Brazilian Journal of Biology®

ISSN 1519-6984 (Print)
ISSN 1678-4375 (Online)

Original Article

Physicochemical, microbiological and parasitological analysis of water for human consumption in a quilombola community in Alagoas

Análise físico-química, microbiológica e parasitológica da água para consumo humano em comunidade quilombola em Alagoas

M. S. Correia[a,b], E. N. A. Santos[a], P. K. A. Magalhães[a,b], A. M. Santos[a], M. I. C. S. de Messias[a,b], J. C. Santos Júnior[f], A. P. M. Carvalho Neto[a], M. A. Souza[a], S. A. Fonseca[a], G. C. Ferreira Júnior[c], M. G. S. Cavalcanti[d], J. G. Costa[e], P. R. B. Miranda[a] and T. J. M. Rocha[a,f*]

[a]Centro Universitário Cesmac, Maceió, AL, Brasil
[b]Instituto Federal de Alagoas, Maceió, AL, Brasil
[c]Instituto Federal de Educação, Ciência e Tecnologia do Acre, Xapuri, AC, Brasil
[d]Universidade Federal da Paraíba, João Pessoa, PB, Brasil
[e]Embrapa Alimentos e Territórios, Maceió, AL, Brasil
[f]Universidade Estadual de Ciências da Saúde de Alagoas, Maceió, AL, Brasil

Abstract

Water is the indispensable natural resource for all living beings. For human consumption, it must be potable, so as not to pose a risk to health, and can be used for ingestion, food preparation and personal hygiene. Knowing this importance, this study aimed to carry out physical-chemical, microbiological and parasitological analyzes of water for human consumption in a quilombola community of Santa Luzia do Norte in Alagoas. A cross-sectional, experimental and quantitative study was carried out between January and December 2019. The physical-chemical parameters of residual chlorine, turbidity, fluoride, fluoridation, color and pH were analyzed, microbiological analyses were based on the research of total and thermotolerant coliforms (*E. coli*) and parasitological analyses were performed based on the research of protozoa and intestinal helminths. Some physical-chemical parameters (turbidity and pH) were observed outside the limits required by the Ministry of Health, and the presence of total coliforms in some of the analyzed samples (17.85%), characterizing this community at risk related to waterborne diseases. The samples analyzed did not present infecting forms of parasitic species. Regarding the variables evaluated, the results found showed that the lack of adequate basic sanitation affects the quality of water used for human consumption by the quilombola population of Santa Luzia do Norte-AL.

Keywords: enterobacteria, intestinal parasites, public health, quilombos.

Resumo

A água é o recurso natural indispensável a todos os seres vivos. Para consumo humano, deve ser potável, de modo a não oferecer risco à saúde, podendo ser usada para ingestão, preparação de alimentos e higiene pessoal. Sabendo dessa importância, este estudo teve como objetivo realizar análises físico-químicas, microbiológicas e parasitológicas da água para consumo humano em uma comunidade quilombola de Alagoas. Foi realizado um estudo transversal, do tipo experimental e quantitativo, realizado na comunidade quilombola de Santa Luzia do Norte-AL, entre janeiro a dezembro de 2019. Foram analisados os parâmetros físico-químico de cloro residual, turbidez, fluoreto, fluoretação, cor e pH, as análises microbiológicas foram baseadas na pesquisa de coliformes totais e termotolerantes (*E. coli*) e as análise parasitológicas foram realizadas com base na pesquisa de protozoários e helmintos intestinais. E a pesquisa de protozoários oportunistas pelo método de Ziehl-Neelsen modificado. Foi observado alguns parâmetros físico-químicos (turbidez e pH) fora dos limites exigidos pelo Ministério da Saúde, e a presença de coliformes totais em algumas das amostras analisadas (17,85%), caracterizando esta comunidade em situação de risco relacionado às doenças de veiculação hídrica. As amostras analisadas não apresentaram formas infectantes das espécies parasitárias. Em relação às variáveis avaliadas, os resultados encontrados demonstraram que a falta de saneamento básico adequado afeta a qualidade da água utilizada para consumo humano pela população quilombola de Santa Luzia do Norte-AL.

Palavras-chave: enterobactérias, parasitoses intestinais, saúde pública, quilombos.

*e-mail: tmatosrocha@cesmac.edu.br
Received: February 9, 2022 – Accepted: May 17, 2022

1. Introduction

Quilombola communities are part of one of the major emergency issues of Brazilian society (Vieira and Monteiro, 2013). These groups have their own historical trajectory and are provided with specific territorial relationships with presumption of black Afro-Brazilian ancestry and are distinguished by their ethnic identity, and in particular by their social organization and predominantly rural location (Bezerra et al., 2014). Therefore, they account for spaces of collective experience, of ethnic and cultural preservation of the national intangible heritage.

Studies have recognized that the most common health problems in quilombola communities comes from a complex set of determinants and factors linked to the political, socioeconomic, cultural, geospatial, and environmental context and in particular from the set of historical inequalities associated with the black ancestry of these communities. A factor that, links this segment of the population to poverty, reduces their access to health services and other essential services (Batista and Rocha, 2019). Cardoso et al. (2018), when evaluating such conditions, identified that these communities comprise individuals, mostly with low levels of education and income, living in geographic isolation, practicing subsistence agriculture, livestock and handicrafts, and face precarious living conditions.

As a result of this reality, some authors have been pursuing to develop profiles of illnesses and deaths of these people to better understand their living conditions. These surveys have revealed high rates of infectious diseases, infant mortality, nutritional deviations, and prevalence of chronic degenerative diseases (Cardoso et al., 2018). Other studies have analyzed the socio-environmental and socio-housing characteristics of these regions in an attempt to understand the relationship between health-disease and the conditions of vulnerability of these communities (Souza Filho and Prioste, 2017).

