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Chemical composition of bottled water on Croatian market

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Abstract: The Ordinance on natural mineral, natural spring and table waters regulates the market of bottled water. The Directive on the quality of water intended for human consumption sets water quality standards and three categories of parameters (microbiological, chemical and indicator). Microbiological parameters show the degree of water pollution by microorganisms, while chemical parameters show the degree of water pollution by different chemical substances. Natural spring and natural mineral water have a certain chemical composition in which the concentrations of individual elements have the prescribed maximum allowable amount. If the concentrations of individual elements exceed the maximum allowed amount, they can have a harmful effect on the human body. All categories of bottled water (table, spring and mineral) can be carbonated and non-carbonated, depending on the carbon dioxide (CO_2) content. Due to extracting and bottling of drinking water, in order to improve its quality, it is necessary continuously conduct analyses that prove the safety of drinking water.

Key words: water, table water, mineral water, spring water, chemical composition

Kemijski sastav vode u bocama na hrvatskom tržištu

Sažetak: Pravilnikom o prirodnim mineralnim, prirodnim izvorskim i stolnim vodama regulira se tržište flaširanih voda dok se Direktivom o kvaliteti vode namijenjene za ljudsku potrošnju određuju standardi kvalitete vode te tri kategorije parametara (mikrobiološki, kemijski i indikatorski). Mikrobiološki parametri pokazuju stupanj onečišćenja vode mikroorganizmima, dok kemijski pokazuju stupanj onečišćenja vode različitim kemijskim tvarima. Prirodna izvorska i prirodna mineralna voda imaju određeni kemijski sastav kod kojeg koncentracije pojedinih elemenata imaju propisanu maksimalno dopuštenu količinu. Ukoliko koncentracije pojedinih elemenata prelaze maksimalno dopuštenu količinu, mogu štetno djelovati na ljudski organizam. Sve kategorije flaširanih voda (stolna, izvorska i mineralna) mogu biti gazirane i negazirane, što ovisi o sadržaju ugljikovog dioksida (CO_2). Zbog crpljenja i flaširanja vode za piće te poboljšanja kvalitete pitke vode, potrebno je kontinuirano provoditi analize kojima se dokazuje zdravstvena ispravnost vode za piće.

Ključne riječi: voda, stolna, mineralna, izvorska, kemijski sastav

1. INTRODUCTION

Millions of liters of water in all kinds of packaging are sold every day in the world. In addition to inorganic and organic pollutants from the environment, bottled water can be additionally contaminated as a result of improper transportation and storage. In parallel with the large consumption of bottled water, the importance of using drinking water from public water supply systems has been pointed out in recent years. The safety and quality of tap water is analyzed more often than bottled water. In 2018, the European Commission proposed an amendment to the Ordinance on the quality of drinking water, which would require EU member states to improve access to drinking water for all citizens. Among other things, this means that Europeans should be assured that they can drink tap water, safe for consumption, on city streets and in public buildings, as well as in restaurants and catering facilities. According to the UNESCO report, Croatia is the 4th country in Europe in terms of total renewable reserves of drinking water per capita with 32,818 m³ per year. If these water reserves are calculated by the area of the territory, Croatia is the first in Europe in terms of water reserves and the third in the world (1).

The bottling and sale of non-carbonated water has started on a larger scale in Croatia in the last 15 years. The quality of bottled water depends on its geochemical properties, but also on potential anthropogenic pollution. Contaminated water can become a source of unwanted organic and inorganic compounds, but also a wide range of viruses and bacteria. Bottled water contains a number of macro- and microelements depending on the origin of the water itself (2). The bottled water industry is an important sector in a number of European Union countries, and in 2017, the value of production in this industry was 12.4 billion euros, and the total consumption was 52 billion liters (3). Bottled water production is an expensive and resource-intensive process. Most bottles are made of polyethylene terephthalate (PET), which is recyclable but not biodegradable. In the USA, only 23% of PET bottles are recycled, while in Croatia only 17% of PET bottles reach recycling yards. The European association Plastics Europe warns of the seriousness of the problem posed by waste PET bottles, as most bottles end up in the environment.

