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Technical Article

Water quality in Vão Grande quilombola communities, municipality of Barra do Bugres (MT)

Qualidade da água em comunidades quilombolas do Vão Grande, município de Barra do Bugres (MT)

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ABSTRACT

The objective of this study was to analyze the quality of water consumed by residents of the communities Morro Redondo and Baixios in the Quilombola settlement in Vão Grande, municipality of Barra do Bugres, Mato Grosso, Brazil; and to analyze the potential risks to public health. The following parameters were evaluated: alkalinity, hardness, turbidity, electrical conductivity, chemical oxygen demand, pH, temperature, chlorides, calcium, magnesium, sodium, iron and potassium, in different surface sources of water supply. Results were compared with parameters that define the potability of water. Samples were collected from July 2013 to April 2014, always near the 15th day of each month. The variables alkalinity and pH presented minimum values lower than the expected; and the variables turbidity and electrical conductivity showed maximum values above the limit. In general, the evaluated water sources present good quality, not offering potential risk to health. However, for safe consumption, it is recommended at least filtration and disinfection.

Keywords: basic sanitation; drinking water; public health.

RESUMO

Objetivou-se neste trabalho analisar a qualidade da água consumida pelos moradores das comunidades Morro Redondo e Baixios do assentamento quilombola da localidade Vão Grande, Município de Barra do Bugres, Mato Grosso, e os potenciais riscos à saúde da população. Avaliou-se alcalinidade, dureza, turbidez, condutividade elétrica, demanda química de oxigênio, pH, temperatura, cloretos, cálcio, magnésio, sódio, ferro e potássio, em diferentes fontes superficiais de abastecimento de água, e comparou-se os resultados com parâmetros que definem a potabilidade da água. As coletas foram realizadas no período de julho de 2013 a abril de 2014, sempre próximas ao dia 15 de cada mês. As variáveis alcalinidade e pH apresentaram valores mínimos abaixo do esperado e as variáveis turbidez e condutividade elétrica apresentaram valores máximos acima do permitido. De modo geral, as fontes de água avaliadas apresentaram boa qualidade, não oferecendo risco potencial à saúde dos moradores. Porém, para um consumo seguro, recomenda-se pelo menos filtração e desinfecção.

Palavras-chave: saneamento básico; água potável; saúde pública.

INTRODUCTION

Natural water is not a totally pure substance, as even the rain present organic substances and atmospheric gases, as well as traces of minerals and metals. In the hydrological cycle, precipitation is the water factory that recharges the surface and underground springs. In tropical regions, rain is the predominant type of precipitation: water, in the liquid state, when it reaches the ground, falls on or through the soil, dissolving and incorporating organic and mineral substances, as well as microorganisms. Generally, surface water presents lower concentration of dissolved mineral substances and more particulate substances in suspension, especially of organic origin.

Water is the natural resource indispensable to all living things. For human consumption, it must be potable, so as not to pose a health hazard, and it can be used for ingestion, food preparation and personal hygiene (BRASIL, 2011; SOUZA, 2000). Even in urban settlements, there is a common lack of supply of piped and treated water or even insufficient supply, leading users to compulsory rationing or to alternative sources such as cisterns, caves, mines, streams, wells or even rainwater, among others.

In rural areas, the situation is even more serious, since public authorities do not even know the conditions of basic sanitation (such as sewage collection and treatment and supply of drinking water), which leads people to seek water supply alternatives, using non-potable

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sources — the criterion of choice considers traditional knowledge, experience and visual appearance. Purification techniques such as filtration, heat treatment (boiling), ultraviolet treatment (exposure to sunlight) and chlorination are not commonly observed in rural areas.

Water contamination may be related to the pollution of streams and rivers by chemicals used in agriculture and mining, transported by rains or septic tank filters (BRASIL, 2014), as well as domestic sewage (FREITAS; BRILHANTE; ALMEIDA, 2001) or animal waste thrown in the open without prior treatment.

The ingestion of non-potable water can transmit various diseases to human beings, such as cholera and hepatitis A, among others (FREITAS; BRILHANTE; ALMEIDA, 2001). In addition, insufficient water generates unsatisfactory hygienic habits, which may lead to illness. Thus, it is important to emphasize that both the quantity and quality of water are related to several diseases to humans (BRASIL, 2006).

Among the current legislations that regulate the water quality of supply systems, there is Ordinance No. 2914/11 of the Ministry of Health, which regulates the procedures of control and surveillance of water quality for human consumption and defines the standard of potability (BRAZIL, 2011). It is also possible to observe the Water Quality Control Manual of the National Health Foundation (FUNASA) (BRASIL, 2014), and the Inland Water Quality Report of the State of São Paulo, of the Environmental Company of the State of São Paulo (CETESB) (CETESB, 2009).

