DOI: http://doi.org/10.21698/simi.2019.fp43

UNIVERSAL SCREENING OF PRIVATE WELLS WATER QUALITY IN THE MUNTENIA REGION, ROMANIA

Gina Vasile Scaeteanu[1], Roxana Maria Madjar[1*], George Adrian Peticila[2]

[1]University of Agronomic Sciences and Veterinary Medicine, Faculty of Agriculture, 59 Blvd. Marasti, 011464, Bucharest, *rmadjar@yahoo.com, Romania
[2]University of Agronomic Sciences and Veterinary Medicine, Faculty of Horticulture, 59 Blvd. Marasti, 011464, Bucharest, Romania.

Abstract
Drinking water quality is an actual and stringent problem and the presence of nitrate and nitrite ions above limits imposed by legislation may produce methemoglobinemy and different types of cancer. Because nitrate is odourless, colourless and tasteless is undetectable without tests and well water is recommended to be evaluated from this point of view, especially when in the proximity of the wells are activities which may contribute to water contamination. The present research was carried out with aim to achieve nitrate and nitrite levels from wells located in three areas from Muntenia region: Chiajna (Ilfov), Letca Noua (Giurgiu) and Manastirea (Calarasi). The obtained results evidenced that 10 from 14 analysed wells contain nitrate levels were over imposed limit, one of them located in Manastirea (Calarasi) being even 4 times higher. Regarding nitrite, water from one sampling point is over 0.5 mg/L, all the rest being lower and much lower than imposed limit.

Keywords*: health, nitrate, nitrite, pollution, well water*

Introduction
Over last decades, nitrate levels in groundwater have gradually increased in many European countries and the main factors responsible for this situation are represented by the use of nitrogenous fertilizers, intensive agriculture and disposal of wastes mainly from animal farming (WHO, 2016).
Beside methemoglobinemy, the most common manifestation derived from excessive nitrate exposure, literature presents some other negative health effects associated with nitrates: various types of cancer (Dourson & Baily 1990; Mirvish 1991; Prakasa & Puttanna 2000; Gulis et al 2002), central nervous system defects (Dourson & Baily 1990; Mirvish 1991), hypertrophy of the thyroid (Vermeer et al 1998).
In Romania there were developed projects concerning nutrient control in order to minimize pollution effects, especially nitrate pollution. Thus, Integrated Nutrient Pollution Control Project was intended to implement EU Nitrate Directive for nitrate vulnerable zones by application some specific measures in order to contribute to reduction of nitrate pollution. Some legislative regulations for Romania sustain reducing water pollution caused or induced by nitrates from agricultural sources and preventing further pollution (Council Directive 91/676/EEC). Application and implementation of Council Directive 91/676/EEC is depicted in a report from the

Commission to the Council and The European Parliament which is based on the information provided by Member States for 2012-2015 period of time concerning water quality, designation of nitrate vulnerable zones, action programs.
In Romania and European Union, the guideline values for nitrate and nitrite are 50 mg/L and 0.5 mg/L, respectively. As nitrate and nitrite may occur simultaneously in drinking water and having in view the cumulative hazardous effect of their presence, according to Council Directive 98/83/EC, there must be ensured the relation: [nitrate]/50 + [nitrite]/3≤ 1, where the square brackets represent the concentrations in mg/L for both species.
The aim of the research was to evaluate the nitrate and nitrite levels of water collected from private wells located in three areas from Muntenia region, as it follows: Chiajna (Ilfov), Letca Noua (Giurgiu) and Manastirea (Calarasi). The results were compared with quality standards for drinking water imposed by Council Directive 98/83/EC and also with Romanian legislation and discussed as a constituent part of our previous researches on this topic.

