

Chemistry

Diagnosis of water analysis from an artesian well in the Central Region of Rio Grande do Sul

Diagnóstico da análise de água de um poço artesiano da Região Central do Rio Grande do Sul

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ABSTRACT

Water must meet some standards of potability established in the legislation, since it is a resource of utmost importance to man, when designated for human consumption can be used for ingestion, preparation and production of food, and for personal hygiene independently of the origin (BRASIL, 2011). Thus, this study aims at diagnosing the water quality from an artesian well in the Central Region of the State of Rio Grande do Sul, in order to prove the potability in relation to the potable parameters established in Portaria No. 2.914, of December 12, 2011, of Ministry of Health. For this, the experimental procedures held were: pH determination, temperature, total dissolved solids, hardness, sodium and potassium, total coliforms and residual iron concentration. After the water sample analysis, it was verified that the consumption of this sample is indicated for the population, since the parameters obtained are in accordance with Portaria N° 2.914, of 2011.

Keywords: Artesian well; Potability; Water

RESUMO

A água deve atender a alguns padrões de potabilidade, estabelecidos na legislação, visto que é um recurso de suma importância para o homem, quando designada para consumo dos seres humanos pode ser utilizada para a ingestão, preparo e produção de alimentos, e para a higiene pessoal independente da origem (BRASIL, 2011). Com isso, este estudo visa diagnosticar a qualidade da água de um poço artesiano da Região Central do Estado do Rio Grande do Sul, a fim de comprovar a potabilidade perante aos parâmetros de potabilidade estabelecidos na Portaria N° 2.914, de 12 de dezembro de 2011, do Ministério da Saúde. Para isto, os procedimentos experimentais realizados foram: determinação do valor de pH; temperatura; sólidos totais dissolvidos; dureza; sódio, potássio, coliformes totais e concentração residual de ferro. Após a análise da amostra de água, verificou-se que o consumo desta amostra analisada é indicado para a população, visto que os parâmetros obtidos estão de acordo com a Portaria N° 2.914, de 2011.

Palavras-chave: Poço artesiano; Potabilidade; Água

1 INTRODUCTION

Water is of utmost importance for life. With the technology development resulting in an increased pollution of the environment, the water has lost its natural characteristics. Among the waters that lose their natural characteristics is the artesian well water, which at first should be clear, free of impurities and ready for human consumption, since the disrespect with nature has been growing, damaging the groundwater and consequently the water that flows there (TUCCI; CABRAL, 2003).

It is known that of the total volume of water on the planet, the presence of salt water, in the oceans and the seas, corresponds to 97.5% and the fresh water, in rivers, lakes, glaciers and underground, corresponds to only 2.5%. From this small amount of fresh water, 68.9% is found in glaciers, permanent snow coverage, 29.9% is related to underground fresh water, and 0.3% is from water coming from rivers and lakes (ALMEIDA, 2010).

In view of the above, this study aims at diagnosing the quality of water from an artesian well in the Central region of Rio Grande do Sul State, in order to prove potability in relation to the parameters established in Portaria N° 2914 of December 12, 2011, of the Ministry of Health. For this, the experimental procedures held were: pH value determination; temperature; total dissolved solids; hardness; sodium; potassium; total coliform and residual iron concentration.

2 REFERENTIAL

2.1 Hydro resources and water properties

Drinking water is every water fit for consumption. It must contain a certain amount of dissolved minerals, be free of toxic materials and microorganisms. It is considered an essential resource to human being. One of the main problems in the water use is related to its contamination, that is, this resource has been polluted in such way that it can no longer be consumed in its natural state. The artesian well

is a soil perforation that captures water by reaching an aquifer, establishing a geological engineering work of access to underground water for its collection. It does its work because through the pressure made by the water current, in which an extremity with a small diameter and great depth is drilled, over 40 meters, in which the water flows out by itself, because its own pressure is enough to take it to the surface (HIRATA, 2002).

The potability of water for the human consumption is currently managed by Portaria nº 05/17A, published in the Diário Oficial on October 03, 2017, by the Ministry of Health. It was titled as "Portaria de Consolidação das Normas sobre as Ações e os Serviços de Saúde do Sistema Único de Saúde". This regulation revoked the Portaria 2914/11, also in the Ministry of Health, which also disposed about water potability.

Water hardness refers to the amount of biocarbonates, carbonates, sulfates or calcium and magnesium chlorides dissolved in it. In other words, the greater the concentration of this salts in the water, the harder it is considered to be.

Sodium is present in water naturally due to its extraction process. Besides being a natural sodium, this mineral plays a very important role in health when ingested on a regular basis. It regulates the electrolyte balance in our body.

Potassium is a fundamental element to human nutrition, and its presence in many foods, such as meat, fish and fruit, and there is no evidence that it can cause any harm to the health of the consumer, although there is a concern for individuals in high-risk groups.