While it is the right of every human being to have access to safe housing and basic services, many remote communities do not have, at least, a water supply system, which causes various health and social problems, such as increased incidence of water-related diseases (CARMO, BEVILACQUA; BASTOS, 2008), increased infant mortality and diseases caused by lack of hygiene, among others. In addition, these communities suffer from lack of information on basic concepts of sanitation, which makes them susceptible to diseases (SOARES; BERNARDES; CORDEIRO NETTO, 2002) and, more seriously, to death.

Peripheral populations, such as indigenous, agrarian reform settled, riverside and quilombolas people are more susceptible to lack of sanitation because they are located in rural areas, far from major centers and government actions. This can aggravate the water situation of these communities, besides beliefs and customs that lead to resistance in the implementation of good practices of use and manipulation of water resources.

Nery (2001) reports that all quilombola communities need access to water and sewage, and that these needs will be effective from the correct sanitary education, ensuring information about the correct sanitation systems and their use, while preserving the local cultural characteristics. The author estimates that the population of remaining quilombolas in Brazil reaches about 2 million people, whose communities are mostly in the rural zone and, therefore, with less coverage of basic sanitation services. According to CPISP (2016), there are 1,518 quilombola communities in the country, of which 68 are in the state of Mato Grosso; of that total, 10 communities (15%) are located in the municipality of Barra do Bugres, 4 of them in the locality called Vão Grande.

Therefore, the aim of this study was to analyze the physical and chemical quality of water sources consumed by residents of the Morro Redondo and Baixios communities in the quilombola settlement of Vão Grande, in the municipality of Barra do Bugres, Mato Grosso. Also, it is necessary to compare the results with current legislations and to evaluate the risk to the health of the residents.

METHODOLOGY

Vão Grande is a region of the municipality of Barra do Bugres, Mato Grosso, home to four quilombola communities, three of which (Baixios, Morro Redondo and Gruta Camarinha) on the right bank of the Jauquara River, and one (Vaca Morta) on the left bank. They are all close to each other, located in the valley between two geological elevations of the Serra das Araras formation. The local climate is tropical monsoon, according to Köppen classification, with high temperatures, rainfalls concentrated in summer and dry in winter.

We decided to evaluate the water of the Morro Redondo and Baixios communities due to the easy access by terrestrial routes. Nine collection points were determined, divided in different sources of supply, among them mines and streams.

Prior to the start of the collections, visits were made to the residents of the region to determine the target points of the collections and to let the residents aware of the importance of these analyses. This work is part of a research project in interface with the extension belonging to the "BB Água Limpa" Program of the State University of Mato Grosso.

The physical and chemical analyses were performed at the Laboratory of Water Quality (LaQuA) and at the Laboratory of Chemistry, both belonging to the Rene Barbour campus of the State University of Mato Grosso (UNEMAT) in Barra do Bugres, Mato Grosso, and in a certified private laboratory.

Samples were collected monthly from July 2013 until April 2014, except in October 2013. Previously cleaned and sterilized plastic bottles were transported in iceboxes to preserve samples at low temperature up to the laboratory. To ensure the reliability of the results without contamination during collection and afterwards, collection handlers wore lab coats, gloves, masks and caps. All analyses were performed in a maximum of 24 hours after collection and in triplicate.

In the UNEMAT laboratories, alkalinity, hardness, chemical oxygen demand, chlorides, calcium and magnesium analyzes were performed by titration based on the methodologies described in the Standard Methods for the Examination of Water and Wastewater (APHA, AWWA, WEF, 2005). For the analysis of pH, electrical conductivity and turbidity, the pH meter, conductivity meter and turbidimeter were used, respectively. The temperature was measured at the time of collection through a mercury thermometer from 0 to 60ºC. The sodium, potassium and iron analyses were carried out in a certified private laboratory.

The data were tabulated in an electronic spreadsheet and submitted to the normality test using the free software Action. Results were compared with potability indicators for drinking water.

RESULTS AND DISCUSSION

Data analysis by the Shapiro and Wilk test (1965) at 5% significance revealed the non-normality of the results. Therefore, we chose the descriptive statistics to present the data by means of the median (M), interquartile distance (D), maximum (Max) and minimum (Min), according to Table 1.

Alkalinity

Alkalinity is related to the ability of water to neutralize acids and may be associated with the presence of carbonates, bicarbonates, hydrates, phosphates, borates and silicates. Almost always bicarbonates of calcium and magnesium are the most present elements, and in this case, alkalinity tends to be equal to hardness. Alkalinity higher than hardness may be indicative of the presence of sodium and potassium bicarbonates (BLUMBERG; AZEVEDO NETTO, 1956).

