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PHYSICO-CHEMICAL ANALYSIS OF DRINKING WATER FROM THE TOWN OF BÂRLAD, VASLUI COUNTY

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ABSTRACT

The quality of drinking water was investigated in two localities from Vaslui county (Bârlad and Văleni) by comparison with a sample from Galați county. A number of parameters such as pH, turbidity, conductivity, nitrates, nitrites, temporary hardness, dissolved oxygen were analysed for each water sample collected during the month of May. The obtained values of each parameter were compared with the standard values set by the local standards, Law no. 458/2002 regarding the quality of drinking water.

KEYWORDS: drinking water, physico-chemical analysis, nitrate, pH value, hardness

1. Introduction

Water is an essential constituent of living matter, having a role in the development of vital processes. For the adult human body, water represents approximately 60% of its body weight. Drinking water is important to public health, whether it is used for domestic use, recreational purposes, or food production. Improved water supply and sanitation and better management of water resources can boost countries' economic growth and contribute greatly to poverty reduction [1].

The water quality of Romania is monitored according to the methodological structures and principles of the *Sistemului de Monitoring Integrat al Apelor din România* - S.M.I.A.R. (Integrated Water Monitoring System in Romania), restructured according to the European Directives' requirements.

A number of scientific procedures and tools have been developed to assess drinking water contaminants. These procedures include the analysis of various parameters such as pH, turbidity, conductivity, total suspended solids (TSS), total dissolved solids (TDS), temporary and total hardness, dissolved oxygen. These parameters can affect the quality of drinking water, if their values are in concentrations higher than those of the safety limits established by the World Health Organization (WHO) and other regulatory bodies. Therefore, drinking water quality survey by researchers and government departments has been regularly conducted all over the world [2-4].

Nitrates are a common pollutant of drinking water, with a major source being the use of fertilizers in agricultural activities, and in some countries nitrate levels in drinking water supplies have increased due to more intensive agriculture and animal husbandry. Nitrates in water are dangerous because they turn into nitrites, either by boiling or in the body, and nitrites affect haemoglobin and metabolism. 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). Several epidemiological studies have investigated the possible association between chronic exposure to nitrates in drinking water and the risk of bladder, colon or rectal cancer [5-6].

The determination of microplastics or antibiotics in drinking water is also very topical. The number of scientific publications on microplastics in surface water and in drinking water has increased exponentially. These indicated that microplastics are frequently found in drinking water sources. The effects on human health are not yet known, but plastic often contains additives such as stabilizers or flame retardants, as well as other toxic chemicals that can be harmful to animals or humans who ingest them [7, 8].

In order to carry out the water quality study, four samples of drinking water were collected from different areas: one sample of well water and one tap water from the town of Văleni – Vaslui county; one sample from the tap of the public supply system in the town of Bârlad and one sample from the tap of the public supply system in the town of Galați. The water samples from Galați and Văleni, Vaslui county, were

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analysed in order to compare the tap water of the public supply system of Bârlad.

2. Experimental results

2.1. Determination of water turbidity

The turbidity of the water is due to the presence in water of very fine particles (organic and inorganic) that are in suspension and that do not settle over time. Turbid water is an epidemiological danger because suspended particles can constitute a support for pathogenic germs.

Turbidity represents the optical scattering effect of a light flux when passing through a fluid medium that contains particles in suspension or in a colloidal state.

The quantitative determination of the turbidity is done in the laboratory with the turbidimeter (Figure 1). The determination of turbidity is based on the Tyndall effect, according to which turbid water becomes bright if a light beam passes through it, due to the fact that the suspended particles laterally scatter some of the light rays [9].

Fig. 1. *Turbidimeter HACH*

The measure unit used in measuring turbidity is the Formazin Nephelometric Unit (FNU). Figure 2 shows the results obtained after the turbidity determination.