The waters that we find on the market can be divided into 3 categories, namely: natural mineral waters, natural spring waters and table waters. Croatian bottled water is one of the export potentials, while the import of bottled water into Croatia is negligible. The largest domestic producer of bottled water is Jamnica, which, according to the amount of extracted water, has a share of about 70% of bottled water production in the country. Jamnica distributes about 75% of bottled water to the domestic market, while about 25% is exported. Apart from Jamnica, the most important domestic producers of bottled water are Podravka, Cedevita and Naturalis. The aim of this paper was to describe the categories of bottled water, their chemical composition and different possibilities of bottled water contamination.

1.1 Natural mineral waters

The definition of mineral water was given back in 1911 at the International Balneological Congress in Nauheim, Germany, and meant water containing at least 1000 mg/L of dissolved mineral substances. The definition has changed over the years, so today some waters in the world are called "mineral" although the content of mineral substances in them is much lower than the initially defined value (3). Today in Croatia, water can be called natural mineral water if it contains more than 1 gram of mineral substances in one liter of water or larger amounts of components that are not regularly found in groundwater, spring water or surface water or are present in them only in insignificant traces (4). Mineral waters in Croatia are usually cold, and if they have an elevated temperature, they are called thermal mineral waters. In the area of northern Croatia, there are springs of water enriched with mineral

components from the deposits through which the water flows. In addition to dissolved substances, the waters of these sources also contain more than 1 g L^{-1} CO_2, so they are classified as effervescent waters. The most famous springs are Jamnica, Apatovac, Lasinja and Lipik. At the Jamnica location and in Lipik, cold mineral water is bottled and sold as natural mineral water. Mineral waters in Dalmatia are sometimes highly mineralized due to the content of sea water, and the best-known sources are in Split, Zakučac and Mokošica.

According to the Ordinance on natural mineral, natural spring and table waters (Official Gazette 55/2022, 85/2019), natural mineral water is water that meets the microbiological criteria prescribed in the articles, originates from an aquifer, and is extracted and filled from one or more natural or drilled springs (4).

Natural mineral water must not be subjected to any treatment or technological procedures, other than:

- separation of unstable elements (iron and sulfur compounds) by filtration procedures
- separation of iron, manganese, sulfur and arsenic compounds from certain natural mineral waters by treatment with ozone-enriched air
- removal of fluoride with active aluminum oxide
- separation of other undesirable constituents
- complete or partial removal of free CO_2 using only physical methods to the extent to which such treatment does not alter the composition of the water that gives it its characteristic properties (4).

Carbonated natural mineral water can be divided into three categories, namely naturally carbonated natural mineral water (the CO_2 content is the same at the source and after bottling), natural mineral water with an increased content of carbon dioxide from the source (the CO_2 content after bottling is higher than the CO_2 content determined at the source) and carbonated natural mineral water (added CO_2 that does not originate from the aquifer).

In terms of the content of minerals determined as dry residue, natural mineral waters are divided into:

1. Natural mineral waters with a very small amount of minerals (< 50 mg L^{-1})
2. Natural mineral waters with a small amount of minerals (< 500 mg L^{-1})
3. Natural mineral waters rich in minerals (> 1500 mg L^{-1}).

Mineral waters are an important source of minerals for the human body. The main elements of mineral waters are anions F^-, Cl^-, NO_2^-, Br^-, NO_3^-, PO_4^{3-} and SO_4^{2-} and cations Na^+, K^+, Mg^{2+}, Ca^{2+}. The results of an extensive study of bottled waters conducted in Poland showed that the composition declared on the label differs from the measured results (3). This can be caused by the packaging itself, the time and method of storage, and the processes involved in filling the water into packaging. Also, the type of packaging itself in which the water is filled plays a significant role because, for example, water stored in plastic bottles has a shorter shelf life than water stored in glass bottles. Most producers of mineral water do not inform consumers about the pH value and electrical conductivity of the water because these characteristics are not mandatory, while information about the anions Br^-, NO_2^-, NO_3^- and PO_4^{3-} is usually omitted. In addition, scientists warn that when buying mineral water, one should read the product label. The label should contain the composition and concentrations of dissolved mineral substances, the name of the source, the trade name, the producer's name and the place of its production, information about the applied disinfection processes (if any), the CO_2 content, and in the case of water containing more than 1.5 mg L^{-1} of fluoride, there should be information that "it should not be consumed by babies and children under 7 years of age" (3).