In the evaluated points in the Baixios and Morro Redondo communities, values between 4.02 and 162.92 mg.L^{-1} were found (Table 1). The maximum value found is within the normal range (BRASIL, 2014). However, both the minimum and median values are below the minimum recommended in the same standard.

Vinaga *et al.* (2015), in a study conducted near the Vão Grande settlement, in the same region, found lower values, ranging from 2.06 to 56.32 mg.L^{-1}. High values of alkalinity are related to organic matter decomposition processes and to the high respiratory rate of microorganisms with release and dissolution of carbon dioxide in water (BRASIL, 2006), which may justify the highest values found.

In water treatment systems, when alkalinity is very low, it is necessary to cause artificial alkalinity to make the water suitable for flocculant treatment with aluminum sulfate, which can be done with the application of hydrated lime or sodium carbonate (BRASIL, 2009). Alkalinity also provides information for studying the fouling or corrosive characteristics of water.

For human consumption, alkalinity is not relevant and has no sanitary significance, and can be consumed without restrictions, in moderate concentrations. However, high values can impart bitter and unpleasant taste to water, becoming a restrictive factor to consumption. The communities did not report unpleasant taste in water, indicating that alkalinity does not offer any restriction to consumption.

Table 1 – Results of the descriptive statistics for the variables alkalinity, hardness, turbidity, electrical conductivity, chemical oxygen demand, hydrogenation potential, temperature, chlorides, calcium, magnesium, sodium, iron and potassium.

Variable	Median	Interquartile Distance	Maximum	Minimum	Parameter	Reference
Alkalinity (mg.L^{-1})	27,56	17,36	162,92	4,02	30 a 500	FUNASA[1]
Hardness (mg.L^{-1})	13,40	11,40	140,26	2,01	< 500	Ordinance nº 2.914 of MH[2]
Turbidity (NTU)	15,74	46,74	226,00	2,63	< 5	Ordinance nº 2.914 of MH
Electrical conductivity (⊠S.cm^{-1})	54,65	21,45	142,30	8,38	< 100	CETESB[3]
Chemical oxygen demand (mg.L^{-1})	40,45	34,82	194,14	3,87	-	Not referenced
pH	6,51	0,81	8,79	5,69	6,0 a 9,5	Ordinance nº 2.914 of MH
Temperature (° C)	27,00	7,00	45,00	22,00	0-30	CETESB
Chlorides (mg.L^{-1})	2,80	0,82	5,11	1,40	< 250	Ordinance nº 2.914 of MH
Calcium (mg.L^{-1})	2,94	2,65	9,62	0,80	-	Not referenced
Magnesium (mg.L^{-1})	1,31	1,46	4,57	0,31	-	Not referenced
Sodium (mg.L^{-1})	0,08	0,06	0,27	0,01	< 200	Ordinance nº 2.914 of MH
Iron (mg.L^{-1})	0,003	0,002	0,009	<0,001	< 0,30	Ordinance nº 2.914 of MH
Potassium (mg.L^{-1})	0,21	0,20	0,68	0,02	< 10	CETESB

[1]Manual of water quality control for technicians working in water treatment plants; [2]Ordinance nº 2914 of 2011 of the Ministry of Health; [3]Interranean Water Quality Report in the State of São Paulo; FUNASA: National Health Foundation; CETESB: Environmental Company of the State of São Paulo; MS: Ministry of Health; NTU: nefoliometric turbidity units.

Hardness

Hardness is caused by carbonates and bicarbonates of calcium and magnesium and represents the ability of water to consume soap. It can be classified as temporary, when caused by calcium and magnesium, or permanent, due to the presence of chlorides, nitrates and sulfates. When temporary, it can be eliminated by a simple boil.

By Ordinance No. 2914 of the Ministry of Health (BRASIL, 2011), the hardness of public water supply should be less than 500 mg.L^{-1}. In the evaluated sources, values between 2.01 and 140.26 mg.L^{-1} were found, with a median of 13.40 mg.L^{-1} (Table 1), thus below the maximum value allowed, indicating good water for consumption.

The water used by the evaluated communities can be classified as soft (0 to 55 mg.L^{-1}), slightly hard (56 to 100 mg.L^{-1}) and moderately hard (101 to 200 mg.L^{-1}). One resident reported that the water goes bad in the dry season, wasting a lot of soap, being an indication of moderately hard to hard water.

Turbidity

According to the legislation (Ordinance No. 2914/11 of the Ministry of Health), 5 nephelometric turbidity units (NTU) are permitted. The measured values ranged between 2.63 and 226.00 NTU (Table 1). Suspended materials such as clay, finely divided organic and inorganic matter, among others, may increase turbidity, being a sanitary indicator and standard of acceptance of water for human consumption (BRASIL, 2006).