From the chart it can be seen that the water sample that has the highest turbidity value is the Văleni well water - 1.2 FNU, while the other samples have values close to 0.4 FNU. From the analysed samples, none of them exceeded the maximum value allowed by the legislation in force, according to Law 458/2002 including subsequent amendments and additions. The maximum admitted valued is 5 FNU. Therefore, all analysed samples are within the maximum limit allowed by the law in force.

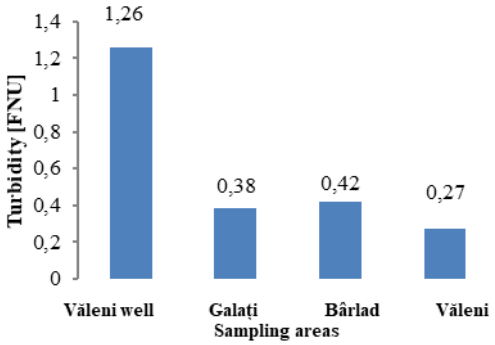

Fig. 2. *Results obtained from the determination of turbidity*

2.2. Determination of water pH

The water's pH is one of the most important factors when it comes to water quality, irrespective of whether it is well water or drinking water from the public supply system. Law no. 458/2002 regarding the quality of drinking water stipulates a pH between 6.5-9.5. Water that has a pH between 0-7 is considered acid, the pH 7 of the water shows that the water is neutral, and above the level of 7 pH units the water has a basic character, it is alkaline.

The pH determination for this article was carried out with the HACH multiparameter with the special pH probe. Figure 3 shows the results obtained after the pH determination.

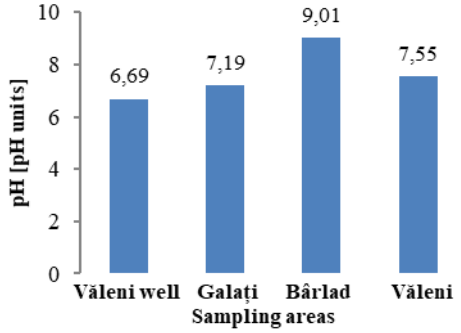

Fig. 3. *Results obtained from the determination of pH*

From the above chart, it can be seen that the water sample with the highest pH is the one collected from the public supply system of Bârlad with a value of 9 pH units that has an alkaline character, while the other analysed water samples have close pH values between 6.69 to 7.55.

According to Law no. 458/2002 regarding the quality of drinking water, the pH value of the

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drinking water must be between 6.5 and 9.5 pH units. All analysed water samples do not exceed the maximum value allowed by the legislation in force.

2.3. Determination of water conductivity

Conductivity is a measure of the water's ability to conduct an electrical current. Conductivity in water is affected by the presence of dissolved inorganic solids, like chloride, nitrate, sulphate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminium cations (ions that carry a positive charge).

The basic unit of conductivity is the siemens. Conductivity is measured in micro siemens per centimetre (µs/cm).

Conductivity is measured with the HACH multiparameter and a probe for determining conductivity. The voltage is applied between two electrodes in a probe immersed in the water sample. The voltage drop caused by water resistance is used to calculate the conductivity per centimetre. The indicator converts the probe measurement in micro siemens per centimetre and displays the result to the user.

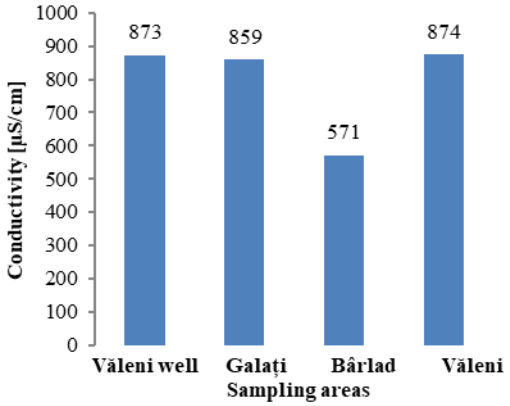

Fig. 4. *Results obtained from the determination of water conductivity*

From the data presented in figure 4, it can be seen that the highest value of conductivity is the Văleni tap sample, i.e., 874 µS/cm, and the lowest conductivity was obtained by the drinking water from the public supply system of Bârlad.

