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REVIEW ARTICLE

SURVEY OF THE PHYSICAL-CHEMICAL AND MICROBIOLOGICAL QUALITY OF WATER

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ABSTRACT

Understanding the importance of water for human consumption, and the problems related to the contamination that humans cause in them and ends up harming it, this study aims to analyze the physico-chemical and microbiological parameters of the water of three points of supply in the municipality of Anagé in Lindo Horizonte Bahia, comparing with the norms of quality of the 518 portaria of the ministry of health. Without proper treatment and proper care, water becomes a vehicle for disease-causing microorganisms. For the accomplishment of this work three samples were collected, being of the truck kite that and supplies the town, of the rain collected in an appropriate reservoir and of the local dam. The analysis was made with the following physical-chemical parameters: Electrical conductivity, turbidity, hydrogen ionic potential, electrical resistivity, chlorine content determination, total alkalinity, total hardness and dissolved solids content. For the microbiological analysis, the total and fecal coliforms were tested according to the methodology (SMEWW-SM9223). According to the analyzes carried out, the water from the dam is not suitable for human consumption in accordance with current legislation, due to the high turbidity content and the presence of Escherichia coli. The analyzes of the other supply points are also not in adequate drinking conditions according to the parameters required by the legislation. New analyzes can be carried out to reinforce the results obtained and the population should be made aware of the quality of the water being consumed and the importance of the same for the human being.

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INTRODUCTION

Water is of utmost importance to sustain life, is of adequate use, safe and sensitive being one of the most used substances in nature (Ding *et al.,* 2015). Safe drinking water is one of the most important factors for government and scientific bodies around the world, as water potability is mandatory for health and livelihoods (Lal, 2015). Considering that considerably every living organism depends on a minimum water supplement and considering that all physiological action occurs in aqueous solutions (Jordaan and Bezuidenhout, 2016). The main utilities of water are: household and industrial supplies, irrigation, supply of animal headquarters, preservation of flora and fauna, entertainment and leisure, species creation, electric power generation, navigation, landscape harmony, dilution and transport of (Olorode *et al.,* 2015). According to the Quality Standard of Ordinance MS No. 518/2004, it says that the quality control of water for human consumption is the grouping of actions carried out by the managers in the conduct of the system or the alternative solution of water supply, designated to to verify if the water supplied to the population is potable (Garner *et al.,* 2016; Palamuleniand Akoth, 2015). According to ordinance MSNo. 2,914 / 2011, it is established as potable water for human consumption, whose microbiological, physical, chemical and radioactive parameters meet the drinking standard and do not pose health risks (Funasa *et al.,* 2013). There are factors that affect water quality, and in this municipality there are aspects that can trigger this, because the trucks that transport water do not follow the procedures cited by the ordinance. The dam of the region has no specific treatment, in addition to contain sewers that are drained from nearby houses and feces that may be contaminated from animals that inhabit the area. Moreover, the boxes water that store water from the toe and the kite truck, do not have internal washing of them (Carvalho, 2015). According to (Almeida, 2018), an ideal water for human consumption, its visible part must be in balance and according to its crystalline color visible or free of organic materials. In addition to the physicochemical parameters, in order to require a clean water, the microbiological analysis must be free of

pathogenic bacteria according to Ministry of Health no. 5, Annex XX. The study in question will be carried out in the town of Lindo Horizonte, municipality of Anagé, in the interior of Bahia, with the main purpose of collecting the necessary data to support the physical-chemical and microbiological analysis of 3 specific points, the dam, which supplies the village, and the reservoir of rainwater, where all are used to supply the population, but without adequate treatment. The physical-chemical parameters to be analyzed are: Electrical conductivity, hydrogen ionic potential (pH), electrical resistivity, dissolved solids content, turbidity, alkalinity, chloride content and total hardness. For the microbiological analysis will be carried out the research of total coliforms, fecal and heterotrophic bacteria.