The increase in turbidity, which occurred in December, can be explained by the occurrence of intense rainfall during this period, causing surface runoff and transport of all particle types from the soil surface to the springs, as well as the elevation of sediments, as explained by Moura, Assumpção and Bischoff (2009). This result reveals the need for greater attention regarding turbidity in the rainy season. A basic measure for the removal of turbidity is filtration, which can be done by consumers themselves (in communities where there is no public treatment system) with the use of simple filters, which does not exclude the need for disinfection with chlorine, for example.

Although turbidity is associated with suspended particles, the size, geometric shape and color of these particles also influence it. Turbidity itself poses no health risk, but is aesthetically unpleasant, causing consumer disgust. In addition, suspended particles can harbor pathogenic microorganisms, reducing the efficiency of disinfection treatments (DASSOLER *et al.*, 2015). Turbidity also directly interferes with the penetration of light into the water column, hampering the development of photosynthetic organisms such as phytoplankton, algae and submerged plants.

Electric conductivity

The electrical conductivity (EC), in some points, exceeded the value of 100 μs.cm^{-1} cited by CETESB, reaching EC maximum value (142,30 μs.cm^{-1}) in November 2013, the month that marks the beginning of the rainy season in the region. The rain may have contributed to the dissolution of rocks and the transport of ions to the springs. In contrast, Souza *et al.* (2014) determined, in Almada River, Bahia, a maximum value of 175 μ.cm^{-1} in April, when the fluviometric level was lower, causing a concentration of the ions in solution to occur. Souza, Bacicurinski and Silva (2010), while studying the water from the Paraíba do Sul River in Taubaté, São Paulo, Brazil, also observed a reduction of EC in the rainy season, explained by a possible dilution of river water with rainwater.

Higher values of electrical conductivity may be related to environments polluted by domestic or industrial sewage (BRASIL, 2014), which may be the case of the Almada River in Bahia, and the Paraíba do Sul River in São Paulo, but it is not the case of the Vão Grande region, where the present study was conducted. Therefore, the elevation of EC in the month of November may be associated with natural causes, such as the dissolution of mineral rocks, which may increase the concentration of ions in natural surface waters.

Even with the occurrence of high values in isolated points and at the beginning of the rainy season, the EC values measured in the sources of the Vão Grande locality do not represent a risk to the residents' health. However, monitoring studies of water quality variation are important and should be consistent.

Chemical Oxygen Demand

The chemical oxygen demand (COD) levels varied in the collection period with a maximum of 194.14 mg.L^{-1} and a minimum of 3.87 mg.L^{-1} (Table 1). There are no established values for this variable in water legislation. The lower the COD of a water source, the lower the organic load diluted therein and, therefore, the better its quality in relation to this variable.

Zuccari, Graner and Leopoldo (2005), while evaluating the COD of the river water that receives the wastewater from the city of Botucatu, São Paulo, found values of 78 to 170 mg.L^{-1}. In the water sources evaluated in Vão Grande, values higher than those found by the aforementioned authors were observed, revealing that there is organic contamination, not by dumping of domestic or industrial sewage, which does not exist in that place, but perhaps by the dumping of residue from pigpens and corals, common in the region, or even by the high presence of organic plant material.

Evaluating the water of the stream Cerradinho, downstream of the city of Jaboticabal, São Paulo, Scandolera *et al.* (2001) found COD between 32 and 201 mg.L^{-1}, values considered high by the authors, who denominated it as wastewater. These results indicate a need for attention to the maximum COD values in the Vão Grande locality, pointing to unidentified sources of contamination.

Hagemann (2009) evaluated the COD of rainwater collected directly from the atmosphere in the city of Santa Maria, Rio Grande do Sul, between 9 and 31 mg.L^{-1}. Strohschoen *et al.* (2009), also in Rio Grande do Sul, found COD from 64.4 to 81.0 mg.L^{-1} for Forqueta River, and 95.5 to 101.0 mg.L-1 for Forquetinha River. These values are higher than the minimum found in Vão Grande, suggesting that, in relation to COD, the waters are of good quality. Thus, attention is only required to the points where high values were obtained, because there may be some source of isolated contamination, not identified in this study.

pH

For the pH variable, values between 6.0 and 9.5 are recommended (Ordinance No. 2914/11 of the Ministry of Health), for the water of the supply system. In Vão Grande, values between 5.69 and 8.79 (Table 1) were found, with a minimum slightly below the recommended lower limit and the maximum within the desirable limit.

Natural waters, which do not receive treatment, have pH between 4 and 9, and are mostly slightly basic due to the presence of bicarbonates and carbonates of alkaline and earth alkaline metals. The results were within this range, revealing the normality of Vão Grande water relative to pH. This is a positive factor, even though pH was slightly lower than that standardized by Ordinance No. 2914/11 of the Ministry of Health, which is perfectly correctable, and does not represent risk to residents.