Experimental
Evaluation of the nitrate and nitrite levels for water collected from private wells located in Chiajna (Ilfov), Letca Noua (Giurgiu) and Manastirea (Calarasi) was performed according to the procedures described below. The research was carried out during 2018-2019 and for each area were selected several sampling points which are sources of drinking water and/or are used for domestic usage (cooking, washing), as it follows: 6 points (**A1-A6**) for Chiajna, 4 points for Letca Noua (**B1-B4**) and 4 points for Manastirea (**C1-C4**).
Sampling depths for investigated points are: **a)** for Chiajna - 22 m (A1), 70 m (A2), 13 m (A3), 32,5 m (A4), 8 m (A5), 19 m (A6); **b)** for Letca Noua - 20 m (B1), 18 m (B2), 14 m (B3), 13 m; **c)** for Manastirea - 5 m (C1), 6 m (C2), 6m (C3), 5m (C4).
The results represent the average of the determinations. Water samples were collected in pre-cleaned polyethene bottles, preserved at 4ºC and the analyses were conducted within 48 hours of collection. The samples were allowed to stay until they reached room temperature before analysis.
Nitrate ions concentrations were quantified by spectrophotometric means using 2,4-disulphonic acid in basic medium when it was obtained yellow nitroderivatives that have absorption maxima at 420 nm. The nitrite levels were determined spectrophotometrically as well, using Griess reagent. After diazotation reaction between sulphanilic acid and nitrites followed by coupling with naphthylamine, it was obtained a pink azoic compound with absorption maxima at 540 nm. Spectrophotometric measurements were carried out using Metertek SP830 Plus apparatus.

Results and Discussion
For tested samples, the nitrate and nitrite levels present large variations that are depicted in Table 1, Figure 1 and Figure 2. For Chiajna, nitrate levels are within 10.94 and 128.02 mg/L, with an average for investigated area of 66.75 mg/L. In the case of A3, A5 and A6, the nitrate levels exceeded maximum admitted level, meanwhile in the case of A4 found concentration was near reference value.
Related to nitrite levels, as average, the obtained value (0.295 mg/L) is lower than imposed concentration (0.5 mg/L), but for A5, found concentration exceeded the

limit. Concerning relation imposed by Council Directive 98/83/EC, for A3, A5 and A6 sampling points was encountered the same alarming situation. Thus, the results obtained for the relation $[NO_3^-]/50 + [NO_2^-]/3$ are over limit in the case of A3, A5 and A6 sampling points. In this context, water provided by A3, A5 and A6 wells is not suitable to be consumed and its use for any domestic purpose also must be forbidden.

Table 1. Nitrate and nitrite contents for well water from Chiajna, Letca Noua and Manastirea

Nr. crt.	Well	NO_3^-, mg/L	NO_2^-, mg/L	$[NO_3^-]/50 + [NO_2^-]/3$
Chiajna, Ilfov				
1.	A1	12.66	0.106	0.288
2.	A2	10.94	0.162	0.272
3.	A3	99.12	0.361	2.102
4.	A4	46.12	0.090	0.952
5.	A5	128.02	0.565	2.748
6.	A6	103.66	0.487	2.235
Average		**66.75**	**0.295**	**1.432**
Letca Noua, Giurgiu				
1.	B1	34.73	0.080	0.721
2.	B2	103.32	0.175	2.124
3.	B3	126.87	0.480	2.697
4.	B4	105.75	0.229	2.191
Average		**92.66**	**0.241**	**1.933**
Manastirea, Calarasi				
1.	C1	208.79	0.169	4.232
2.	C2	75.75	0.102	1.549
3.	C3	95.46	0.084	1.937
4.	C4	103.08	0.145	2.110
Average		**120.77**	**0.125**	**2.457**
MAL*		**50**	**0.5**	**≤1**

*According to Council Directive 98/83/EC and to Law no. 458/2002 (2011)
value below MAL value that exceed MAL

In the case of Letca Noua area, nitrate levels exceeded maximum admitted level (MAL) for three sampling points (B2, B3 and B4), even of 2.53 times (Table 1, Figure 1). Consequently, relation imposed by Council Directive 98/83/EC has led to values higher than limit for the same sampling points: 2.124 mg/L (B2), 2.697 mg/L (B3), 2.191 mg/L (B4). Only B1 sampling point presented a value below limit (0.721 mg/L). Nitrite levels are below 0.5 mg/L, the highest found concentration being encountered for B3 (0.480 mg/L) (Table 1, Figure 2).

