# FOUNTAINE WATER POTABILITY ASSESSMENT IN THE SUCEAVA COUNTY

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**Abstract**

*Due to the qualitative changes of groundwater, produced by pollution with substances that alter the physical, chemical and biological qualities of water, at the level of individual water sources (wells), there are frequently recorded exceedances of the maximum permissible concentration for chemical parameters such as ammonium, nitrates, nitrites, hardness, etc.*

*The quality of water in wells is influenced by the soil structure and various sources of pollution and the excessive use of fertilizer for fertilization and also by rain washing of agricultural soils (especially in winter). The presence of severe storms can be important sources of nitrate contamination for surface waters. Even the natural structure of the soil can alter the quality of the water.*

*Increased concentrations of nitrate in drinking water can be produced by several sources already mentioned, but also by the non-compliance with hygienic-sanitary conditions and location of wells.*

*The goal of this study is to increase the awareness of the importance of monitoring the quality of the water that people consumes. Systematic monitoring of the quality of drinking water is essential, considering the negative influence of the exceedence of maximum admissible values for some parameters, especially on the organisms of children and infants for whom can even lead to death.*

*The results show that the maximum admissible limit values for nitrate and ammonium concentrations in the fountaine water from the Suceava district are exceeded in some cases, while the other parameters under investigation are in general within the permissible limits.*

***Key words**: water quality, legislation, pollution, monitoring*

## INTRODUCTION

Water resource efficiency policy must be based on an awareness of the amount of resources that can be used, as well as the impact of activities on the environment and how it is affected. Any human action that does not respect the environment will be reflected by the boomerang effect on the health of the population. Sustainable management is based on identifying, recognizing and ensuring the basic needs of consumers (Connolly et al.2021). Providing the drinking water needed for urban and rural consumers must be an action that does not harm the environment and avoids waste as much as possible. Chemical, physical, biological processes, flow Regulation in transmission/distribution pipelines are aspects that have the role of ensuring the smooth functioning of the process as well as reducing the effects on the environment.

Options for water sources used for drinking water and irrigation will continue to evolve, with an increasing dependence on groundwater and alternative sources, including wastewater.

Strategies for water quality and human health were developed by the World Health Organization, which established and regulated global standards. Regarding water quality, WHO guidelines recommend water Safety plans (WSP) as the most effective means of ensuring the safety of a drinking water supply on a regular basis. This plan aims to protect the health of the population by supporting the development of regulations and standards, at national and local level (studies based on health statistics – analysis of particularities and possible diseases, depending on geographical areas), the adoption of preventive approaches to risk management (water safety plans).

Deep-sea waters differ in their physico-chemical composition and microbiological load from surface waters. Although they are often superior to characteristics such as turbidity, bacteriological content and total organic concentrations may however have high hardness levels, or may present a load above the maximum permissible dose of iron, chromium, fluorine, manganese, etc. Water potentiation is the process by which water, surface or deep, is treated physico-chemically and microbiologically to serve human consumption without harming it. The water is carefully monitored throughout the technological flow from extraction to the consumer's tap. At national level, the main law imposing the quality of drinking water is Law no. 458/2002. The ways in which drinking water can be obtained differ from one area to another depending on several external factors such as: water type, geographical location, economic conditions, technology used, labor force, dimensions, complexity of processes. Nitrite can be formed during the biodegradation of nitrate, ammonia nitrogen and other nitrogen substances and is an important indicator of pollution of natural water systems. In addition, it is easily oxidized to nitrates by dissolved oxygen, thereby lowering the oxygen level in the water (Gutiérrez et al.2019). When nitrate-contaminated water supplies are a source of drinking water, they are also worrying about the risk of consumer disease. Compared to nitrites, nitrates are compounds with less toxicity, posing a hazard only when ingested in excessive doses or converted into nitrites. Nitrites can have adverse effects on human health. For examination, the in vivo reaction between nitrites and secondary tertiary amines produces N-nitrosamines, products with carcinogenic potential.

## MATERIALS AND METHODS

In order to carry out the water study, samples were taken from several points, in sterile containers, according to the methodology. The areas that were part of this study are: Campulung Moldovenesc (11 samples), Cajvana, Gura Humorului, Vatra Moldovitei, Demacusa, Radauti. 23 samples were collected and analyzed in the laboratory of the ICAS Institute - Campulung Moldovenesc. To check the potability of the analyzed waters, the following determinations have been made: pH analysis, measurement of alkalinity and conductivity, determination of nitrates, sulphates and ammonium.