The water contamination by iron and manganese is considered undesirable. These metals are chemical substances that can generate unwanted coloration and taste.

The pH value can vary depending on the ions interaction in suspension (Zhang *et al*/2008). The presence and quantity of these ions are a consequence of the atmospheric air circulation and the emitting source conditions (Campos *et al*/2007).

Total solids correspond to the total weight of dissolved constituents present in water. All impurities, with the exception of the dissolved gases, contribute to the total solids load.

Coliforms are Gram-negative bacteria that do not form spores, are facultative anaerobes, and are rod-shaped. Total coliforms are represented by four genera: Citrobacter, Enterobacter, Escherichia and Klebsiella, all from the Family of enterobacteriaceae (FRANCO; LANDGRAF, 2008).

2.2 Water quality parameters

The quality of the water can be indicated through various parameters. Table 1 shows the standard result of water quality for human consumption.

Table 1 – Standard result of water quality for human consumption

Parameters	VMP
Total hardness	250 mg/L
Sodium	200 mg/L
Potassium	NE
Iron	0,30 mg/L
pH	NE
Temperature	Room
Total Solids	500
Coliforms	Absence in 100mL

Source: Potability Norm, Annex XX of Portaria de Consolidação nº 5/2017.

*not established

Source: Author's (2022)

3 EXPERIMENTAL PROCEDURES

The water sample analyzed was collected in the second half of the year 2021, from a 78-meter deep artesian well, located in a municipality in the Central Region of Rio Grande do Sul. This artesian well was chosen because it generates gravel

water, without any type of treatment, and is used for the human consumption. Approximately 20 people consume water from this well every day. Because of this, the need to analyze and confirm if this water meets the regulation in force, is justified.

The following is the description of each experimental procedure performed.

Total Hardness Determination (Complexation reaction): measure 100 mL of the sample and place in 250 mL Erlenmeyer flasks, add 1 mL of buffer solution pH=10, and 3 molar NaOH for pH adjustment until pH equals 10. Then, place approximately 0.02 grams of the indicator black eriochrome tenured with EDTA 0,02 M until the violet color vanishes and a blue color appears. After the procedure, perform the calculation, as the reaction is 1:1 (v/v), therefore the number of EDTA and CaCO₃ are equal. Repeat the procedure 3 times for each sample.

The calculation is held, according to Equation (1).

$$\frac{\text{mg of the sample}}{L} = M \text{ of EDTA} \times V \text{ use in L} * MM \text{ do CaCO}_3 \times 1000 \quad (1)$$

Where:

M = molecular mass

M = molarity

Sodium and Potassium Determination: the analysis of sodium and potassium in the sample is performed by flame photometry.

Iron Concentration Determination (spectrophotometry): first prepare the calibration curve with iron concentrations ranging from 0.024 to 0.088 ppm. Then, verify the absorbance measurements of all points in the curve to analyze the iron concentration in water.

For sample preparation, dilute the sample 10 times. Repeat the procedure 3 times for each sample.

pH Value Determination: the pH analysis is performed with a portable potentiometer. This is inserted into the flask with the sample for reading. Take a reading 3 times and write down the values.

Temperature Determination: the temperature is checked in loco with a digital thermometer. This is inserted inside the flask with the sample for measurement. Perform the reading 3 times and write down the values.

Total Dissolved Solids Determination: first, the 500 mL beakers are weighed on an analytical balance (masses are noted), add 200 mL of the sample, and evaporate with a hot plate until almost all of the water is gone. Add another 200 mL of the sample and evaporate until almost dry. Add another 100 mL of sample to the beakers and evaporate until completely dry. Cool the beakers and weight them on the balance. After that, the calculation is performed, according to Equation (2).

$$\frac{\text{mg of the dry residue}}{L} = \frac{1000x(P - T)}{A} \quad (2)$$

Where:

P = Weight of the beaker with dry residue, in mg.

T = Weight of the beaker before adding the sample, in mg.

A = Volume in L of the sample.

Repeat the procedure 3 times for each sample.

Fecal Coliforms Determination: sterilize the test tubes in the autoclave, and the needed materials (lab coat, volumetric flask of 100 mL, volumetric pipettes of 10 mL, pens, beakers) are sterilized in UV ray for 20 minutes. After these procedures, in the chapel is placed 100 mL of the sample in a volumetric flask. Then, Colitag is added and mixed until completely solubilized (yellow liquid). Afterwards, 10 mL of the mixture is measured with a pipette and placed in 10 test tubes, then placed in the oven at 45 °C, for 48 hours. If there is a change in the color, the tubes are taken to a device where they are examined for fluorescence, indicating if they contain fecal coliforms.

4 RESULTS

Generally, the pH value can interfere with the dissociation balance or in the ionization degree, especially of some insecticides, changing their biological activity.

The hardness is a characteristic parameter of the quality of water supply, but in terms of its potability, relatively high values are admitted. Very hard water, as well as very soft water, is not appropriate for other domestic use.