According to the legislation of Romania, the admitted value for the water's electrical conductivity is 1000 µS/cm, which indicates that the analysed samples are within the limits imposed by the legislation.

2.4. Determination of hardness

The water hardness is the total concentration of calcium and magnesium ions from a water sample and is indicated as calcium carbonate concentration. Temporary hardness is a part of the total hardness that disappears on boiling.

The main natural sources of hardness in water are polyvalent metallic dissolved ions from sedimentary rocks, seepage and leaks from soils. Calcium and magnesium, the two main ions, are present in many sedimentary rocks, the most common being limestone and chalk.

Water hardness is measured in hardness degrees (German - ºdH, French - ºTH, English - ºe, American) and in mE/L (milliequivalents/liter of water). In Romania the German hardness degree is used (ºdH).

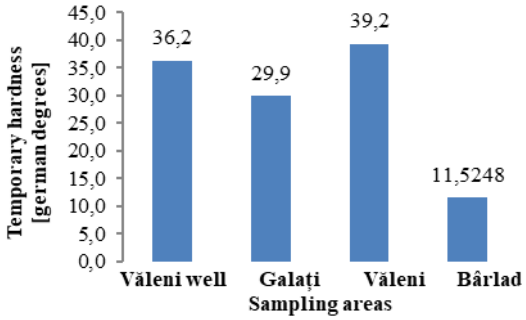

Fig. 5. *Results obtained from the determination of temporary hardness*

After determining the temporary hardness of the analysed water samples, it was observed that the lowest value was obtained for the water sample collected from the public supply system of Bârlad, with a value of 11.52 German degrees, and the highest value is from the Văleni tap water, with a value of 39.2 German grades.

2.5. Determination of nitrates

Nitrates are also found naturally at safe and healthy levels in some foods (such as spinach and carrots) and come from natural processes such as plant decomposition. Nitrates are in many fertilizers used on yards, golf courses and crops. Other sources of nitrates include discharge from sewage systems and animal waste.

Natural processes can lower the level of nitrates in drinking water – usually less than 3 mg/L. The health concern is with nitrate levels above 10 mg/L. High level of nitrates in water can be the result of the leak or leaks from fertilized soil, sewage, landfills, animal feedlots, septic systems, or urban drainage. It can be difficult to identify the source of nitrates in

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drinking water because there are a lot of possibilities [10].

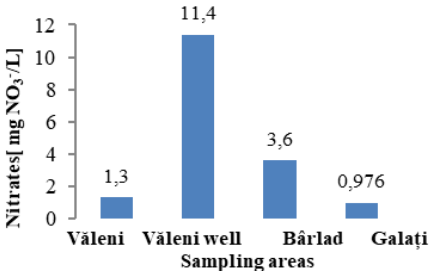

Fig. 6. *Results obtained from the determination of nitrates*

According to the attached chart in figure 6., it can be observed that the highest value for nitrates was obtained by the well water sample from Văleni – Vaslui county, with a higher value than the other samples, i.e., 11.4 mg NO_3^-/L, followed by the other samples with low values. The lowest value was obtained by the sample collected from the public supply system of Galați.

Romanian legislation imposes a maximum admissible limit for nitrates in water of 50 mg NO_3^-/L, which means that no sample exceeded the maximum amount allowed by law.

In Romania, nitrate poisoning is still a problematic reality, especially in the north-eastern region of the country.

2.6. Determination of nitrites

Nitrites are a salt or ester anion of nitric acid that can be naturally or artificially present in groundwater. Nitrites come from fertilizers through water drain, sewage and mineral deposits. Nitrite is used in food production for curing meat products because it inhibits the growth of bacteria. Unfortunately, it can also stimulate bacteria growth when it is introduced in high levels in a body of water.