***pH determination*** - indicates the alkaline or basic character of the water at the time of analysis. According to the national rules in force, the pH value must be within the range of 6,5-8,0. Values below 6,5 indicate an acidic character, which may cause corrosive action on transmission lines and distribution plant and adverse effects on human consumers. Water with a pH value greater than 9,5 does not reprezent a risk to consumer health, but may cause stone deposits on the transport facilities. The determination of the pH value was carried out using the Titroline easy titrator (the analytical method complies with the SR ISO20523:2008 standard). The samples that were analyzed were homogenized and brought to 25ºC temperature.The slightly alkaline water, assessed by pH values, from the wells that were the subject of this study falls within the quality standard no. 458/200.

***The alkalinity measurement*** was carried out with the TitroLine easy titrator immediately after pH determination by titrating 100 ml of the sample with 0,1 N hydrochloric acid to pH 4,5.

***Conductivity*** is the sum of mineral substances dissolved in water, suspended particles and microorganisms are not quantified in the final value, as they can be removed by physico-chemical methods. The higher the purity of the water, the lower the electrical conductivity. According to specialized studies, ultra purified water has a conductivity value of 5,5*10-6 S/m; drinking water 0,005-0,05 S/m while sea water 5 S/m (conductivity is directly proportional to salinity and temperature). The conductivity of the fountain water samples was measured with a WTW 730 conductivity meter, with TetraCon325 conductivity cell, at a temperature of 25ºC, after mixing the sample by gentle stirring, according to SR EN 27888.

**Determination of nitrate, ammonium and sulphate**

Nitrate can reach groundwater and surface waters as a result of human activity when pesticides are misused, while nitrite can occur in drinking water distribution pipes when the water does not have a constant flow and the chlorination stage has not been performed properly. The levels of nitrites and nitrates in water are important indicators of its quality.

For the determination of nitrates, ammonium and sulphates, liquid phase ion chromatography was used, with simultaneous analysis of cations and anions. The apparatus used was ion chromatograph ICS3000 Dionex. The isocratic cation method for $NH_4^+$ measurement was used, with 20 mM methanesulphonic acid as eluent. For anions ($NO_3^-$ and $SO_4^{2-}$ ) the isocratic method was used, with eluent carbonate-bicarbonate mixture (4,5 mM $Na_2CO_3$ + 1,4 mM $NaHCO_3$). The eluent flow rate was 1ml/min (EN ISO 10304-1).

The quality assurance of the results was achieved by using the methodology provided in the EMEP and ICP Forests Manuals for precipitation analysis, which included participation in intercalibration exercises with other laboratories from Europe. As a reference, a sample of non-carbonated mineral water Bucovina was used in each series of analyzes, which specifies on the label the values of the parameters analyzed in this study. The obtained values were within ±10% of those specified on the label.

## RESULTS AND DISCUSSIONS

The values of the parameters determined in this study are generally within the allowable limits, with a few exceptions. The results obtained for the determination of conductivity, alkalinity and pH are found in Table 1. Similar results was found and by another researchers in different contries.

**Table 1. pH, conductivity and alkalinity values**

| Nr. crt. | Samples collection | pH | Conductivity (µS/cm) | Alkalinity (µE/l) |
|---|---|---|---|---|
| 1 | Sample 1 | 7.34 | 1037 | 6482 |
| 2 | Sample 2 | 7.02 | 553 | 3628 |
| 3 | Sample 3 | 6.97 | 587 | 3798 |
| 4 | Sample 4 | 7.39 | 607 | 4254 |
| 5 | Sample 5 | 7.39 | 578 | 3746 |
| 6 | Sample 6 | 7.29 | 784 | 3736 |
| 7 | Sample 7 | 7.63 | 494 | 4155 |
| 8 | Sample 8 | 7.07 | 686 | 4161 |
| 9 | Sample 9 | 7.16 | 540 | 3845 |
| 10 | Sample 10 | 7.05 | 626 | 4569 |
| 11 | Sample 11 | 7.26 | 598 | 4791 |
| 12 | Sample 12 | 7.28 | 645 | 4585 |
| 13 | Sample 13 | 7.35 | 583 | 3694 |
| 14 | Sample 14 | 6.69 | 450 | 3927 |
| 15 | Sample 15 | - | 690 | - |
| 16 | Sample 16 | 7.53 | 637 | 2880 |
| 17 | Sample 17 | 7.46 | 850 | 4132 |
| 18 | Sample 18 | 6.93 | 533 | 4930 |
| 19 | Sample 19 | 7.27 | 617 | 4981 |
| 20 | Sample 20 | 7.18 | 759 | 3456 |
| 21 | Sample 21 | 6.62 | 899 | 5371 |
| 22 | Sample 22 | 6.99 | 677 | |
| 23 | Sample 23 | 7.13 | 746 | 5520 |

Moreover, temperature controls rate of reactions, metabolic activities and growth of living organisms in water. The pH of the samples ranged between 6.54 and 7.19, with an average of 6.87. The maximum value was for the municipal water source and the minimum was for the natural source. All values lied between the recommended values (6.5–8.5) by ISO 10500.