Ferreira et al. (2014) when studying the supply of water for human consumption in quilombola communities in the municipality of Santana do Mundaú - AL, found the lack of access to potable water and the lack of adequate hydraulic installations in the residences of the remaining communities of quilombos - a scenario that, associated with inadequate conditions of transport and storage of water from alternative sources of supply, have generated higher risks and greater susceptibility to waterborne diseases. Other studies carried out in quilombola communities in the North and Northeast regions of the country reinforce these findings and also reveal the persistence of precarious habits of supply and sanitation in these locations, namely: elimination of feces and urine in the environment, on the ground and in dams; failure to carry out chlorination or filtration procedures; use of artisan wells, cloth filters and clay filters; storage in buckets, drums and pans; lack of proper plumbing for supply and absence of a toilet inside their home (Araújo et al., 2009; Amorim et al., 2013; Ferreira et al., 2014; Magalhães Filho and Paulo, 2017).

Thus, considering that the low socioeconomic and socio-housing level associated with geographic isolation, together with precarious living conditions are some of the factors that delay the improvement of the population's quality of life, the present study aimed to carry out a physical analysis, chemical, microbiological and parasitological aspects of water for human consumption in a quilombola community in Alagoas. Such a study, in the context of quilombola communities, becomes relevant, as it can provide important subsidies to plan out preventions, improve health promotion actions and guide priorities in the formulation of actions and public policies aimed at these peoples.

2. Materials and Methods

2.1. Study area

The quilombola community of Santa Luzia do Norte (Figure 1) was granted official certification by the Palmares Cultural Foundation on April 19, 1995, published in the D.O.U. on 05/20/2016 (Alagoas, 2015). The main economic activities practiced by the community are subsistence agriculture and handicraft manufacturing. Some residents work in the city, and other sources of income are retirement programs and income transmission, such as the old Bolsa Família, now called Brazil Aid.

According to a survey by the Secretary of State for Women and Human Rights, the quilombo records the existence of 350 families, however, in the Single Registry for Social Programs (CadÚnico), only 56 families are registered. Regarding socioeconomic data, the survey shows that 60.71% of families are in extreme poverty, 17.85% in poverty, 58.92% receive the Bolsa Família Program (BFP) (Alagoas, 2015). Before the beginning of the collections, visits were made to the 56 families registered to determine the target points of the collections and make the residents aware of the importance of these analyzes. The study was approved by the Ethics and Research Committee (CEP) of the CESMAC University Center, obtaining approval on 03/15/2019 under CAEE No. 07351019.5.0000.0039.

The quilombola population was informed about all the research data, in relation to its direct and indirect objectives, risk and beneficial, about the willingness of the research, about the interruption of the research without burden and at any time. Agreeing to participate in the research, participants were invited to sign the Informed Consent Form (TCLE), issued in two ways, one copy for the researcher and another for the individual, TCLE based on the guidelines of CNS/MS resolution 466/12.

According to field research, the community has basic infrastructure for electric energy services, cellphones, water supply, a health center, education (Municipal school up to the fifth grade), in addition to evangelical and catholic churches and a residents' association.

2.2. Type of study, location and collection

A cross-sectional, experimental, and quantitative study was carried out in the quilombola community of Santa Luzia do Norte-AL, between January and December 2019. The water samples were collected directly from the tap of the residences to perform the physical, chemical, parasitological, and microbiological analysis. The collections

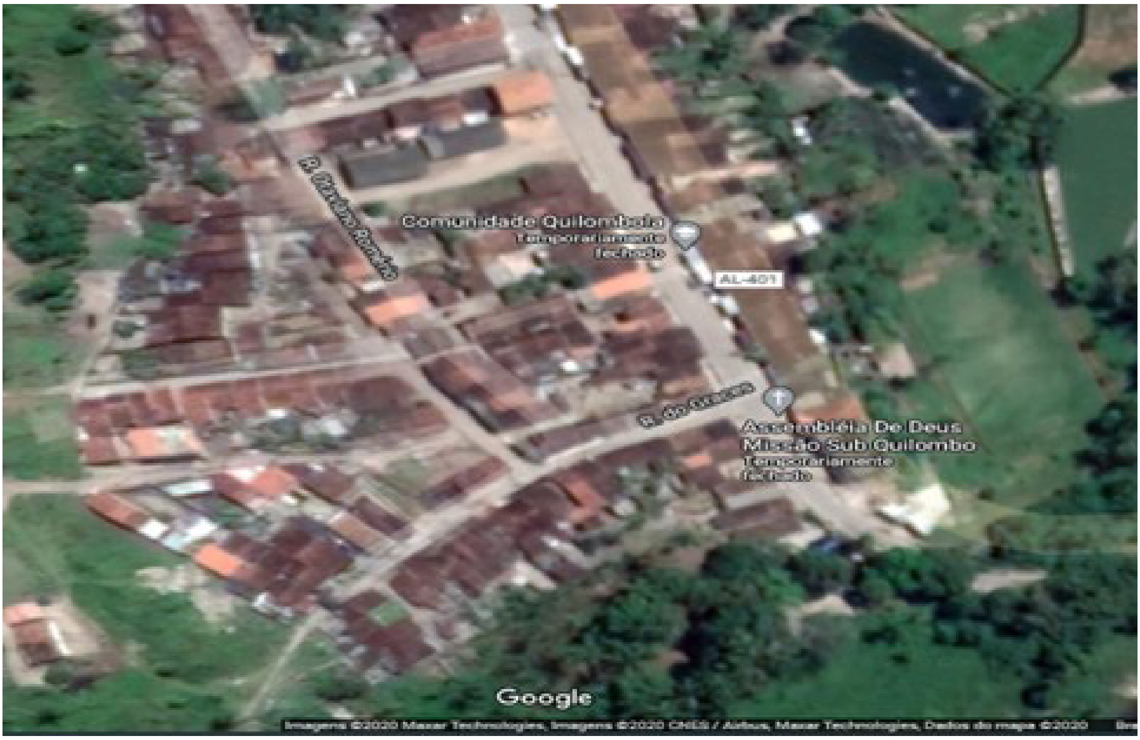

Figure 1. Map of the quilombola community of Santa Luzia do Norte – AL. Source – Google Maps, 2019.

