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Study of drinking water quality in Cahul district

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Abstract

Groundwater is the main source of drinking water in the Republic of Moldova for the entire rural population and 30% of the urban population (65% of the total population of the country). In this study, the quality of drinking water from Cahul District (The Republic of Moldova) was investigated. Various water samples were collected from wells of rural localities, namely, Taraclia de Salcie, Doina, Huluboaia, Al.I. Cuza, having as reference the water from the central network of Cahul. Organoleptic, physico-chemical and microbiological analysis were performed. The analyzed water samples have no large deviations from the standards, except of the water from the village of Al.I. Cuza. This situation is very serious, because for a part of the population of Al.I.Cuza, this well is the only source of water and there is a possibility that some habitans use it as drinking water. In the future, our main goal is to perform the analysis of several water samples in Cahul County, in order to identify the suitable drinking water sources

***Keywords**:* water quality, nitrates, water well.

1. Introduction

Water has the greatest impact on public health concerning all environmental factors, its quality having an essential influence on consumers' health. The supply of drinking water is a major problem for rural localities in the Republic of Moldova [1]. The large urban localities and some surrounding villages are supplied centrally with water from the river Nistru and the Prut, but in rural areas, where 60% of the population is located, water from groundwater and deep water is supplied for drinking purposes [2].

The situation of drinking water is alarming, environmental pollution is due to lack of systems which gives sewerage and inadequate waste water treatment. In some localities, such as the long Floreşti district, in more than 60% of the village's wells, oil substances have been identified, and in large quantities, the water sources are banned from being used for drinking purposes, even if there are no other sources of supply of drinking water.

At present, there is no unified monitoring of water quality in the Republic of Moldova. About 60 % of the population of the Republic of Moldova consumes polluted water due to lack of or degradation of drinking water supply networks. 92% of the 1689 localities have no centralized water supply systems. Thus, the population is forced to consume water from wells that have no hygienic rigors. 80% of the 130 thousand fountains are heavily polluted by nitrates and nitrites. There are studies which showed that the state of degradation of population health is due to 80 % of polluted water or water scarcity [2, 3, 4].

In this respect, legislative measures must be taken to prevent disease and to control the quality of water from groundwater, used as drinking water in households. The legislative framework on drinking water in the Republic of Moldova is according to THE LAW No. 272 of 10.02.1999 on drinking water, published on 22.04.1999 in the Official Gazette (Monitorul Oficial) No. 39-41, art. no: 167 and entered into force on 07.12.2000, with some subsequent legislative amendments [5, 6].

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In the present paper, the quality of drinking water from Cahul District (The Republic of Moldova) was investigated to identify possible sources of drinking water. Various water samples were collected from wells of rural localities, such as, Taraclia de Salcie, Doina, Huluboaia, Al.I. Cuza, using as reference the water from the central network of Cahul. In order to establish if there are some deviations from the standards, various organoleptic, physico-chemical and microbiological analysis of water samples were performed.

2.Materials and methods

2.1. Materials

Five water samples were collected from the southern area of Cahul district. Four water samples were collected from various rural fountain of the Cahul county and one was used as a witness (sample M), representing the water from the central drinking water supply network of the Cahul town. Water sampling was carried out according to EN ISO 5667-3-2005 standard SM. The water of the fountain was collected from the Taraclia de Salcie (sample T), Doina (sample D), Huluboaia (sample H) and Al.I. Cuza (sample C) localities. The samples were analyzed in the Sanitaro-hygienic laboratory of the Cahul Regional public Health Center.