Acidic nature of water is a characteristic of oligotrophic water bodies indicating its good quality (Soni et al. 2013). The conductivity of the water samples ranged between 132 and 145 µS/ cm with an average of 138.6 µS/cm. The low value of conductivity indicates the smaller number of ions present in the water sample, making it suitable to drink. The value of TDS (total dissolved substances) for the samples ranged between 26.5 and 72.5

mg/l with an average of 45.1 mg/l m. These values are quite low compared with the recommended values by IS 10500, which is 500 mg/l.

Alkalinity of the samples ranged between 71 and 120 mg/l with an average of 93.2 mg/l. These values were less those recommended by IS 10500, which is 200 mg/l (Chauhan et al, 2020).

If the value of electrical conductivity needs to be decreased, this can be achieved by nanofiltration of water leading to a decrease of up to 70% or reverse osmosis which reduces the initial conductivity of water by 95% (Mănescu, 1994).

The result for nitrates, nitrites, ammonium and sulphates in the samples analyzed are shows in table 3.

Drinking water contaminated with ammonium, nitrates, and nitrites makes consumers sick, with the most serious effects on the young people (Connolly et al.2001).

In addition, nitrite interacts with the pigment in the blood to cause meta-hemoglobin, especially in infants. This condition limits the ability of the blood to carry oxygen from the lungs to the body. Reduced oxygen transport becomes clinically manifest when concentrations of methHb reach 10% of normal concentrations of HB and above; the condition, called metemoglobinemia, causes cyanosis and, at higher concentrations, asphyxia (Pal, 2017). The normal level of methHb in humans is less than 2%; in infants under 3 months, it is less than 3%. Due to the possibility of simultaneous occurrence of nitrite and nitrate in drinking water, the sum of the ratios of each concentration (C) to its orientation value (GV) should not exceed 1.

Major issues include whether the relationship of colon cancer risk with nitrate concentration is a linear trend, and if so, over what range of concentrations.

Maximum permitted limits in national legislation: nitrates: 50 mg $NO_3$/L, ammonium: 0,5 mg $NH_4$/L, sulphates: 200 mg $SO_4$/l (table 2).

**Table 2. Nitrates, Amonium and reference values from various international and national organizations.**

| Parrameter | Directive 98/83/EC Annex IB | WHO Guide 2005 | Ministry of Health Canada environmental Protection Agency USA | National legislation |
|---|---|---|---|---|
| Nitrates | 50 mg/l | 45mg/l | 45mg/l | 50 mg/l |
| Amonium | 0,5 mg/l | 1,5 mg/l | | 0,5 mg/l |
| Sulfates | 200 mg/l | 200 mg/l | 200 mg/l | 200 mg/l |

The exposure limit for nitrate in drinking water set by the World Health Organisation (WHO) and adopted by many countries, is 50 mg/l $NO_3$ (nitrate ion), the equivalent in N-$NO_3$ (nitrogen) being 11.3 mg/l, conversion factor 0.226 (WHO, 2017). The limit set in the US and Canada is approximately the same, 10.0 mg/L NO3-N.

The association between drinking water nitrate and increases in colorectal cancer has to be assessed in terms of its likely validity. The association is weak, with the most definitive evidence of association being an increase from very low levels to nitrate concentrations of around 3, with a relative risk of 1.024 per mg/l nitrate increase, or around 1.08 for the 0-3 mg/L range (Elwood, 2022).