The pH range recommended by Ordinance No. 2914/11 of the Ministry of Health refers to the pH suitable for ingestion and also to the pH suitable for better efficiency of the treatment processes. Resolution RDC No. 54 (BRASIL, 2000), which regulates the minimum and maximum parameters for mineral waters, establishes pH values between 4 and 9, revealing that the water consumed by the residents of Vão Grande is perfectly framed in the quality standard for mineral water, offering no risk to its consumers.

Temperature

The temperature has been high in some points, especially in the dry season, when the climate is hotter, reaching 45ºC. In addition to the hot weather, the collections were carried out from 10:00 a.m. to 2:00 p.m., which directly influences the results. The maximum value was measured in a source that was exposed directly to the sun, being an isolated case, not representing the whole.

The temperature of the water bodies is seasonal and varies according to latitude, season, geographical location, depth, among other factors. There is no standardized temperature in literature. CETESB (2009) makes only a reference to the range of 0 to 30ºC, an interval also cited by Silva *et al.* (2008); however, this represents a further range of expected values than an acceptable limit — nevertheless, it serves as a parameter.

In Vão Grande, the minimum measured temperature was 22ºC, with a median of 27ºC, values that are close to the average annual atmospheric temperature for the municipality of Barra do Bugres (25.5ºC), according to data available on the city hall website which are in the bands cited by CETESB (2009) and Silva *et al.* (2008), indicating total normality.

Special attention should be given to sources that have higher temperatures. For example, enterococci, subgroup of streptococci, are organisms that can grow at temperatures up to 45°C. High water temperatures may represent a potential risk of proliferation of pathogenic organisms, becoming a vehicle of microbiological contamination. On the other hand, high temperatures also tend to provoke rejection of water consumption by people, who obviously prefer to consume fresh water.

Chlorides

Chloride values, in the period and in the sources evaluated, were between 1.40 and 5.11 mg.L^{-1} (Table 1). The Ministry of Health establishes 250 mg.L^{-1} as the maximum value allowed, which reveals the good quality of the water in this question, converging to potability.

In Colorado do Oeste, Rondônia, Coswosk *et al.* (2013), evaluating the potability of natural waters of a river, observed values of chloride of the order of 12 mg.L^{-1}, therefore close to those found in the natural surface waters of Vão Grande. Considering the geographical proximity between Mato Grosso and Rondônia, and that the region of Barra do Bugres is close to the transition between the Cerrado and Amazon biomes, the values are consistent. Similar result was also found by Zuffo *et al.* (2013), also for the state of Rondônia.

According to Ramos Junior and Cruz (2012), chlorides are always present in natural waters and may be the result of contact with mineral deposits and sea water, as well as sewage and irrigation water. In the Vão Grande region there is no significant dump of sewage in the springs, since there is no collection network and the population density is low. Irrigation is done with improvised systems in some domestic gardens and the region is far from the coast, therefore, it is probable that the source of chlorides in the waters of the region is the very soil and mineral rocks that appear in the mountainous parts.

At low levels, chloride does not pose a health hazard, but it can give salty taste to the water, causing refusal or rejection to consumption; it can also accelerate the corrosion process in steel or aluminum pipes. In the case of the studied region, however, the residents did not report bad taste characteristic of salt in the water; in addition, the pipes used are of low density polyethylene, or PVC, which avoids problems of corrosion.

Calcium and Magnesium

Calcium and magnesium salts, in normal concentrations, pose no risk to human health, and are even recommended for the healthy growth of bones and teeth. They may still offer protection against some diseases, for example osteoporosis. The harmful levels of calcium and magnesium are not reported by the current legislation, and an indirect evaluation is made by means of hardness.

At the evaluated points, calcium ranged from 0.80 to 9.62 mg.L^{-1} and magnesium from 0.31 to 4.57 mg.L^{-1} (Table 1). The Mg:Ca ratio ranged from 1:2.5 to the minimum and 1:2.0 to the maximum. According to Blumberg and Azevedo Netto (1956), natural waters are expected to have a Mg:Ca ratio of the order of 1:5 to 1:20. In this case, the waters of the studied region are not in the expected pattern, presenting a higher proportion of magnesium in relation to calcium. This is not an alarming factor since the total hardness is below the maximum allowed value and the individual values of both calcium and magnesium are low.

A calcium-deficient diet is associated with increased risk of diseases such as osteoporosis, nephrolithiasis, colorectal cancer, hypertension, stroke, coronary artery disease, insulin resistance and obesity. Water is considered an important source of this mineral, especially for children (WHO, 2011). When ingested in excess, calcium is excreted by the kidneys in healthy people, whereas it can cause calcifications in the kidneys of people with renal dysfunction.