1.2 Natural spring waters

Ordinance (4) defines natural spring water as water that is intended for consumption in its natural state, originates from an aquifer protected from any pollution, and is extracted and filled from the spring. The composition, temperature and other characteristics of the spring water must be constant within the natural fluctuations and must not change in the event of a change in the discharge of the spring.

Spring water can be:

- natural spring water - water without added CO_2
- natural spring water with carbon dioxide or carbonated natural spring water - spring water to which CO_2 is added.

Like natural mineral water, spring water must meet certain standards when being bottled. A limited number of technological procedures are allowed to improve characteristics, and similar to mineral water, the disinfection process is not carried out and must meet the same microbiological criteria. Natural spring water is an excellent raw material for the production of non-alcoholic beverages. CO_2 can be added to it, when it is labeled as "carbonated spring water" on the declaration. The declaration on the packaging of spring water is marked as "spring water" and it must not contain designations, images or drawings that could lead to confusion with natural mineral water, and this especially applies to the names "effervescent water", "mineral water", "mineral" (4). The Republic of Croatia is rich in drinking water reserves and sources of natural spring water.

1.3 Table waters

Table water is water produced from water for human consumption and/or natural mineral and/or natural spring water with the addition of one or more allowable substances for the purpose of improving chemical properties (4). For the purpose of producing table water from drinking water, it is allowed to add sodium chloride, calcium chloride, sodium carbonate, calcium carbonate, sodium hydrogen carbonate, magnesium carbonate, sodium sulfate, magnesium sulfate, sodium fluoride and carbon dioxide. The declaration on the packaging for table water also contains the designation "table water".

In order to be able to use table water, it must meet the microbiological parameters of water safety for table water, the chemical and indicator parameters of table water in packaging, and the conditions for using and marketing table water.

Of the technological processes for treating table water, it is allowed to separate its unstable elements such as compounds of iron, manganese, arsenic and sulfur by filtration procedures and to separate other undesirable constituents.

2. CHEMICAL COMPOSITION OF WATER

The chemical composition of water depends on a number of factors, such as, for example, the geochemical properties of the aquifer, the path that water takes during its circulation in nature, potential pollutants in the aquifer recharge zone, etc. Depending on the source, natural mineral and natural spring waters have a specific chemical composition, Table 1. and 2.

Table 1. Chemical composition of mineral waters1

Trade name of the product	Source name	Source usage location	Cations (mg L^{-1})				Anions (mg L^{-1})				Volatile residue (at 180°C) (mg L^{-1})
			Mg^{2+}	Ca^{2+}	Na^{+}	CO_2	HCO_3^-	SO_4^{2-}	Cl^-	F^-	
Donat Mg	Rogaška Slatina	Rogaška Slatina	100	39	150	350	750	220	7.5	-	-
Studenac	Grofova vrela	Lipik	101.0	72.5	26.4	13.3	493	31.3	51.2	1.2	528
Jamnica	Janino vrelo	Pisarovina	805	114	43	27.1	2246	116.1	262	0.9	2479
Radenska	Kraljevi vrelec		400	220	95	70	2000	72	44	-	-
Kalnička	Kalničke kapljice	Apatovec	650	62	-	-	1410	11.7	-	0.388	1856
Sarajevski kiseljak	Vrelo Park	Kiseljak	621	236.5	41.3	19.5	1805	533	86.6	0.63	2200

Table 2. Chemical composition of spring waters2

Trade name of the product	Source name	Source usage location	Cations (mg L^{-1})				Anions (mg L^{-1})			
			Na^{+}	Ca^{2+}	Mg^{2+}	K^{+}	HCO_3^-	Cl^-	SO_4^{2-}	F^-
Sveti Rok	Sveti Rok	Sveti Rok	1.2	47.6	9.9	0.3	189.1	1.7	2.3	0.02
Studena	Studena	Lipik	11.6	85.8	26.8	1.2	416	3.6	5.8	0.25
Kala	Kala	Apatovec	7	87	19	-	378	11	-	-
Cetina	Cetina	Civljane	1.85	76.2	1.19	0.44	238.5	3.3	3.42	0.038
Jana	Sv. Jana		1.8	63.8	32	0.6	381	2.9	7.2	0.02
Bistra	Topličica 2	Gotalovec	2.6	57.4	25.4	0.8	289.9	3.3	13.25	0.092