were performed in triplicate, using sterilized containers, and packed in thermal boxes, according to the hygiene standards and sampling control described by Macêdo (2003). The analysis was performed within 24 hours after collection, to preserve the samples, since coliform in this condition multiply rapidly, thus interfering with the analysis result. After collection, the samples were sent to the Research Laboratory of the Centro Universitário Cesmac, Campus I. To ensure the reliability of the results without contamination during and after collection, the collection handlers wore lab coats, gloves, masks and caps. The research was carried out through a non-probabilistic sample of 56 quilombola households, which were chosen through convenience.

2.3. Physicochemical analyzes

The Hydrogenonic potential (pH) was measured at 35ºC within 2 hours after collection. A benchtop pH meter (pHmeter), NI PHM, from NOVA Instruments® was used. The values were cataloged with two decimal places of precision, performing the analyzes in triplicate. To determine the free residual chlorine, the N,N-diethyl-p-+enylene diamine (DPD) method was used, using the Acquacloro device. 10mL sample of water from the drinking fountains was placed in a cuvette fitted to the device and the reagent for free chlorine (DPD) was added. The reading was taken directly in mg/L and this process was performed for each water outlet from the drinkers.

To determine turbidity, the nephelometric method was used through the turbidity device. The sample of 10 mL of water was placed in the glass cuvette inherent to the device and introduced into it and the result was provided in nephelometric turbidity unit (NTU). 10 mL of each water outlet for each drinking fountain were collected and analyzed.

To determine the fluorine present in the samples, the colorimetric method was used with the SPADNS reagent, through the AcquaFluor device, where it was calibrated with distilled water in the operational range indicated by the program and later used with the transfer of 10 mL of the sample to an appropriate cuvette and 2 ml of SPADNS reagent was added. Then, the properly capped vial was placed in the device, where the result, expressed in mg/L, was verified. This process was performed for each water outlet from each drinker on each collection day.

Color was determined by visual comparison of the sample with distilled water at the first run. In a Spectroquant@ Move 100 device, 10 mL of each sample was inserted from the water outlets of the drinkers and the results were expressed in color units.

2.4. Microbiological analysis

2.4.1. Total coliform and thermotolerant coliform

In this step, the methodology of the American Public Health Association (Salfinger and Tortorello, 2001) was followed, through the methodology of multiple tubes for three tubes, as described below. First, the samples were submitted to serial dilution, obtaining 1:10 and 1:100 dilutions, then 10 ml of the undiluted sample were transferred to tubes containing 10 ml of Lactose Lauryl Broth (double concentration), in triplicate. For the 1:10 and

1:100 dilutions, 1 ml was transferred to tubes containing 10 ml of Lactose Lauryl Broth (CLL) (single concentration), in triplicate. Thus, totaling 9 tubes for each sample and its subsamples. Tubes with CLL contained inverted Duhran tubes and were incubated at 35 ± 1°C for 24 to 48 hours. Tubes with bacterial growth (cloudy culture medium) and gas formation inside the Duhran tubes were considered positive.

From the positive tubes in CLL, a loop was transferred to tubes containing 10 ml of Caldo Verde Brilhante (2% bile) (CVB), this being the confirmatory test for total number of coliforms. Tubes with BVC contained inverted Duhran tubes and were incubated at 35 ± 1°C for 24 to 48 hours. Tubes with bacterial growth (cloudy culture medium) and gas formation inside the Duhran tubes were considered positive for confirmation of total number of coliforms.

To search for thermotolerant (fecal) coliform, from positive tubes in CVB, a handle was transferred to tubes containing Escherichia coli Broth (ECC), they were incubated at 45.5°C for up to 48 hours and the tubes with bacterial growth (cloudy culture medium) and gas formation inside the Duhran tubes were considered positive for thermotolerant coliform.

To quantify total and thermotolerant coliform, the Most Probable Number (MPN) technique was performed, using the multiple tube technique in a series of three tubes, with the results obtained through the MPN table for three tubes. The results obtained were compared to the standard recommended by Ordinance no. 2914/2011 of the Ministry of Health, which provides for the procedures for controlling and monitoring the quality of water for human consumption and its potability standard (Brasil, 2011).

2.4.2. Quantification of heterotrophic bacteria

For the quantification of heterotrophic bacteria, 0.1 mL of each subsample was added to 0.1 mL of each subsample in Petri dishes containing the Nutrient Agar culture medium, with the help of an automatic pipette and sterilized tips and spread over the entire surface of the plate with a Drigalski handle, this procedure being carried out in triplicate and the entire assembly of the plates carried out inside the safety cabin. Counting three plates per subsample and totaling 45 plates at the end of this procedure. Petri dishes were incubated in an oven at 35ºC for 24 hours. After this period, the quantification of total bacteria was performed by counting Colony Forming Units (CFU). The final values were obtained through the arithmetic mean of the triplicates, where the results in CFU/0.1 mL were multiplied by 10 since the values in the resolution are expressed in CFU/mL.