Magnesium is the fourth most abundant cation in the human body and the second in the intracellular fluid, being cofactor for about 350 enzymes, many of them involved in energy metabolism. Reduced levels of magnesium are associated with hypertension, coronary heart disease, type 2 diabetes mellitus and reduced insulin sensitivity.

Ingestion of too much magnesium may cause temporary diarrhea, but rarely causes hypermagnesemia in people with normal renal function. Concentrations of magnesium in drinking water above 250 mg.L^{-1} may have a laxative effect, although individuals who are continuously exposed to this condition may adapt. In all analyzed sources of Vão Grande, the maximum value was well below the alarm level for magnesium, which indicates that water is safe for human consumption.

Sodium

The measured values of sodium ranged from 0.01 to 0.27 mg.L^{-1} with a median of 0.08 mg.L^{-1} (Table 1). Ordinance nº 2914/11 of the Ministry of Health allows a maximum of 200 mg.L^{-1} of sodium, revealing that, in relation to this element, the waters of Vão Grande are suitable for human consumption.

Kemerich *et al.* (2013), studying water quality from the simulated surface runoff in the Vacacaí-Mirim River basin in Rio Grande do Sul, found sodium values between 2 and 171 mg.L^{-1}, which are much higher than those found in Vão Grande.

The concentration of sodium in water above 200 mg.L^{-1} causes unpleasant taste and may be a restriction factor to its consumption, which is not the case of the sources used by the quilombola inhabitants of Morro Redondo and Baixios.

Iron

Ordinance nº 2914/11 of the Ministry of Health limits the iron content in the waters in 0.3 mg.L^{-1}. In the measurements made in the sources of Vão Grande, a maximum value of 0.009 mg.L^{-1}, minimum < 0.001 mg.L^{-1} (limit of detection of the apparatus) and median of 0.003 mg.L^{-1} (Table 1) were observed. The maximum value is well below the limit allowed by the legislation, evidencing the good quality of the water in relation to this element. Oliveira Filho, Dutra and Ceruti (2012) found much higher values (0.43 to 0.48 mg.L^{-1}) in a study carried out in the Santa Rosa River basin in Paraná.

Iron ions can be deposited in the hydraulic apparatus and cause incrustations, allowing the appearance of ferruginous bacteria, besides provoking characteristic and unpleasant taste and odor. In sanitary ware and clothes, it can cause the appearance of ferruginous stains (MORUZZI; REALI, 2012).

Iron is an abundant element on the earth's surface and its main natural sources are the weathering of rocks and the erosion of rich soil in this element. According to Oliveira Filho, Dutra and Ceruti (2012), high levels of iron in surface waters may be associated with increased rainfall runoff due to the reduction of riparian forests and soil cover.

In the region of Vão Grande, where the water samples were obtained, the margins are preserved and the agriculture and livestock activities are little technified and practiced in small areas; the soil is sandy with a medium texture and the predominant rock material is limestone. Thus, and in the absence of effluent discharge in the water bodies, it is believed that the main source of iron can be the rocks and the local soil in natural conditions, but at low levels and safe for human consumption.

Potassium

Potassium was found in values ranging from 0.02 to 0.68 mg.L^{-1}, with a median of 0.21 mg.L^{-1} (Table 1). Potassium is an important element in the human body and, along with sodium, it participates in intracellular exchanges. Ordinance nº 2914/11 of the Ministry of Health does not establish limits for potassium in human water supply. In agriculture, potassium is beneficial and desirable a nutrient.

CETESB (2009) reports that the concentrations of potassium in natural waters do not exceed 10 mg.L^{-1}, indicating that the waters of Vão Grande are within the expected standard for this element.

Lucas, Folegatti and Duarte (2010) while evaluating the water quality of the Marins river basin, a tributary of the Piracicaba River, found potassium values ranging from 4.5 to 51.6 mg.L^{-1}, much superior to those found at Vão Grande, evidencing the good quality of the water in comparison with other places.

Nery (2001), studying the importance of water analysis for public health in two regions of the state of Rio de Janeiro, observed that the regularity of the drinking water supply system and improvements in the distribution system are risk reduction factors to the health of the population.

CONCLUSION

Regarding the evaluated variables, the water sources used by the residents of the quilombola communities Baixios and Morro Redondo, in Vão Grande, are of good quality. However, filtration and disinfection are recommended. Only turbidity presented very divergent values and deserves attention. The monitoring of water quality should be continuous and with more comprehensive studies, investigating other important variables to define the potability. Public authorities must interfere in the site, providing at least water filtration and disinfection equipment, as well as a continuous monitoring program.