Table 2 describes the sample results of the artesian well analyzed according to the procedures described above.

Table 2 – Results of the Artesian well water

Parameters	Average (mg L-1)	RSD* (%)
Hardness	138.6	4.4
Sodium	28	0
Potassium	1.66	4.5
Iron	ND	-
pH	6.9	3
Temperature	25	2
Total Solids	279	3.31
Coliorms	ND	-

*RSD: standard relative deviation; VMP: maximum allowed value; NE: non established; ND: non detected.

Source: Author's (2022)

Total hardness is calculated as the sum of the calcium and magnesium ion concentrations in the water, translated as calcium carbonate. The hardness of a water can be permanent or temporary. Temporary hardness, also called carbonate hardness, happens because of the presence of calcium and magnesium bicarbonates. This type of hardness resists to soap and leads to incrustations. It is denominated temporary because the bicarbonate, by the heat action, decompose into carbon dioxide, water, and insoluble carbonates that precipitate. Thus,

according to Table 1, it can be observed that in the sample it was detected 138.6 mg/L of calcium carbonate, indicating that the water is classified as having medium hardness, and suitable for human consumption.

The sodium content in the sample analyzed, 28 mg/L, demonstrates that the water is below the maximum value allowed by the legislation.

Potassium is an essential element for humans and is widely found in the environment. Found in low concentrations in natural waters, it rarely hits levels that can be classified as of risk to human health (adverse effects can occur in susceptible individuals). As potassium salts are largely used in the industry and in fertilizers for agriculture, industrial and agricultural discharges can increase the concentrations in the fresh water springs. In the analyzed sample, a concentration of 1.66 mg/L of potassium was found.

Iron is one of the best known metals, a chemical element with the Fe symbol with the atomic number 26, and atomic mass of 55,845 g/mol. It belongs to group 8 of the periodic classification of chemical elements and is found in the solid state at room temperature, due to the elevated fusion point of 1535 °C and boiling of 2862 °C (MEDEIROS, 2010). In the sample analyzed, it was not detected iron residues, which is very beneficial to human health, because if ingested on high concentrations, it leads to neurological disorders, as Parkinson's disease (DP) and Alzheimer's dementia (DA), by accumulating in human tissue (FERNANDEZ *et al* 2007).

The pH value found was 6.9. It is worth noting that the term pH represents the concentration of hydrogen ions in a solution. In water, this factor is of exceptional importance, mainly in treatment procedures. In the routine of the treatment stations the pH value is measured and adjusted whenever needed to improve the processes of coagulation and flocculation of the water and also in the disinfection control. The pH value varies from 0 to 14. Below 7 the water is considered acidic and above 7, alkaline. Water with 7 pH is neutral. The Portaria nº

518/2004 of Ministry of Health recommends that the pH value of the water be kept between 6 and 9 in the distribution system.

The temperature is related to the increase in water consumption, fluoridation, solubility, and ionization of coagulant substances, change of pH, disinfection, etc. In the sample was verified the temperature of 25 °C.

In accordance with the data in Table 1, it can be verified the values of the total solid, 279 mg/L, does not exceed the maximum allowed value of 500 mg/L.

Drinking water must not contain pathogenic microorganisms and must be free of fecal contamination bacterium. The fecal contamination indicators, traditionally accepted, belong to a group of bacteria called coliforms. The main representative of this group is called *Escherichia coli*. Therefore, in the water sample it was not detected the presence of coliforms, indicating that the water is drinkable.

5 FINAL CONSIDERATIONS

Despite the the beneficial effects presented by these waters, in certain cases they can be harmful. Those with low sodium content should be consumed preferably by people with arterial hypertension. Although the low levels of this element in mineral waters do not provoke an increase in the blood pressure, their constant and excessive consumption contributes to an increase in the daily intake of sodium, and may exceed the daily recommended limit of 1300 mg for adults, which is not indicated for people with hypertension (CIÊNCIA e SAÚDE, 2015; FOOD, 2015; MARTINS, 2015).

In addition to the sodium content, the concentration of potassium and calcium is also relevant to health. People with hypertension should consume mineral water and other foods with higher potassium and calcium content, because the intake of these elements attenuates the effects caused by sodium ingestion (PEREIRA *et al*/2009; SANTOS, 2009).

Groundwater fulfills an important function and, in many cases, is vital for the supply of drinking water. It was verified that most of the results obtained in the experimental procedures are in accordance with the parameters of potability. Therefore, the consumption of this analyzed sample is indicated for the population, since the analyzed parameters are in accordance with Portaria N° 2.914.

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How to cite this article

PEIXOTO, S., C.; RESMINI, J., P., M. Diagnosis of water analysis from an artesian well in the Central Region of Rio Grande do Sul. **Ciência e Natura**, Santa Maria, v. 44, e43, 2022. DOI 10.5902/2179460X69657. Available at: <https://doi.org/10.5902/2179460X69657>.