2.5. Parasitological analysis

Three methods of identification of parasites were chosen, based on the characteristics of the biological cycles and with the greatest potential for pathogenicity, making it necessary to search for larvae, cysts, eggs and trophozoites of protozoa and helminths. The first to be carried out was the method of Hoffman, Pons and Lutz adapted to the research, based on spontaneous sedimentation in water, allowing to find protozoan cysts, as well as helminth eggs and larvae (Ferreira, 2012; Hoffman, 1987).

With sterile gauze 100 mL of water was filtered into Falcon tubes, then left to rest for 24 hours. The supernatant was removed and the sediment was analyzed, depositing it on a slide for microscopy and adding Lugol for observation under a microscope in 10x and 40x objectives. The analysis was performed in triplicate by biomedical morphologists.

The second method performed was the MIFC or BLAGG, where 2 mL of the filtrate was removed from Falcon tubes carried out using the adapted Hoffman, Pons and Lutz method. In this method, the resulting liquid was deposited in 10 mL Falcons tubes, where it should rest for 2 to 24 hours, then add 4-5 mL of sulfuric ether to the 2 mL, and centrifuge it for one minute with a rotation from 1500 to 1600 RPM. Finally, the supernatant was discarded and the sediment is extracted from the bottom of the tube, using a Pasteur pipette, onto a slide with a drop of Lugol, for observation under a microscope with 10x and 40x objectives, a method also performed in triplicate by morphologists (Abreu et al., 2010).

The last technique used for this work was the Faust method (centrifugal-flotation with zinc sulfate), chosen for the detection of light structures, which can also be used for the detection of heavy eggs, which suggests that it is a technique with good diagnostic sensitivity (Katagiri and Oliveira-Sequeira, 2010).

An adaptation was also necessary for this technique, given that it was working with water samples, so the samples were filtered in a sterile beaker, and the final filtrate was transferred to three 10 mL Wasserman tubes. Then, the samples were centrifuged for five minutes at 2500 rpm, and at the end, the supernatant was discarded in order to reduce dirtiness and 10 mL of distilled water was added. Only a second centrifugation was performed, the supernatant was discarded and then a 33% zinc sulfate solution with a density of 1.18 g/mL was added and centrifuged for one minute at 2500 rpm. This technique required rapid reading, in triplicate and performed by a biomedical morphologist.

Modified Ziehl Neelsen stain was used to detect *Cryptosporidium* sp. and *Cystoisospora belli*. Smears were made on frosted-tipped slides using 10 µl of the concentrated material and dried at room temperature. Subsequently, the slides were stained with phenylated fuchsin for 20 min without heating. Then, they were washed for 1 min and decolorized with 2% sulfuric acid solution and washed again in running water for 1 min. The slides were then stained with 2.5% malachite green counterstaining solution for 10 min. Washed again in running water for 1 min, the slides were examined by two microscopists using light immersion microscopes and 100x magnification objectives.

2.6. Statistical analysis

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

3. Results and Discussion

3.1. Physicochemical analyzes

Regarding the physical-chemical parameters residual chlorine, pH, turbidity, fluorine and color, fluoridation and residual chlorine, an average of the values found was performed and gathered in the Table 1.

Regarding the apparent color analysis of all the samples studied, the results were lower than 0.9 uH. For legislation (Brasil, 2011) the maximum allowed value of apparent color is 15 uH. Thus, it is concluded that 100% of the samples are within the maximum value established for color. It can be observed that for the residual chlorine parameter, the values found in practically all samples are between 0.10 and 1.5 mg/L. It is known that it is of fundamental importance that drinking water has at least 0.2 mg/L of free residual chlorine to guarantee its potability (Brasil, 2011). Sample C5 was the only one that was outside the values established by current legislation (0.1 mg/L).

According to Table 1, the water pH of some samples was slightly acidic, as it varied between 4.3 and 7.0, that is, these samples were not potable, which is different from the results of the studies by Mousinho et al. (2014) and Naime et al. (2009), when stating that pH values below six are considered acidic pH, and values above 9.5 are alkaline, and do not meet the current legislation on water potability. The pH parameter is very important because it indicates the acidity or basicity of the solutions. Under low pH conditions, water tends to be corrosive, as the acidity attacks metals. Waters with high pH are basic, often causing incrustations in the materials that come into contact with it (Sperling, 2005).

According to the legislation of water for human consumption, it is known that the maximum allowed value (MAV) for turbidity is 5 uT, it is observed that only two samples presented values above the allowed limits established for turbidity (samples C35 - 7 .4 uT and C38 - 6.6 uT). The turbidity of natural origin does not trigger any health risk other than an unpleasant appearance. However, these solids can be used by pathogenic microorganisms as shelter, hindering the efficiency of disinfection. If the turbidity is coming from an anthropogenic origin, it may be relatively associated with toxic compounds and pathogenic organisms. Among the analyzed samples, all obtained satisfactory results for the physical-chemical aspects (Morena et al., 2017).

Of the 56 samples analyzed for fluoridation, it was found that none of the samples presented values above the acceptable level (1.5 mg/L), in accordance with current legislation. Fluoridation of public water supply (FAAP) is considered the most effective collective method of preventing dental caries, with the best cost-benefit ratio, as it is able to reach all segments of the population, regardless of age and socioeconomic or cultural level (Santos et al., 2012). Among the chemical agents analyzed (Table 1) that are present in water are the main ones; chlorine that serves to eliminate bacteria and other microorganisms; fluoride for dental caries prevention; turbidity that determine when the presence of solid material and the pH that reveals the stability of the water being it acidic or basic.

The Ministry of Health allows the use of fluoride to prevent cavities. According to Lima and Cury (2001) there has been a very expressive decline in the fight against caries in developed countries. Fluoride is administered into the water immediately after treatment and distributed to the population through water distribution systems.