REFERENCES

AMERICAN PUBLIC HEALTH ASSOCIATION (APHA); AMERICAN WATER WORKS ASSOCIATION (AWWA); WATER ENVIRONMENT FEDERATION (WEF). (2005) *Standard methods for the examination of water and wastewater*. 21. ed. Washington, D.C.: APHA.

BLUMBERG, E.; AZEVEDO NETTO, J.M. (1956) Alcalinidade e dureza das águas naturais. *Revista DAE*, v. 28, n. 1033, p. 63-79.

BRASIL. (2000) Ministério da Saúde. Agência Nacional de Vigilância Sanitária. Resolução RDC nº 54 de 15 de junho de 2000. Regulamento Técnico para fixação de identidade e qualidade de água mineral natural e água potável. Disponível em: <http://www.anvisa.gov.br/anvisalegis/resol/2000/54_00rdc.htm>. Acesso em: 17 jun. 2016.

_____. (2006) Ministério da Saúde. Secretaria de Vigilância em Saúde. *Vigilância e controle da qualidade da água para consumo humano*. Brasília: Ministério da Saúde. 212 p. (Série B. Textos Básicos de Saúde).

_____. (2009) Fundação Nacional de Saúde (FUNASA). *Manual prático de análise de água*. 3. ed. Brasília: Fundação Nacional de Saúde. 144 p.

_____. (2011) Ministério da Saúde. Agência Nacional de Vigilância Sanitária. Portaria nº 2.914 de 12 de dezembro de 2011. Dispõe sobre os procedimentos de controle e de vigilância da qualidade da água para consumo humano e seu padrão de potabilidade. Disponível em: <http://bvsms.saude.gov.br/bvs/saudelegis/gm/2011/prt2914_12_12_2011.html>. Acesso em: 1º jul. 2016.

_____. (2014) Ministério da Saúde. Fundação Nacional de Saúde. *Manual de controle da qualidade da água para técnicos que trabalham em ETAS*. Brasília: FUNASA.

CARMO, R.F.; BEVILACQUA, P.D.; BASTOS, R.K.X. (2008) Vigilância da qualidade da água para consumo humano: abordagem qualitativa da identificação de perigos. *Engenharia Sanitaria e Ambiental*, v. 13, n. 4, p. 426-434.

COMISSÃO PRÓ-ÍNDIO DE SÃO PAULO (CPISP). *Terras quilombolas*. Disponível em: <http://www.cpisp.org.br/terras>. Acesso em: 22 jun. 2016.

COMPANHIA AMBIENTAL DO ESTADO DE SÃO PAULO (CETESB). (2009) *Qualidade das águas interiores no estado de São Paulo*. São Paulo: CETESB. 44 p.

COSWOSK, R.C.; GEMELI, M.B.; OLIVEIRA, L.C.J.; FRAGA, C.I.M.; PAULA, N.R.F. (2013) Estudo da potabilidade da água para consumo humano na cidade de Colorado do Oeste. *In*: SIMPÓSIO DE RECURSOS HÍDRICOS, 2., 2013, Rolim de Moura/RO. *Anais*...

DASSOLER, D.; VALVASSORI NETO, D.; MADEIRA, F.T.; MELO, A.R.; CAMPOS, D.P. (2015) Verificação da Potabilidade da Água na Residência de um Morador do Bairro Beatriz em Maracajá/SC. *Revista Científica Química Geral*, v. 1, n. 1.

FREITAS, M.; BRILHANTE, O.M.; ALMEIDA, L.M. (2001) Importância da análise de água para a saúde pública em duas regiões do Estado do Rio de Janeiro: enfoque para coliformes fecais, nitrato e alumínio. *Cadernos de Saúde Pública*, v. 17, n. 3, p. 651-660.

HAGEMANN, S.E. (2009) *Avaliação da qualidade da água da chuva e da viabilidade de sua captação e uso*. 141f. Dissertação (Mestrado) – Universidade Federal de Santa Maria, Santa Maria.

KEMERICH, P.D.C.; MARTINS, S.R.; KOBIYAMA, M.; SANTI, A.L.; FLORES, C.E.B.; BORBA, W.F.; FENANDES, G.D.; CHERUBIN, M.R. (2013) Qualidade da água oriunda do escoamento superficial simulado em bacia hidrográfica. *Ciência e Natura*, v. 35, n. 2, p. 136-151.

LUCAS, A.A.T.; FOLEGATTI, M.V.; DUARTE, S.N. (2010) Qualidade da água em uma microbacia hidrográfica do Rio Piracicaba. *Revista Brasileira de Engenharia Agrícola e Ambiental*, v. 14, n. 9, p. 937-943.

MORUZZI, R.B.; REALI, M.A.P. (2012) Oxidação e remoção de ferro e manganês em águas para fins de abastecimento público ou industrial – uma abordagem geral. *Revista de Engenharia e Tecnologia*, v. 4, n. 1, p. 29-43.