All categories of bottled water (mineral, spring and table water) can be carbonated or non-carbonated, and this depends on the content of carbon dioxide, regardless of whether it was present or was added during production. Although according to the legal definition, mineral water can be carbonated or non-carbonated, in everyday speech people use the name "mineral water" for carbonated water. This happens because Jamnica, Studenac and Kalnička, which are both mineral and carbonated waters, were among the first bottled waters. In addition, there is also confusion due to different approaches in defining mineral waters. Although none of the criteria is prescribed by legal regulations, in Europe there are two approaches to the definition of mineral water, namely the German and the French. The German approach defines mineral waters as waters that have more than 1000 mg of volatile residue. The volatile residue represents the total amount of suspended and dissolved substances in water. Waters that have less than 1000 mg of volatile residue are defined as spring waters. On the other hand, the name mineral water in France is awarded by the French Academy of Medicine to a small number of waters that have a recognized positive effect on human health (5,6). From table 2. it is evident that Jamnica, Kalnička and Sarajevski kiseljak have more than 1000 mg of volatile residue.

In order for water to be acceptable for use, it must meet certain criteria that are prescribed by different administrative institutions, in this case the Ministry of Health and the World Health Organization. During the past centuries, various human activities (especially industry) have affected the natural state of water, and in some cases even pure natural water is overloaded with harmful chemical substances that can have a negative effect on the human body. For this reason, research aimed at analyzing selected elements in samples of bottled water was conducted in Croatia. They analyzed antimony, arsenic, boron, barium, calcium, cadmium,

chromium, potassium, magnesium, sodium, nickel and lead, and the results obtained by the research show that all Croatian bottled waters are safe for use (7).

In 2017, the Ministry of Health issued the Ordinance on compliance parameters, analysis methods, monitoring and safety plans for water for human consumption and the manner of keeping the register of legal entities performing the activity of public water supply, which stipulates (8):

- safety parameters (microbiological and chemical), indicator parameters (microbiological and chemical) and parameters of radioactive substances in water for human consumption
- parameters, parameter values, types and scope of analyses of samples and the frequency of sampling water for human consumption for the implementation of monitoring of water for human consumption and for the implementation of monitoring of radioactive substances
- methods of laboratory testing of water for human consumption
- types and scope of analyses and the number of required samples of water for human consumption for the purpose of testing its safety in buildings before issuing an operating permit
- monitoring of water for human consumption and the method of implementing risk assessment in the implementation of the program of monitoring water for human consumption

In order to improve the quality of drinking water, the Directive on the quality of water intended for human consumption defines drinking water quality standards and 48 parameters that must be monitored and tested (6). The parameters are divided into three categories, i.e. microbiological parameters, chemical parameters and indicator parameters.

2.1 Microbiological parameters

Water is a favorable living environment for microorganisms, and they can get into the water by washing the soil with wastewater and from the digestive system of people and animals. There are two groups of microorganisms in water, namely decomposers of organic matter and producers of new organic matter. In addition, faecal microorganisms, some of which are pathogenic, can be found in water. Pathogenic microorganisms can be the cause of disease because they survive long enough in water systems. Such water can pose a risk to human health. The presence and number of microorganisms in water are determined by microbiological analysis. Microorganisms enter water occasionally, at irregular time periods and in various concentrations. They normally do not reproduce in water, but only stay for a longer or shorter time. For this reason, the determination of the amount of microorganisms in drinking water is limited. Microorganisms indicators of the safety of drinking water are used to test the basic microbiological characteristics of water. The main microbiological parameters of safety of drinking water are coliform bacteria (Escherichia coli, enterococci and Pseudomonas aeruginosa), Table 3.

Table 3. Microbiological parameters of safety of water for human consumption at the time of bottling or other packaging that is placed on the market in bottles or other packaging (8)

Microbiological parameter	Measurement unit	MAC
Escherichia coli	number/250 mL	0
Enterococci	number/250 mL	0
Number of colonies 22°C	number/1 mL	100
Number of colonies 36°C	number/1 mL	100
Pseudomonas aeruginosa	number/250 mL	0

The microbiological parameters of bottled waters in Croatia are defined by the Ordinance on natural mineral, natural spring and table waters (4). According to this Ordinance, natural mineral water and natural spring water at the source and when being placed on the market must not contain in any tested sample of 250 mL:

- parasites and pathogenic microorganisms
- bacteria Escherichia coli and other coliform bacteria and faecal streptococci
- sporogenous sulfite-reducing anaerobic bacteria
- Pseudomonas aeruginosa bacteria

2.2 Chemical parameters

The Ordinance on natural mineral, natural spring and table waters defines chemical parameters that indicate the degree of water pollution with chemicals that can pose a risk to human health (Table 4)(4).