3.2. Microbiological analyzes

Ordinance No. 2,914, of the Ministry of Health, of December 12, 2011 (Brasil, 2011), declares that if there is presence of total coliforms and/or E. coli, the water is already considered unfit for consumption, thus having to pass by prior treatment. The presence of total coliforms may be related to contamination by sewage networks where waste is often released in places close to the water catchment and also by the lack of sewage networks in many places, which is considered one of the main reasons for soil contamination (Morena et al., 2017).

Among the most encountered pathogenic bacteria that are transmitted by water are *Salmonella* spp., *Shigela* spp., *Escherichia coli*, *Campylobacter* spp. (Santos et al., 2015). *E. coli* is a bacterium that inhabits the intestines of humans and animals, being the best indicator of fecal contamination, as it is a bacterium that is easy to isolate and identify in water. Regarding the analysis of thermotolerant coliforms, all samples showed absence of these pathogens (Table 2).

For total coliforms, 17.85% of the samples (10) showed the presence of these microorganisms, with values ranging from 21 MPN/mL to 42 MPN/mL. The coliform group is formed by gram-negative, aerobic, non-sporogenic bacilli, and they are part of the microbiota of the gastrointestinal tract of human beings, the presence of these microorganisms in the water determines its quality. Under normal conditions, coliforms are not considered pathogenic, but in high values they can cause diarrhea and even urinary infections (Jawetz et al., 2000; Silva and Junqueira, 2001).

Although the number of positive samples was low for total number of coliforms, it is worth mentioning that measures should be taken to further reduce this number. Some measures, such as periodic cleaning of reservoirs and proper maintenance of faucets, can be taken, as the lack of maintenance can interfere with the quality of the water that comes from the treatment plant (Morena et al., 2017).

Corroborating the results observed in this research, Ferreira-Júnior et al. (2015), when analyzing water samples from 12 preschools in the municipality of Rio Largo, observed that all samples showed absence of *E. coli* (fecal/thermotolerant coliforms), however, the percentage verified for total coliforms (58.33%), was higher than those found in this work. Total coliforms are bacteria that are not necessarily present in feces and therefore the presence of these microorganisms indicate contamination by other sources such as soil. The presence of thermotolerant coliforms in water indicates possible contamination by feces and, therefore, indicates the presence of pathogenic microorganisms, which, because they are rarer and more fragile to environmental conditions, require a more complex analysis to be evidenced (Silva and Araújo, 2003).

Table 1. Result of the analysis of free residual chlorine. Turbidity. Fluoridation. Color and pH of water for human consumption in a quilombola community in Alagoas, from January to December 2019.

Sample	Free Residual Chlorine (mg/L)	Turbidity (uT)	Fluoridation (mg/L)	Color (uH)	pH
C1	0.3	0.8	1.5	0.1	6.9
C2	0.3	0.2	1.5	0.3	7.0
C3	0.3	0.7	1.3	0.4	6.6
C4	0.3	0.5	1.4	0.6	6.6
C5	0.1	0.2	1.3	0.8	4.4
C6	1.5	0.7	1.2	0.7	4.4
C7	0.3	0.7	1.1	0.3	4.7
C8	1.0	0.4	1.5	0.2	6.1
C9	1.5	0.8	1.5	0.2	4.3
C10	1.0	0.7	1.3	0.1	6.1
C11	0.3	0.7	1.4	0.1	6.3
C12	1.0	0.4	1.3	0.3	6.5
C13	1.0	0.2	1.2	0.4	4.7
C14	0.3	0.7	1.1	0.6	4.4
C15	1.0	0.4	1.3	0.8	4.4
C16	1.0	0.8	1.2	0.7	4.7
C17	1.0	0.1	1.1	0.3	6.1
C18	1.0	0.5	1.5	0.2	4.3
C19	1.0	0.2	1.5	0.2	6.1
C20	1.0	0.7	1.3	0.1	6.3
C21	1.0	0.7	1.4	0.1	4.4
C22	1.5	0.4	1.3	0.3	4.4
C23	1.5	0.8	1.2	0.4	4.7
C24	1.0	0.1	1.1	0.1	6.1
C25	1.5	0.5	1.3	0.3	4.3
C26	1.0	0.2	1.4	0.4	6.1
C27	1.5	0.7	1.3	0.6	6.3
C28	1.0	0.7	1.2	0.8	4.4
C29	1.0	0.4	1.1	0.7	4.4
C30	1.0	0.8	1.4	0.3	4.7
C31	1.0	0.1	1.3	0.2	6.1
C32	1.0	0.5	1.2	0.2	4.3
C33	1.0	0.2	1.1	0.1	6.1
C34	1.5	0.7	1.5	0.1	6.3
C35	1.0	7.4	1.5	0.3	6.4
C36	1.0	0.2	1.3	0.4	6.7
C37	1.0	0.4	1.4	0.6	5.8
C38	1.0	6.6	1.3	0.8	6.4
C39	1.0	0.9	1.2	0.7	4.4
C40	0.5	0.4	1.1	0.3	4.4
C41	0.3	0.6	1.3	0.2	4.7
C42	0.3	0.5	1.2	0.2	6.1
C43	0.5	0.2	1.1	0.1	4.3
C44	1.0	0.9	1.4	0.4	5.2
C45	1.0	0.4	1.3	0.7	5.0
C46	1.0	0.6	1.2	0.6	5.1
C47	1.0	0.5	1.1	0.9	5.1
C48	0.3	0.2	1.5	0.0	4.4
C49	0.8	0.2	1.5	0.0	4.4
C50	0.3	0.9	1.3	0.0	4.7
C51	0.3	0.4	1.4	0.0	6.1

*Ordinance No. 2914/2011 of the Ministry of Health, which provides for the procedures for controlling and monitoring the quality of water for human consumption and its potability standard (Brasil, 2011).