METHODOLOGY

Characteristics of the local: Lindo Horizonte municipality of Anagé is located southwest of the state of Bahia, 47.9 km from Vitoria da Conquista - BA and 495 km from the capital Salvador - BA. Its estimated population is approximately 4,000 inhabitants. The climate is defined as subsumed dry. The agricultural and livestock economy is defined by planting sugar cane, corn and beans; cattle, goats, pigs and poultry.

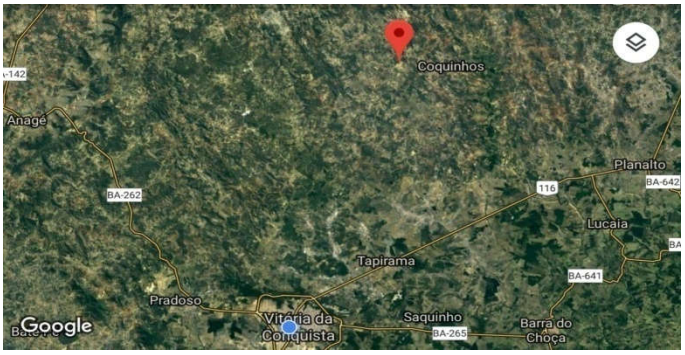

Figure 1. Beautiful Horizon - Anagé - BA, satellite photo

Figure 2. Beautiful Horizon - Anagé - BA, photo captured by a drone

Type of research and collection process: It is understood a cross-sectional and quantitative field research carried out in the city of Lindo Horizonte-Anagé interior of Bahia, Brazil. In this place the water is distributed to the population through three points: In the dam of the region, rainwater by the gutter (trough, toeclose) of the house of residents and water of the (prainha) of Anagé, an area further away from the tourists provided by the kite truck and unloaded in fixed boxes for the whole region, both without adequate treatment. The points chosen were according to the form of water distribution: From the dam of the region, because the pump is not working the water collection was done on the dam itself. Faucet from a water box that is fixed on the ground to the residents of the area and rainwater from a water box belonging to a resident of the region. For the physical-chemical parameters, three bottles were used, one for each collection point, bottles of 1.5 liters of polypropylene (mineral water), sealed, which were only opened on the spot and washed three times with the sample water so that sterile. They were collected on the same day and identified as soon as they were collected, labels were placed stating temperature, time and order of collection. Then sent to the refrigerator (not freeze), the next day 4/22 the samples were placed in styrofoam box and transported 50 km to the city of Vitória da Conquista. For microbiological analysis of total and fecal coliforms three sterile autoclaved flasks were used at 121ºC / 15min sealed that were only opened in the place. The antisepsis of the hands was performed before the collection procedure, the water was drained from the points to be collected for 3 minutes, after draining, it was cleaned from the collection point (tap) with a 70% alcohol-containing spray and then allowed to drain water for 2 minutes, and finally the bottle was opened near the point and the collection was performed respecting the volume limit of the bottle and without bubbles, placed in the styrofoam under refrigeration of 2º to 8ºC and transported to 50 km until the city of Vitória da Conquista.

MATERIALS AND METHODS

For the physical-chemical parameters, the sample pH, electrical conductivity, TDS (oxygen content dissolved in water), turbidity, and electrical resistivity were performed. The equipment used to carry out the tests were the micro processed Conductivity Meter Químis, model Q405M, serial number 09112578; Portable digital oximeter ICEL Manaus, model OD - 400, serial number 04000.0179; Chemical bench thermometer, model Q400AS, serial number 08071347; and portable chemical turbidimeter Químis, model Q279P - 0 - 0, serial number 10014168. The tests of total hardness, chloride content and alkalinity were performed with adequate glassware according to their methodologies. The microbiological method was used the SMEWW-SM9223 method to know whether or not it has the presence of total and fecal coliforms. All the equipment was previously calibrated to minimize the errors of measurement of the parameters. The water samples from the flasks were then transferred in sufficient quantity to the respective beaker and then made the analyzes on the corresponding equipment, always following the instructions formulated according to the manufacturer.