Nitrate concentrations found for well water samples collected from Manastirea, Calarasi are all over maximum admitted level of 1.5 to 4 times higher, with an average of 120.77 mg/L (Table 1, Figure 1). In contrast to nitrate levels, nitrite levels for C1-C4 sampling points are below 0.5 mg/L (Table 1, Figure 2). All the

results of the relation $[NO_3^-]/50 + [NO_2^-]/3$ are higher than imposed value, the increasing order being C2 < C3 < C4 < C1.

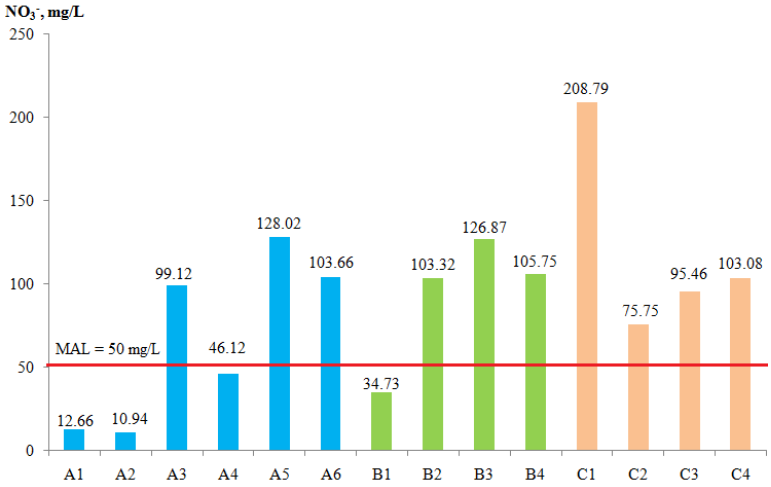

Figure 1. Nitrate levels determined for well water collected from Chiajna (A1-A6), Letca Noua (B1-B4) and Manastirea (C1-C4)

The obtained results are of great concern having in view that 71.42% from all analyzed water samples contain nitrates over MAL, one of them being 4 times higher than limit. As average, well water collected from Chiajna, Ilfov present the lowest nitrate levels (66.75 mg/L), followed by those collected from Letca Noua, Giurgiu (92.66 mg/L) and from Manastirea, Calarasi (120.77 mg/L).
This situation appeared mainly due to agricultural practices associated with nitrogen fertilisation adopted by locals. Beside this evident explanation which is sustained by the position of wells in the proximity of the greenhouses and solariums, it could be taken into consideration also, the improper position of the wells near septic fosses and livestock facilities.
The obtained levels of nitrate in investigated areas correlated with literature data regarding relation between nitrate and methemoglobinemy (Fan et al 1987) must represent a serious threat and consumption of water from these sources must be suspended. Also, having in view the agricultural potential of Giurgiu and Calarasi areas, nitrate levels must be monitored strictly and the environmental risk which arises from nitrate presence is necessary to be estimated.

Figure 2. Nitrite levels determined for well water collected from Chiajna (A1-A6), Letca Noua (B1-B4) and Manastirea (C1-C4)

Regarding nitrite, 92.85% from investigated water samples correspond to limit imposed by legislation, only one sample which originates from Chiajna has nitrite concentration slightly above limit (0.565 mg/L).

Integration of the obtained results into our previous researches

There are many studies that deal with nitrate levels found in well water collected from different areas in Romania. Extreme values were reported for well water from Ozun village (Covasna) when nitrate levels exceeded the limit value even 3 times, meanwhile nitrite concentrations were within safe limit (Raduly & Farkas 2017). Nitrate levels over 300 mg/L were also reported for water collected from wells located in Salaj (Martonos & Sabo 2017).

The results presented in this paper represent a constituent part of our previous researches on this topic. Accordingly, the results depicted in Table 2 and Figure 3 indicate that the highest nitrate levels were found in Matca (279.57 mg/L, as average), followed by Sahateni (248.9 mg/L, as average). These results are not totally unexpected having in view that Matca is the most important vegetable area from Galati and high nitrate levels in soil were reported (Lacatus et al 2016).

The lowest nitrate levels, even below MAL (as average), were found in Prahova County, followed by Ilfov County.