Table 1. Continued...

Sample	Free Residual Chlorine (mg/L)	Turbidity (uT)	Fluoridation (mg/L)	Color (uH)	pH
C52	0.3	0.6	1.3	0.0	4.3
C53	0.8	0.5	1.2	0.0	6.1
C54	0.8	0.2	1.1	0.0	4.4
C55	0.3	0.9	1.3	0.0	4.7
C56	0.3	0.4	1.2	0.0	6.1
Limits*	**Min 0.2 mg/L Max 2 mg/L.**	**Max 5 uT**	**1.5 mg/L**	**<0.9 uH**	**6.0 - 9.5**

*Ordinance No. 2914/2011 of the Ministry of Health, which provides for the procedures for controlling and monitoring the quality of water for human consumption and its potability standard (Brasil, 2011).

Table 2. Result of microbiological analysis of water for human consumption in a quilombola community in Alagoas, from January to December 2019.

(Sample)	Total number of coliform	*E. coli*	Heterotrophic bacterium
C1	21 MPN/mL	Absent	Absent
C2	Absent	Absent	Absent
C3	Absent	Absent	Absent
C4	Absent	Absent	Absent
C5	Absent	Absent	Absent
C6	29 MPN/mL	Absent	Absent
C7	23 MPN/mL	Absent	Absent
C8	Absent	Absent	Absent
C9	Absent	Absent	Absent
C10	Absent	Absent	100
C11	Absent	Absent	Absent
C12	Absent	Absent	Absent
C13	Absent	Absent	Absent
C14	Absent	Absent	Absent
C15	Absent	Absent	109
C16	27 MPN/mL	Absent	Absent
C17	Absent	Absent	Absent
C18	Absent	Absent	Absent
C19	Absent	Absent	Absent
C20	Absent	Absent	Absent
C21	22 MPN/mL	Absent	Absent
C22	Absent	Absent	Absent
C23	Absent	Absent	132
C24	Absent	Absent	Absent
C25	Absent	Absent	Absent
C26	Absent	Absent	Absent
C27	35 MPN/mL	Absent	Absent
C28	Absent	Absent	Absent
C29	Absent	Absent	Absent
C30	Absent	Absent	Absent

*Ordinance No. 2914/2011 of the Ministry of Health, which provides for the procedures for controlling and monitoring the quality of water for human consumption and its potability standard (Brasil, 2011). MPN = MOST PROBABLE NUMBER

Table 2. Continued...

(Sample)	Total number of coliform	*E. coli*	Heterotrophic bacterium
C31	Absent	Absent	Absent
C32	Absent	Absent	Absent
C33	26 MPN/mL	Absent	Absent
C34	Absent	Absent	128
C35	Absent	Absent	Absent
C36	Absent	Absent	Absent
C37	Absent	Absent	Absent
C38	Absent	Absent	Absent
C39	Absent	Absent	Absent
C40	42 MPN/mL	Absent	90
C41	Absent	Absent	Absent
C42	Absent	Absent	Absent
C43	Absent	Absent	Absent
C44	Absent	Absent	Absent
C45	Absent	Absent	Absent
C46	Absent	Absent	Absent
C47	Absent	Absent	Absent
C48	Absent	Absent	Absent
C49	Absent	Absent	Absent
C50	40 MPN/mL	Absent	82
C51	Absent	Absent	Absent
C52	Absent	Absent	Absent
C53	Absent	Absent	Absent
C54	Absent	Absent	Absent
C55	Absent	Absent	Absent
C56	23 MPN/mL	Absent	116
Stablished limits*	**Absent in 100 mL**	**Absent in 100 mL**	**<500 UFC/mL**

*Ordinance No. 2914/2011 of the Ministry of Health, which provides for the procedures for controlling and monitoring the quality of water for human consumption and its potability standard (Brasil, 2011). MPN = MOST PROBABLE NUMBER

The main objective of disinfection processes is the destruction or inactivation of pathogenic, disease-causing organisms or other undesirable organisms. Sodium hypochlorite has antimicrobial activity due to the action of hydroxyl ions (increase in water pH) on essential bacterial enzymatic sites, which interfere with the integrity of the cytoplasmic membrane, promoting irreversible inactivation. Thus, configuring biosynthetic alterations in the cellular metabolism of the microorganism (Estrela et al., 2002). Regarding the search for heterotrophic bacteria, none of the samples exceeded the required standard value, 500 CFU/mL (Brasil, 2011), since the quantification ranged from absent to 132 CFU/mL

3.3. *Parasitological analyzes*

By carrying out the parasitological analysis, was not detected, by the parasitological method evaluated, infective forms of the parasitic species, with no cysts and/or oocysts of protozoa and eggs of helminths. Infections by intestinal pathogens are one of the basic public health problems in tropical regions, and, in addition, they have been reported to be responsible for childhood diarrhea (Aslani et al., 2011).

According to Belo et al. (2012), one of the indicators of socioeconomic conditions is the prevalence of intestinal parasites, which may be linked to other factors such as: inadequate sanitary facilities, fecal contamination of water and ingested food, living with animals, hygienic conditions, basic sanitation, biological cycles, and the type of infecting parasite.

Using the Ziehl Neelsen technique, of the 56 water samples analyzed, none of them were positive for the research of coccidia, that is, low efficiency in the recovery of cysts, oocysts and/or eggs, which may be related to environmental influences and the physical-chemical factors, such as water pH, turbidity, among others, thus justifying the low positivity in the results of this study in relation to the parasitological methods used. According to Fricker and Crabb (1998), other factors may also have influenced, such as the concentration of *Cryptosporidium* sp. oocysts, which is based almost exclusively on particle size. The parasitological techniques used are not specific and, consequently, concentrate a large amount of foreign materials that may be present in the water, among them, organic and inorganic particles, bacteria, yeasts and algae, interfering in the detection of these microorganisms.

