Medicina Veterinara, 47(2):144-148
10. Sala C., Morar A., Tîrziu E., Nichita I., Imre M., Imre K., (2016), Environmental occurrence and antibiotic susceptibility profile of *L. monocytogenes* at a slaughterhouse raw processing plant. J Food Prot, 79(10):1794-1797
11. Sala, C., Morar, A., (2015), Hygiene and food technology - Milk and dairy products, eggs, honey, (Ed.) Eurobit, Timișoara, Romania (in Romanian)
12. Suciu O., Morar A., Tîrziu E., Cucerzan A., Bucur I., Imre M., Imre K., Palicica R., Romoșan I., (2021), Assessment of raw milk microbial quality and survey of the occurrence and evaluation of the public health risk of *Escherichia coli* in raw milk from small scale integrated backyard cattle farms in Western Romania. Revista Romana de Medicina Veterinara, 31(1):15-19
13. Tîrziu E., Bărbălan G., Morar A., Herman V., Cristina R. T., Imre K., (2020), Occurrence and antimicrobial susceptibility profile of *Salmonella* spp. in raw and ready-to-eat foods and *Campylobacter* spp. in retail raw chicken meat in Transylvania. Foodborne Path Dis, 17(8):479-484
14. ***Regulation (EC) No 853/2004 of the European parliament and of the Council of 29 April 2004 laying down specific hygiene rules for on the hygiene of foodstuffs
15. *** ANSVSA Order No 55/2010 for the approval of the Veterinary Sanitary Norm and for food safety regarding the sanitary-veterinary conditions in which the direct sale of raw milk can be carried out through vending machines. M.Of. nr. 408. 18 iun. 2010 [in Romanian]
16. *** ISO 4833-1:2013. Microbiology of the food chain — Horizontal method for the enumeration of microorganisms — Part 1: Colony count at 30 °C by the pour plate technique. Available at: <https://www.iso.org/standard/53728.html> (Accessed: March 10, 2021)
17. *** ISO 6887-5:2020 Microbiology of the food chain — Preparation of test samples, initial suspension and decimal dilutions for microbiological examination — Part 5: Specific rules for the preparation of milk and milk products. Available at: <https://www.iso.org/standard/71502.html> (Accessed: March 10, 2021)
18. *** NucleoCounter SCC-100, The Most Precise Automated Somatic Cell. Available at: [Counterhttps://chemometec.com/products/nucleocounter-scc-100-somatic-cell-counter/](https://chemometec.com/products/nucleocounter-scc-100-somatic-cell-counter/) (Accessed: March 10, 2021).