Literature studies show that drinking water with nitrate levels between 41-100 mg/L present risks for adults and young livestock, meanwhile concentrations over 100 mg/L indicate that water should not be used for drinking either by humans or livestock (Daniels & Mesner 2010). A study concerning methemoglobinemy in Romania indicates that 20% of cases appeared when nitrate levels in well water were between 0 and 20 mg/L, meanwhile 58% of cases were associated with nitrate levels between 101 and 500 mg/L (Tudor & Staicu 2009).

Table 2. Nitrate levels in well water from different areas (mg/L)

Nr. crt	Sampling area	Sampling points	NO_3^-	Average NO_3^- content	Reference
1	Buzau, Sahateni	8	48.2 - 540.80	248.90	Pele et al 2010
2	Calarasi, Manastirea	4	75.74 - 208.78	120.77	this study
3	Constanta, Cobadin	5	19.55-235.56	103.02	Vasile Scaeteanu & Madjar 2018
4	Galati, Matca	7	149 - 452	279.57	Pele et al 2010
5	Giurgiu, Letca Noua	4	34.73 - 126.87	92.66	this study
6	Ilfov, Chiajna	6	10.94 - 128.02	66.75	this study
7	Ilfov, Clinceni	8	44.70 - 66.58	49.78	Pele et al 2010
8	Prahova, Fantanele	4	20.33 - 87.09	45.83	Vasile Scaeteanu et al 2014
9	Prahova, Maneciu-Ungureni	7	8.53 - 49.22	33.31	Vasile Scaeteanu & Madjar 2017

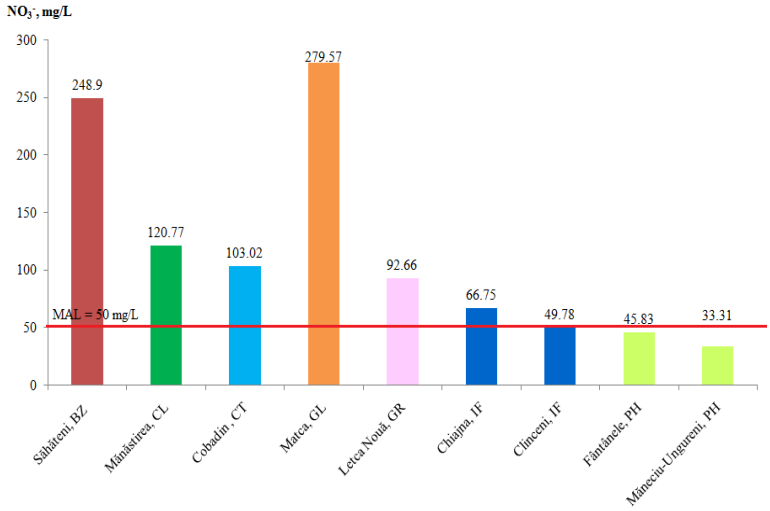

Figure 3. Representation of average nitrate contents found in well water from various areas

Conclusions

The research consisting in evaluation of nitrate and nitrite levels for drinking water collected from private wells located in Muntenia region (Chiajna - Ilfov, Letca Noua - Giurgiu and Manastirea - Calarasi), provided some conclusions.

Three from six investigated wells from Chiajna contain water with nitrate levels over MAL, with an average of 66.75 mg/L.

Nitrate levels form Letca Noua are higher than those found in Chiajna, with an average of 92.66 mg/L. All samples collected from Manastirea are over MAL, one of them being 4 times higher;
Regarding nitrite concentration, water from one sampling point is over 0.5 mg/L, all the rest being lower and much lower than imposed limit.
On the basis of these alarming results (71.42% of all analyzed water samples contain nitrates over MAL), it must be taken into consideration the alternative to find other water sources for drinking and further monitoring and surveillance of water from these points need to be enhanced.
Controlling nitrate levels is very difficult, having in view that nitrate vulnerable areas are agricultural ones. The best manner is prevention by adopting a good management for agricultural practices, for fertilizer and manure applications and by avoiding storage of animal manures near well water sources.

References

***Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (91/676/EEC).

***European Commission – Report from the Commission to the Council and the European Parliament on the implementation of Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources based on Member State reports for the period 2012-2015.