2.2. Organoleptic and physico-chemical analysis

The water quality was investigated using organoleptic, physico-chemical and microbiological analysis. Organoleptic analysis consists of various tests of the color, taste and flavor aspects. The potentiometric method to determine the pH of samples is standardized by SR EN ISO 10523: 2012 and has been applied to all types of drinking or sewage samples with pH between 3 and 10. The pH of the five samples collected from different sources and localities was determined using a pH meter HI5221. The conductivity of the water samples was determined with a Windaus conductometer [7]. In the case of drinking water, Law no. 458/2002 imposes a maximum conductivity of 2500 μS/cm. To measure the nitrate, nitrites, boron, fluorine, ammonia and manganese content, used as water quality indices, a SPECORD Plus-200 spectrophotometer has been used [8].

Spectrophotometric analysis were carried out in the UV-VIS domain, using certain wavelengths: 520 nm for nitrates and nitrites, 310 nm for boron, 600 nm for fluorine, 400 nm for ammonia and 530 nm for manganese. The total water hardness was analyzed using the complexometric method. The solution has been titrated with Trilon B, in the presence of the indicator (eriochrome black T) with the equivalence point at pH≈10, up to the blue-green color [9]. The chlorides were determined by titration with 0.1 N $AgNO_3$, in the presence of 2 ml of 10% K_2CrO_4, used as an indicator, until turning yellow to cloudy brick-red (Mohr's method) [10]. Calcium was determined by titration with Trilon B (EDTA). The water solution with 2 ml of 1N NaOH was titrated with vigorous stirring using Trilon B until the blue-violet color changed [11].

2.3. Microbiological analysis of water

The presence of coliform bacteria has been determined according to the international standard ISO 9308-1: 2014. This method is especially suitable for waters with low bacterial numbers, which will cause less than 100 total colonies on chromogenic coliform agar (CCA). Due to the low selectivity of the differential agar medium, background growth may interfere with the reliable counting of *Escherichia coli* and other coliform bacteria. Therefore, this method is not recommended for small wells [12].

To prepare the sample, filtration by membrane filters and seeding on medium for isolation, the procedure required by ISO 8199 has been followed. The samples were transported and stored at (5±3) °C in accordance with ISO 19458. Thermostatic procedure was performed at a temperature of 36 ±2 °C, 24 h.

Sterile cellulose ether membrane filters, 47-50 mm in diameter, with equivalent filter characteristics with a nominal pore diameter of 0.45 μm have been provided with a net. Filters must not have growth-inhibiting or bacterial growth properties; network printing ink must not also affect bacterial growth. Tweezers with rounded ends have been used to handle membrane filters.

Colonies that respond positively to p-D-galactosidase (pink to red) as putative coliforms other than *Escherichia coli* were counted.

To avoid obtaining false-positive results caused by oxidatively positive bacteria of the genus *Aeromonas spp*, the presence of suspicious colonies is confirmed by an oxidase test (oxidative-negative reaction). There were counted the colonies positive for p-D-galactosidase and p-D-glucuronidase (from dark blue to purple), representing *Escherichia coli* colonies. The total number of coliform bacteria is the sum of the colonies with negative oxidase from pink to red and all colonies from dark blue to purple, according to ISO 8199. A positive oxidase reaction is indicated by the appearance of dark blue for 30 seconds. In the case of coliform bacteria, no such reaction is observed, as they are oxidatively negative.

3. Results and Discussion

The organoleptic examination has shown that the samples are clear and free from impurities. Sample M has a slight chlorine odor, which is common due to the usual water treatment method to reduce pathogens. Unlike the other water samples in the fountain, sample C has been found to be slightly turbid, which could be caused by the unhygienic condition of the fountain by the accumulation of soil or sand. Further analyzes have shown that this sample also presents a microbiological risk. The organoleptic characteristics were shown in Table 1.

In Table 2, the pH and the conductivity values of the five analyzed water samples were shown.