Table 4. Substances that can be naturally present in natural mineral water and their maximum allowable concentrations when filling in packaging (4)
3

Parameter	Measurement unit	Maximum allowable concentration
Antimony	mg L^{-1} Sb	0.0050
Arsenic	mg L^{-1} As	0.010 (total)
Copper	mg L^{-1} Cu	1.0
Barium	mg L^{-1} Ba	1.0
Boron	mg L^{-1} B	**
Cyanides	mg L^{-1} CN^-	0.070
Fluorides	mg L^{-1} F^-	5.0
Cadmium	mg L^{-1} Cd	0.003
Chromium	mg L^{-1} Cr	0.050
Manganese	mg L^{-1} Mn	0.50
Nickel	mg L^{-1} Ni	0.020
Nitrates	mg L^{-1} NO_3^-	50
Nitrites	mg L^{-1} NO_2^-	0.1
Lead	mg L^{-1} Pb	0.010
Selenium	mg L^{-1} Se	0.010
Mercury	mg L^{-1} Hg	0.0010

Table 5 shows the safety parameters of water and their maximum allowable amount in 1 liter of water.

Table 5. Chemical safety parameters of water for human consumption (8)4

Parameter	Units	Maximum allowable amount	Parameter	Units	Maximum allowable amount
Acrylamide	µg/l	0.10	Lead	µg L^{-1}	10
Antimony	µg/l	5.0	Mercury	µg/l	1.0
Arsenic	µg/l	10	Nickel	µg/l	20
Benzene	µg/l	1.0	Nitrates	mg/l	50
Benzo(a)pyrene	µg/l	0.010	Nitrites	mg/l	0.50
Boron	mg/l	1.0	Pesticides	µg/l	0.10
Bromates	µg/l	10	Total pesticides	µg/l	0.50
Cadmium	µg/l	5.0	PAH (polycyclic aromatic hydrocarbons)	µg/l	0.10
Chromium	µg/l	50	Selenium	µg/l	10
Copper	mg/l	2.0	Sum of tetrachloroethene and trichloroethene	µg/l	10
Cyanides	µg/l	50	THM – total	µg/l	100
1,2-dichloroethane	µg/l	3.0	Vinyl chloride	µg/l	0.50
Epichlorohydrin	µg/l	0.10	Chlorites	µg/l	400
Fluorides	mg/l	1.5	Chlorates	µg/l	400
			Dissolved ozone		50

In order for water to be acceptable for use, it must meet certain criteria that are prescribed by different administrative institutions, in this case the Ministry of Health and the World Health Organization. During the past centuries, various human activities (especially industry) have affected the natural and basic state of water. Consistently with that, the awareness of water control and assessment of its suitability for drinking has been raised. In some cases, even pure natural water is overloaded with chemical substances due to its chemical composition and can have a harmful effect on the human body. For these reasons, a study that analyzed selected elements in several samples of bottled water was conducted in Croatia. Some of the elements that were analyzed are antimony, arsenic, boron, barium, calcium, cadmium, chromium, potassium, magnesium, sodium, nickel and lead. The results obtained by this research show that all Croatian bottled waters are safe for use (7).