***Law 458/2002 (2011) regarding drinking water quality.

***Ministerul Apelor si Padurilor, *Controlul Integrat al Poluarii cu Nutrienti*. Available from: http://www.inpcp.ro/ [15.07.2019].

***Official Journal of the European Communities, Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption.

***WHO 2016, Nitrate and nitrite in drinking-water. Background document for development of WHO Guidelines for Drinking-water Quality.

Daniels, B & Mesner, N 2010, 'Nitrate. Drinking water facts', *Utah State University, Water Quality Extension.*

Fan, AM, Willhite, CC & Book, SA 1987, 'Evaluation of the nitrate drinking water standard with reference to infant methemoglobinemia and potential reproductive toxicity', *Regulatory Toxicology and Pharmacology*, vol. 7(2), pp. 135-148.

Lacatus, V, Carstea, & LN, Scurtu, I 2016, 'Water soluble phosphorus soil insurance in plastic houses cutivated with vegetable crops and active substance requirements', *Current Trends in Natural Sciences*, vol.5(9), pp. 68-78.

Martonos, IM & Sabo, HM 2017, 'Quality of drinking water supplies in Almasu rural area (Salaj County, Romania)', *Carpathian Journal of Earth and Environmental Sciences*, vol.12 (2), pp. 371-376.

Pele, M, Vasile, G & Artimon, M 2010, 'Studies regarding nitrogen pollutants in well waters from Romania', *Scientific Papers UASMV Bucharest, Series A, Agronomy,* vol. LIII, pp. 145-151.

Raduly, OC & Farkas, A 2017, 'Nitrate, nitrite and microbial denitrification in drinking water from Ozun village (Covasna County, Romania) and the

association between changes during water storage', *Studia Universitatis Babes-Bolyai Biologia*, vol. LXII, no. 1, pp. 17-28.

Tudor, A & Staicu, C 2009, 'Methemoglobinemia acuta infantila generata de apa de fantana in anul 2009', *National report*.

Vasile Scaeteanu, G & Madjar RM 2017, 'Evaluation of well water quality collected from Maneciu-Ungureni, Prahova County, Romania', *SGEM2017 Vienna GREEN Conference Proceedings*, vol. 17, no.33, pp. 151-162.

Vasile Scaeteanu, G & Madjar RM 2018, 'A baseline assessment of water quality from private wells located in Constanta County and risk implications for community health', *International Symposium the Environment and the Industry - SIMI 2018*, Proceedings Book, pp. 333-340.

Vasile Scaeteanu, G, Madjar, RM, Penescu, A, Dinca, EP & Terzea, IA 2014, 'Nitrate monitoring in private wells from Prahova District', *Scientific Papers Series A, Agronomy*, vol. LVII, pp. 68-73.

Dourson, M, Stern, B, Griffin, S & Baily, K 1990, 'Impact of risk-related concerns on U.S. Environmental Protection Agency programs. Nitrate Contamination', *NATO ASI Series vol. G30*, Editors. Bogardi, I & Kuzelka RD, Springer Verlag, Berlin Heidelberg, pp. 477-487.

Mirvish, SS 1991, 'The significance for human health of nitrate, nitrate and N-nitroso compounds. Nitrate Contamination', *NATO ASI Series vol. G30, eds. I. Bogardi and R.D. Kuzelka, Springer Verlag, Berlin Heidelberg*, pp. 253-265.

Prakasa, R & Puttanna K 2000, 'Nitrates, agriculture and environment', *Current Science*, vol.79, pp. 1163-1168.

Vermeer, ITM, Pachen, DMFA, Dallinga, JW & Kleinjans, JCS 1998, 'Volatile N-Nitrosamine formation after intake of nitrate at the ADI level in combination with an amine-rich diet', *Environmental Health Perspectives*, vol. 106, pp. 459-463.

Gulis, G, Czompolyova & G, Cerhan, JR 2002, 'An ecologic study of nitrate in municipal drinking water and cancer incidence in Trnava District. Slovakia', *Environmental Research*, vol. 88, no. 3, pp. 182-187.