**Tab.3. The values corresponding to nitrates, nitrites, ammonium and sulphates in the samples analyzed**

| Nr. crt. | Sample collection | Nitrates (mg NO3/l) | Amonium (mg NH4/l) | Sulfates (mgSO4/l) |
|---|---|---|---|---|
| 1 | Sample 1 | 4.76 | 1.22 | 134.40 |
| 2 | Sample 2 | 11.23 | 0.72 | 31.46 |
| 3 | Sample 3 | 0.13 | 0.00 | 68.30 |
| 4 | Sample 4 | 1.33 | 0.00 | 52.71 |
| 5 | Sample 5 | 5.00 | 0.00 | 66.39 |
| 6 | Sample 6 | 42.18 | 2.19 | 54.68 |
| 7 | Sample 7 | 4.78 | 0.94 | 21.54 |
| 8 | Sample 8 | 22.45 | 0.00 | 36.06 |
| 9 | Sample 9 | 10.40 | 0.00 | 25.08 |
| 10 | Sample 10 | 3.19 | 0.00 | 22.20 |
| 11 | Sample 11 | 4.21 | 0.00 | 35.34 |
| 12 | Sample 12 | 0.04 | 0.00 | 37.02 |
| 13 | Sample 13 | 0.35 | 0.00 | 92.58 |
| 14 | Sample 14 | 9.43 | 0.00 | 18.80 |
| 15 | Sample 15 | 26.61 | - | - |
| 16 | Sample 16 | 53.47 | 0.00 | 63.21 |
| 17 | Sample 17 | 70.64 | 0.00 | 76.95 |
| 18 | Sample 18 | 1.48 | 0.00 | 30.63 |
| 19 | Sample 19 | 12.05 | 0.00 | 23.30 |
| 20 | Sample 20 | 79.71 | 0.03 | 37.88 |
| 21 | Sample 21 | 29.34 | 0.06 | 122.18 |
| 22 | Sample 22 | 58.28 | 0.04 | 37.41 |
| 23 | Sample 23 | 90.45 | 0.16 | 39.23 |

Other researcher studied the influence of nitrate from drinking water. Their result shows the higher the level of nitrate in drinking water, the higher the risk of CRC (Temkin, 2019). Considering colon and rectal cancer as separate outcomes, they found similar results. Results for CRC combined and rectal cancer alone showed statistically significant increased HRs in the two highest quintiles of exposure (>3.87 mg/L). For colon cancer, this was only seen in the highest quintile (9.25 mg/L), still at concentrations substantially below the current drinking water standard of 50 mg/L. (Schullehner, 2018)

Most New Zealanders are exposed to relatively low levels of nitrate, but some are exposed to high levels (eg 14% exposed to water supplies with more than 1 mg/L N-$NO_3^-$), and many take water from supplies that are not monitored for nitrate (Richards et al., 2022). Consequently, researchers estimated that about 3% of CRC (colorectal cancers) cases in NZ may be attributed to nitrate contamination of drinking water.

In NZ, there are major policy and structural changes that provide an opportunity for meaningful action on drinking water. The first major opportunity is through the establishment of an independent water regulator, *Taumata Arowai.* Taumata Arowai may have the potential authority to review, implement and enforce drinking water standards in NZ (New Zealand Parliament 2021), including establishing a nitrate limit for chronic health conditions. As such, the new water regulatory could set a lower nitrate limit for drinking water, upon appropriate health advice. Some Regional Councils are already targeting limits much lower than the current 11.3 mg/L to improve their drinking water assets (Environment Canterbury is proposing setting limits of 5.65 mg/L). Taumata Arowai will also require smaller suppliers to register and regularly monitor their water supplies resulting in a more comprehensive national database of water contaminants (Richards et al.,2022).

In their research Baruah et. collaborators studied the monitoring and accurate assessment of mine water quality to determine the type of treatment required (if any) before its utilization for potable purposes, thus gains importance. They show that the variation in sulphate concentration, ranged between 48 mg L− 1 and 629 mg L− 1 (mean- 294 mg L− 1) showed higher concentration in the mine water (Baruah et al.2021).

## CONCLUSIONS

The current drinking water standards in Romania comply with the guidelines of the European Union and the World Health Organization. Nitrate, ammonium and sulfates in drinking water can have negative effects on human health.

The values laid down by law for the maximum permissible limits of the three parameters are: For nitrates, the CMA value is 50 mg $NO_3^-$/l, for ammonium CMA is 0,5 mg $NH_4^+$ /l, and for sulphates the CMA value is 200 mg $SO_4^{2-}$/l. The maximum permissible conductivity is 1000 µS/cm and the exceptionally permissible conductivity is 3000 µS/cm.

The values of the parameters determined in this study are generally within the allowable limits, with a few exceptions. Exceedances for nitrate values in fountain water were recorded at Gura Humorului and Cajvana. For ammonium, the values were higher than the tolerable limit at Campulung Sâhla and Izvorul Alb. The conductivity exceeded the permissible limit value for drinking water of 1000 µS/cm at Câmpulung, the Izvorul Alb area.

Monitoring the parameters characterizing water drinking and regularly updating standards is essential to ensure the health of human consumers and to protect the environment.

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