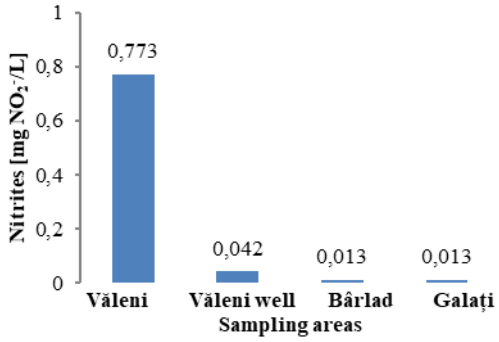

Fig. 7. *Results obtained from the determination of nitrites*

High levels of nitrites are toxic for people and animals, especially for babies. They can enter the body as nitrates, a nutrient that is essential for plant growing and it can be transformed in nitrites that disrupt the ability of haemoglobin to deliver oxygen in the bloodstream [10].

According to the above chart, it can be seen a high difference between the highest and lowest value. The highest value of nitrites can be found in the water from the public supply system of Văleni with a value of 0.773 mg NO_2^-/L, while the other samples have close values. The lowest value was obtained for the water sample from the public supply system of Galați, 0.013 mg NO_2^-/L.

The Romanian legislation provides an admissible maximum limit of 0.5 mg NO_2^-/L. Therefore, it can be observed that the tap water sample from Văleni – Vaslui county, exceeds the maximum concentration allowed by law with a value of 0.22 mg NO_2^-/L.

2.7. Determination of oxygen content in waters

Oxygen is a soluble gas and it is found in water as O_2 molecules. The presence of oxygen in water conditions the existence of the vast majority of aquatic organisms. All waters that are in contact with the atmospheric air contain dissolved oxygen while underground waters are low in oxygen. The solubility of oxygen in water depends on atmospheric pressure, air temperature, water temperature and salinity.

The volumetric (iodometric) method was proposed in order to determine the oxygen.

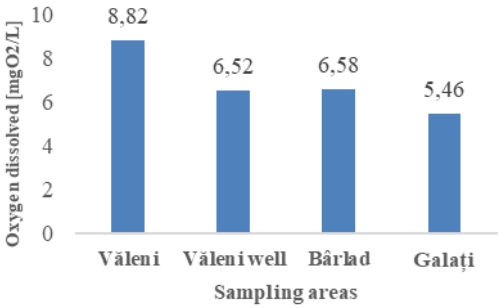

Fig. 8. *Results obtained from the determination of oxygen dissolved*

The concentration of dissolved oxygen is expressed in mg O_2/L or by the degree of water saturation with oxygen. The saturation degree represents the ratio between the quantity of oxygen found in the analysed water sample and the quantity of oxygen dissolved in water under saturation conditions [10].

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Oxygen dissolved in water oxidizes the manganese hydroxide in manganic hydroxide which in the acidic environment removes iodine from potassium iodide in an amount equivalent to the oxygen dissolved in water and which is titrated with sodium thiosulfate in the presence of starch solution.

In the chart presented in figure 8, it can be seen that the highest value of oxygen content in water was determined for the water sample from the public supply system of Văleni with a value of 8.82 mg O_2/L. The lowest value was obtained by the water sample collected from the public supply system of Galați with a value of 5.46 mg O_2/L.

From the presented data, it can be observed that the highest value for oxygen saturation is obtained for the tap water sample from Văleni – Vaslui county with a value of 99.932%. The well water sample from Văleni and the water sample from the public supply system of Bârlad have close values of 78% and the lowest value was obtained for the public supply system with drinking water of Galați, i.e., 65.179%.

3. Conclusions

Following the determinations made, we can conclude that:

- all analysed water samples do not exceed the maximum value of pH, conductivity, temporary hardness, nitrates and oxygen dissolved allowed by the legislation in force;

- the highest value of nitrites can be found in the water from the public supply system of Văleni with a value of 0.773 mg NO_2^-/L. The Romanian legislation provides an admissible maximum limit of 0.5 mg NO_2^-/L. Therefore, it can be observed that the tap water sample from Văleni – Vaslui county, exceeds the maximum concentration allowed by law with a value of 0.22 mg NO_2^-/L.

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