Differently from the results of this work, in a study carried out in the city of Goiânia-GO, of 72 samples collected, two were positive for Cryptosporidium sp using the Ziehl Nelseen technique (Santos, 2009). The monitoring of water quality must be continuous and with more comprehensive studies, investigating other important variables to define potability. The public authority must intervene in the place, providing at least water filtration and disinfection equipment, in addition to a continuous monitoring program.

4. Conclusion

The present study brings unprecedented results regarding the water quality of the quilombola population of Santa Luzia do Norte-AL. Although this community receives piped water, it was important to carry out this research to compare the parameters established by the current legislation. Regarding the variables evaluated, water for human consumption was characterized as “non-potable”, with physical-chemical parameters outside the limits required by the Ministry of Health and the presence of coliform was detected in some of the analyzed samples, characterizing this community at risk related to waterborne diseases. Infecting forms of parasitic species were not found in the analyzed samples.

Taking into consideration all the above, it is essential to suggest the continuous monitoring of water quality, including more comprehensive studies, investigating other important variables, such as the presence of heavy metals and other substances. The public authority must intervene in the place, providing at least water filtration and disinfection equipment, in addition to a continuous monitoring program.

References

ABREU, I.M.O., JUNQUEIRA, A.M.R., PEIXOTO, J.R. and OLIVEIRA, S.A., 2010. Qualidade microbiológica e produtividade de alface sob adubação química e orgânica. *Food Science and Technology*, vol. 30, pp. 108-118. http://dx.doi.org/10.1590/S0101-20612010000500018.

ALAGOAS. Secretaria de Estado do Planejamento, Gestão e Patrimônio, 2015. *Estudo sobre as comunidades Quilombolas de Alagoas*. Maceió: SEPLAG.

AMORIM, M.M., TOMAZI, L., SILVA, R.A.A., GESTINARI, R.S. and FIGUEIREDO, T.B., 2013. Avaliação das condições habitacionais e de saúde da comunidade quilombola Boqueirão, Bahia, Brasil. *Bioscience Journal*, vol. 29, no. 4, pp. 1049-1057.

ARAÚJO, M.A.R., SANTANA, M.C. and AZEVEDO-FILHO, R.D., 2009. *Diagnóstico sócio-sanitário do quilombola Serra do Osso Pesqueira - Pernambuco*. Recife: Centro de Pesquisas Aggeu Magalhães, Fundação Oswaldo Cruz, 49 p. Monografia da Especialização em Gestão de Sistemas e Serviços de Saúde.

ASLANI, M.M., ALIKHANI, M.Y., ZAVARI, A., YOUSEFI, R. and ZAMANI, A.R., 2011. Characterization of enteroaggregative *Escherichia coli* (EAEC) clinical isolates and their antibiotic resistance pattern. *International Journal of Infectious Diseases*, vol. 15, no. 2, pp. E136-E139. http://dx.doi.org/10.1016/j.ijid.2010.10.002. PMid:21130676.

BATISTA, E.C. and ROCHA, K.B., 2019. Sentidos e práticas em saúde mental em comunidades quilombolas no estado de Rondônia. *Psicologia: Ciência e Profissão*, vol. 39, Spe, p. e222123 . http://dx.doi.org/10.1590/1982-3703003222123.

BELO, V.S., OLIVEIRA, R.B., FERNANDES, P.C., NASCIMENTO, B.W.L., FERNANDES, F.V., CASTRO, C.L.F., SANTOS, W.B. and SILVA, E.S., 2012. Fatores associados a ocorrências de parasitoses intestinais em uma população de crianças e adolescentes. *Revista Paulista de Pediatria*, vol. 30, no. 2, pp. 195-201. http://dx.doi.org/10.1590/S0103-05822012000200007.

BEZERRA, V.M., MEDEIROS, D.S., GOMES, K.O., SOUZAS, R., GIATTI, L., STEFFENS, A.P., KOCHERGIN, C.N., SOUZA, C.L., MOURA, C.S., SOARES, D.A., SANTOS, L.R.C.S., CARDOSO, L.G.V., OLIVEIRA, M.V., MARTINS, P.C., NEVES, O.S.C. and GUIMARÃES, M.D.C., 2014. Inquérito de saúde em comunidades quilombolas de Vitória da Conquista, Bahia, Brasil (Projeto COMQUISTA): aspectos metodológicos e análise descritiva. *Ciência & Saúde Coletiva*, vol. 19, no. 6, pp. 1835-1847. http://dx.doi.org/10.1590/1413-81232014196.01992013. PMid:24897483.

BRASIL. Ministério da Saúde, 2011. *Portaria nº 2914, 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*. Diário Oficial da República Federativa do Brasil, Brasília, 14 dez. Seção 1, p. 39.

CARDOSO, C.S., MELO, L.O. and FREITAS, D.A., 2018. Condições de saúde nas comunidades quilombolas. *Revista de Enfermagem UFPE On Line*, vol. 12, no. 4, pp. 1037-1047. http://dx.doi.org/10.5205/1981-8963-v12i4a110258p1037-1045-2018.

ESTRELA, C., ESTRELA, C.R.A., BARBIN, E.L., SPANÓ, J.C.E., MARCHESAN, M.A. and PÉCORA, J.D., 2002. Mechanism of action of sodium hypochlorite. *Brazilian Dental Journal*, vol. 13, no. 2, pp. 113-117. http://dx.doi.org/10.1590/S0103-64402002000200007. PMid:12238801.