MOURA, A.C.; ASSUMPÇÃO, R.A.B.; BISCHOFF, J. (2009) Monitoramento físico-químico e microbiológico da água do rio Cascavel durante o período de 2003 a 2006. *Arquivos do Instituto Biológico*, v. 76, n. 1, p. 17-22.

NERY, T.C.S. (2001) Saneamento: ação de inclusão social. *Estudos Avançados*, v. 18, n. 50, p. 313-321.

OLIVEIRA FILHO, P.C.; DUTRA, A.M.; CERUTI, F.C. (2012) Qualidade das águas superficiais e o uso da terra: estudo de caso pontual em bacia hidrográfica do Oeste do Paraná. *Floresta e Ambiente*, v. 19, n. 1, p. 32-43.

ORGANIZAÇÃO MUNDIAL DA SAÚDE (WHO). (2011) *Hardness in Drinking-water:* background document for development of WHO Guidelines for Drinking-water Quality. Disponível em: <http://www.who.int/water_sanitation_health/dwq/chemicals/hardness.pdf>. Acesso em: 03 jum. 2016.

RAMOS JUNIOR, A.B.S.; CRUZ, M.J.M. (2012) Variabilidade espaço-temporal de parâmetros físico-químicos e metais pesados no rio São Paulo, município de Candeias, Bahia. *Geociências*, v. 31, n. 4, p. 622-637.

SCANDOLERA, A.J.; PALHARES, J.C.; LUCAS JUNIOR, J.; AMARAL, L.A.; MENDONÇA, R.P.; OLIVEIRA, G.P. (2001) Avaliação de parâmetros químicos, microbiológicos e parasitológicos de águas de abastecimento da UNESP e residuária, no município de Jaboticabal, Estado de São Paulo. *Semina: Ciências Agrárias*, v. 22, n. 1, p. 83-91.

SHAPIRO, S.S.; WILK, M.B. (1965) An analysis of variance test for normality (complete samples). *Biometrika*, v. 52, n. 3/4, p. 591-611.

SILVA, A.E.P.; ANGELIS, C.F.; MACHADO, L.A.T.; WAICHAMAN, A.V. (2008) Influência da precipitação na qualidade da água do Rio Purus. *Acta Amazônica*, v. 38, n. 4, p. 733-742.

SOARES, S.R.A.; BERNARDES, R.S.; CORDEIRO NETTO, O.M. (2002) Relações entre saneamento, saúde pública e meio ambiente: elementos para formulação de um modelo de planejamento em saneamento. *Cadernos de Saúde Pública*, v. 18, n. 6, p. 1713-1724.

SOUZA, C.F.; BACICURINSKI, I.; SILVA, E.F.F. (2010) Avaliação da qualidade da água do rio Paraíba do Sul no município de Taubaté-SP. *Revista Biociências*, v. 16, n. 1, p. 16-23.

SOUZA, D.A. (2000) *Desenvolvimento de metodologia analítica para determinação de multiresíduos de pesticidas em águas de abastecimento de São Carlos – SP*. 109f. Tese (Doutorado) – Universidade de São Paulo, São Carlos.

SOUZA, J.R.; MORAES, M.E.B.; SONODA, S.L.; SANTOS, H.C.R.G. (2014) A importância da qualidade da água e os seus múltiplos usos: Caso rio Almada, Sul da Bahia, Brasil. *Revista eletrônica do Prodema*, v. 8, n. 1, p. 26-45.

STROHSCHOEN, A.A.G.; PÉRICO, E.; LIMA, D.F.B.; REMPEL, C. (2009) Estudo preliminar da qualidade da água dos rios Forqueta e Forquetinha, Rio Grande do Sul. *Revista Brasileira de Biociência*, v. 7, n. 4, p. 372-375.

VINAGA, L.; QUEIROZ, T.M.; FERREIRA, F.S.; SOUZA, J.F. (2015) Caracterização físico-química da água utilizada pela população do Assentamento Quilombola Vão Grande – MT. *Acta Iguazu*, v. 4, n. 2, p. 30-44.

ZUCCARI, M.L.; GRANER, C.A.F.; LEOPOLDO, P.R. (2005) Determinação da demanda química de oxigênio (DQO) em águas e efluentes por método colorimétrico alternativo. *Energia na Agricultura*, v. 20, n. 4, p. 69-82.

ZUFFO, C.E.; NASCIMENTO, G.F.; ABREU, F.A.M.; CAVALCANTE, I.N. (2013) Caracterização da Qualidade de Águas Superficiais em Rondônia. *Anuário do Instituto de Geociências*, v. 36, n. 2, p. 25-39.