Table 1. Organoleptic characteristics of water samples

Characteristics	Sample M	Sample H	Sample D	Sample S	Sample C
Aspect	Clear, no impurities	Clear, no impurities	Clear, no impurities	Clear, no impurities	Slightly turbid, few impurities
Odor	Slightly chlorinated	No foreign odor	No foreign odor	No foreign odor	No foreign odor
Taste	No foreign taste	No foreign taste	No foreign taste	No foreign taste	No foreign taste

Table 2. pH of the analyzed water samples

Determined indices	Sample S	Sample H	Sample D	Sample C	Sample M
pH index	9.8	8	8	8	7.2
Conductivity, μS/cm	52.8	38.2	35.8	54.8	22.0

From the determination of the pH index it is observed that the well water samples have a low basic pH, the value being 8, meanwhile sample S having a pH of 9.8. The only compliant sample is the blank test from the water mains in the town of Cahul, pH close to neutral, at 7.2.

In this study, conductivity analysis does not provide relevant data on the potability of water, this indicator not exceeding the maximum required by the standards.

Following the analysis of the water samples, it was found that the water in the wells contains ammonium ions, nitrates, nitrites in considerable quantities, sometimes exceeding the maximum values allowed in the standard.

Thus, the amount of fluorine in sample D exceeds the values required by the standard. The Sample C shows an alarming excess of nitrate levels.

Following the determination of the water hardness values, it was found that sample M can be considered very soft water, and samples S, D and H soft water. As for sample C, it is a hard water, falling within the range of 18-30 degrees German. The higher hardness is due to the fact that this water is a deep water. Hard water does not have a major impact on human health, but some studies state that it can lead to the formation of stones and can sensitize tooth enamel [13].The experimental values of chemical compounds were centralized in the Table 3.

Table 3. The content of some chemical compounds from the analyzed samples

Recorded indices	Sample S	Sample H	Sample D	Sample C	Sample M
Nitrate, mg/L	0.000	0.040	0.030	799.9	0.000
Nitrites, mg/L	0.000	207.000	23.400	0.020	0.000
Boron, mg/L	3.200	2.020	2.790	4.830	2.220
Fluorine, mg/L	0.050	0.400	1.900	0.700	0.800
Ammonia, mg/L	0.020	0.010	0.200	0.090	0.000
Manganese, mg/L	0.000	0.000	0.068	0.040	0.000
Total hardness, German degrees	4.00	8.00	6.00	22.00	3.00
Oxidability mg/O_2	0.20	1.90	2.20	0.30	0.10
Chlorides, mol/m^3	4.10	191.80	30.50	184.00	180.00
Sulphates mg/L	10.90	192.00	110.40	124.80	9.00
Alkalinity, mg/L	18.30	15.25	67.20	42.70	11.00
Calcium, mg/L	2.00	4.00	1.00	0.69	0.20

Table 4. Microbiological analysis of samples

Microbiological indicator	Sample M	Sample D	Sample S	Sample H	Sample C
Coliform bacteria	absent	absent	absent	absent	21 CFU/100 ml
Escherichia coli	absent	absent	absent	absent	3 CFU/100 ml
Enterococci	absent	absent	absent	absent	12 CFU/100 ml

The results obtained from the microbiological analysis were summarized in the Table 4.

Of the five samples analyzed, sample C proved to be microbiologically unsuitable, being detected a large number of cfu, above that allowed by the SM SR ISO 9308-1: 2006 standard. This sample cannot be consumed as drinking water, because it does not correspond from a physico-chemical, sensory and microbiological point of view according to GD 1446, dated December 30, 2016. The drinking water distributed through the aqueducts in Cahul comes from the Prut river. The sampled water sample, sample M, corresponds to the quality requirements for drinking water provided by law.

4. Conclusions

The present study is just one step in the attempt to monitor the quality of drinking water in certain rural areas of the Republic of Moldova. Of the four samples analyzed, sample C, in Al.I. Cuza locality, proved to be non-compliant and is not recommended for consumption as drinking water. Tests should be carried out periodically to determine the quality of the well water before consuming it as drinking water. In the future, a map of drinking water is intended to identify areas where there may be problems, contributing to the efforts of other researchers [14].

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human or animal subjects (if exist) respect the specific regulation and standards.

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