FERREIRA, E.P., FERREIRA, J.T.P., PANTALEÃO, F.S., FERREIRA, Y.P., ALBUQUERQUE, K.N. and FERREIRA, T.C., 2014. Abastecimento de água para consumo humano em comunidades quilombolas no município de Santana do Mundaú - AL. *Revista Brasileira de Geografia Física*, vol. 7, no. 6, pp. 1119-1125. http://dx.doi.org/10.5935/1984-2295.20140011.

FERREIRA, M.U., 2012. *Parasitologia contemporânea*. Rio de Janeiro: Guanabara Koogan, 236 p.

FERREIRA-JÚNIOR, G.C., SANTOS JÚNIOR, J.A., SILVA, A.C.Q.R. and SILVA, F.M., 2015. Qualidade microbiológica da água consumida por crianças de pré-escolas do município de Rio Largo – Alagoas. *Revista de Saúde e Biologia*, vol. 10, no. 3, pp. 43-48.

FRICKER, C.R. and CRABB, J.H., 1998. Water-borne cryptosporidiosis: detection methods and treatment options. *Advances in Parasitology*, vol. 40, pp. 241-278. http://dx.doi.org/10.1016/S0065-308X(08)60123-2. PMid:9554076.

HOFFMAN, R.P., 1987. *Diagnóstico de parasitismo veterinário*. Porto Alegre: Sulina, 156 p.

JAWETZ, E., MELNICK, J.A. and ADELBERG, E.A., 2000. *Microbiologia médica*. 21th ed. Rio de Janeiro: Guanabara Koogan, 175 p.

KATAGIRI, S. and OLIVEIRA-SEQUEIRA, T.C.G., 2010. Comparison of three concentration methods for the recovery of canine intestinal parasites from stool samples. *Experimental Parasitology*, vol. 126, no. 2, pp. 214-216. http://dx.doi.org/10.1016/j.exppara.2010.04.027. PMid:20452348.

LIMA, Y.B.O. and CURY, J.A., 2001. Ingestão de flúor por crianças pela água e dentifrício. *Revista de Saúde Pública*, vol. 35, no. 6, pp. 576-581. http://dx.doi.org/10.1590/S0034-89102001000600012. PMid:11799472.

MACÊDO, J.A.B., 2003. *Métodos laboratoriais de análises físico-químicas e microbiológicas*. 2nd ed. Belo Horizonte: Jorge Macedo, 450 p.

MAGALHÃES FILHO, F.J.C. and PAULO, P.L., 2017. Abastecimento de água, esgotamento doméstico e aspectos de saúde em comunidades quilombolas no estado de Mato Grosso do Sul. *Interações*, vol. 18, no. 2, pp. 103-116. http://dx.doi.org/10.20435/inter.v18i2.1435.

MORENA, M.R., MENDES, H.A.S., SANTOS, A.L.V. and SHERER, E.F., 2017. Análises microbiológica, química e parasitológica da água distribuída no município de Torixoréu – MT. *Revista Eletrônica Interdisciplinar*, vol. 19, no. 2, pp. 98-101.

MOUSINHO, D.D., GONÇALVES, L.S., SARAIVA, A. and CARVALHO, R.M., 2014. Avaliação da qualidade físico-química e microbiológica da água de bebedouros de uma creche em Teresina – PI. *Revista Interdisciplinar*, vol. 7, no. 1, pp. 93-100.

NAIME, R.H., CARVALHO, S. and NASCIMENTO, C.A., 2009. Avaliação da qualidade da água utilizada nas agroindústrias familiares do vale dos sinos. *Revista em Agronegócios e Meio Ambiente*, vol. 2, no. 1, pp. 105-119.

SALFINGER, Y. and TORTORELLO, M.L., 2001. *Compendium of methods for the microbiological examination of foods*. 4th ed. Washington: APHA Press.

SANTOS, C.C.M., RODRIGUES, J.C.S., LOPES, M.R.V., POVINELLI, R.F. and TERRERI, A.M., 2012. Avaliação da concentração de flúor nas águas de abastecimento público: estudo retrospectivo e de heterocontrole. *Revista do Instituto Adolfo Lutz*, vol. 71, no. 3, pp. 507-513.

SANTOS, S.F.O., 2009. Estudo dos parasitos oportunistas em águas fluviais de Goiânia-GO. *Revista de Patologia Tropical*, vol. 37, no. 4, pp. 368-370.

SILVA, N. and JUNQUEIRA, V.C.A., 2001. *Manual de métodos de análises microbiológicas de alimentos*. 2nd ed. São Paulo: Varela, 31 p.

SILVA, R.C.A. and ARAÚJO, T.M., 2003. Qualidade da água do manancial subterrâneo em áreas urbanas de Feira de Santana (BA). *Ciência & Saúde Coletiva*, vol. 8, no. 4, pp. 1019-1028. http://dx.doi.org/10.1590/S1413-81232003000400023.

SOUZA FILHO, C.F.M. and PRIOSTE, F., 2017. Quilombos no Brasil e direitos socioambientais na América Latina. *Revista Direito e Práxis*, vol. 8, no. 4, pp. 2903-2926. http://dx.doi.org/10.1590/2179-8966/2017/31219.

SPERLING, M.V., 2005. *Introdução à qualidade das águas e ao tratamento de esgotos. Princípios do tratamento biológico de águas residuárias*. 3rd ed. Belo Horizonte: UFMG/Departamento de Engenharia Sanitária, 452 p.

VIEIRA, A.B.D. and MONTEIRO, P.S., 2013. Comunidade quilombola: análise do problema persistente do acesso à saúde, sob o enfoque da bioética de intervenção. *Saúde em Debate*, vol. 37, no. 99, pp. 610-618. http://dx.doi.org/10.1590/S0103-11042013000400008.