3. WATER ON THE CROATIAN MARKET

In Croatia, water is defined as a public resource and for human consumption it is extracted and delivered through the public water supply service by public companies, and it is extracted and packaged or bottled for sale on the market by private companies. In Croatia, carbonated mineral water was first bottled, and non-carbonated water began to be bottled and sold to a more considerable extent only in the last 20 years. The two best known water factories in Croatia are Jamnica d.d. with a water bottling tradition since 1828, and Studenac from Lipik with a tradition since 1875. As part of Jamnica d.d., there are also the bottling plant of natural mineral water Jamnica in Pisarovina, the bottling plant of natural spring water Jana and of non-alcoholic beverages in Sveta Jana, the bottling plant of natural mineral water and non-alcoholic beverages Sarajevski kiseljak in Bosnia and Herzegovina, and the bottling plant of mineral water Fonyódi in Hungary. The Ordinance on natural mineral, natural spring and table waters defines the procedure for recognizing mineral and natural spring waters in Croatia, regardless of whether the water is extracted from the soil of Croatia or another country (4). In order for natural mineral water to be on the List of recognized natural mineral waters, it must go through the recognition process (1). For recognition of a natural mineral water, it is necessary to determine its chemical, physico-chemical and microbiological characteristics, and conduct geological and hydro-geological tests at the source. After the adoption of a decision on the recognition of mineral and natural spring waters, the water is included into the register kept by the Ministry of Agriculture and periodically published in the Official Gazette. In 2020, the Ministry published a List of recognized natural mineral waters and natural spring waters that are extracted from the soil of the Republic of Croatia or from a non-member state of the European Union (9). Table 6 shows that, of mineral waters, only Lipički Studenac, Lipički Studenac Grofova vrela, Jamnica and Jana are extracted in Croatia, while Mivela-Mg, Prolom voda and Sarajevski kiseljak are extracted outside of Croatia. Of spring waters, only two (Leda, Nevra) are extracted outside Croatia, while the other eight are extracted in Croatia.

Table 6. List of mineral and spring waters in Croatia (9)5

Type of water	Trade name of the product	Source name	Source usage location	Country of origin
Natural mineral water	Jamnica	Janino vrelo	Pisarovina, locality Jamnička kiselica	Republic of Croatia
	Jana	Sveta Jana	Gorica Svetojanska	Republic of Croatia
	Lipički Studenac Grofova vrela	Grofova vrela	Lipik	Republic of Croatia
	Lipički Studenac	Antunovo vrelo	Lipik	Republic of Croatia
	Mivela-Mg	Mivela-1	Veluće	Republic of Serbia
	Prolom voda	Prolom Banja	Kuršumlija	Republic of Serbia
	Sarajevski kiseljak	Vrelo Park (B4)	Kiseljak	Republic of Bosnia and Herzegovina
natural spring waters	Aqua Sana	Water intake – borehole BU-1	Kosore, Vrlika	Republic of Croatia
	Cetina	Cetina	Civljane	Republic of Croatia
	Gacka	Bobinac	Sinac	Republic of Croatia
	Goda	Goda	Ličko Lešće	Republic of Croatia
	Kala	Kala	Apatovec	Republic of Croatia
	Leda	Vrelo Borak	Široki Brijeg	Republic of Bosnia and Herzegovina
	Nevra	Nevra	Deževice	Republic of Bosnia and Herzegovina
	Santa	Krupa	Krupa	Republic of Croatia
	Studena	Studena	Lipik	Republic of Croatia
	Viva	Ljuta	Gruda, Konavle	Republic of Croatia

4. CONCLUSION

Based on the legal framework of the European Union, three categories of bottled water are legally defined, namely mineral, spring and table water. Natural mineral and natural spring water are extracted from groundwater, while table water is obtained from drinking water with the addition of permitted substances for the purpose of improving chemical properties. All categories of bottled water can be carbonated or non-carbonated, which depends on the content of carbon dioxide, regardless of whether it was present or was added during production.

In order to improve the quality of drinking water, drinking water quality standards are defined and microbiological, chemical and indicator parameters that must be monitored and tested are determined. Microbiological parameters show the degree of water pollution by microorganisms, while chemical parameters show the degree of water pollution by chemicals. Each of the parameters has a maximum allowable amount that one liter of water can contain. If the water contains more than the maximum allowable amount of an individual parameter, it can have a harmful effect on human health and, consequently, must contain a label on the packaging indicating its harmfulness. Bottled water contains anions (hydrogen carbonate (HCO_3^-), sulfate ion (SO_4^{2-}), chloride (Cl^-), fluoride (F^-)) and cations (magnesium (Mg^{2+}), calcium (Ca^{2+}), sodium (Na^+) and carbon dioxide (CO_2)). Spring and natural mineral water must meet certain standards when being bottled, i.e. they can be subjected to precisely defined technological procedures, they must not be disinfected and must meet microbiological criteria. For human health and to improve the quality of drinking water, all the measures prescribed by the regulations must be implemented, because, after all, water is one of the resources without which humanity could not live.

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