Determination of total hardness

Materials: Erlenmeyer 250 mL; Burette; Graduated or volumetric pipettes; Dropper; Samples of water to be analyzed; black indicator of Ericrome T; Standard solution 0.01M EDTA.

Procedures: Pipette 100 mL of the water to be analyzed and transfer to an Erlenmeyer flask; add 1 ml of buffer solution and 0.1 mg of Erythromycin Black T indicator; Titrate with 0.01 M EDTA solution. The appearance of blue staining in titrated indicates the end point of the reaction; enter the amount in ml spent; repeat the procedure in triplicate; calculate the total water hardness expressed in mg / l CaCO3.

Determination of the chloride content: To determine the Chloride content, Mohr method was used, using titration techniques with silver nitrate solution to determine the amount of chloride ions present in the sample.

Materials: Erlenmeyer of 250ml; burette; Graduated or volumetric pipettes; Dropper; Water samples; Phenolphthalein indicator; Silver nitrate solution (AgNO3) 0.1 mol / L.

Procedure: Pipette 100 ml of the water sample under investigation; add 2 to 3 drops of phenolphthalein; titrate slowly with silver nitrate until the sample shows red-brick coloration. Do the procedure in triplicate; calculate the sample concentration in moles per liter and in milligrams per liter.

Determination total alkalinity

Materials: 50 mL volumetric pipette;flask; *Erlenmeyer* 250 ml 50 mL burette; Phenolphthalein; Methyl Orange indicator; Mixture Indicator of bromine cresol green / methyl red; 0.02 N sulfuric acid solution; 0.1 N sodium thiosulphate solution

Procedure: Take 50 mL of the sample and place in the Erlenmeyer flask; add 3 drops of methyl bromide green / methyl red indicator solution; Titrate with 0.02 N sulfuric acid solution until the change from blue-green to pinkish color; note the total volume of H2 SO4 spent (V) in mL.

RESULTS AND DISCUSSION

The samples of water samples were taken in April, in order to verify if there are significant alterations in the physicochemical parameters analyzed and if it can present health risks to the residents who consume water directly from these three points. water supply (Agboli *et al.,* 2018). What can be observed is that the water used in the kite truck and the toe had normal values, where it establishes that the maximum value of turbidity in potable water is up to 5 UNT (Asare *et al.,* 2018). However, the water of the dam had an exorbitant increase in relation to the standard values, not being able to have comparisons with the other points cited (Karbasdehiand colab, 2018).

The color of water negatively interferes with turbidity measurement because of its ability to absorb light, turbidity (suspended material in water) can trap pathogens to this turbidity by disrupting the activity of the chlorine thereon. If water consumed has pathogens (disease-causing organisms) it can cause harm to the health of the population (Nagy-Kovács *et al.,* 2019). According to the analyzes performed, the values of Ph, Electrical Resistivity, TDS and turbidity are within the parameters required by current legislation. There were no significant variations between the samples (Asghari and Mohammadi *et al.,* 2018; Gurjar and Kaur, 2019). Total hardness, and Alkalinity, a comparison of the 3 samples of the 3 collection points was made and all of them did not have significant changes, ie they did not exceed the standard values determined by the legislation (Elmekawy *et al.,* 2018). Most of the natural water's present alkalinity values in the range of 30 to 500 mg / L of CaCO3 per liter of water (Ling *et al.,* 2018). The samples that were made for the test of Total Dissolved Solids (STD) and chlorine concentration, only one, which was the water of the kite truck had a certain increase of values compared to the other samples, but within the limit established by the legislation (Sotomayor and colab., 2018). This high value in relation to the other samples in the determination of chlorine can be due to the high chlorine content used in the water. In the case of dissolved solids, high concentrations of total dissolved solids may contain organic and inorganic ions (such as carbonate, bicarbonate, chloride, sulfate, nitrate, calcium, magnesium and sodium) (Parron *et al.,* 2011). To be considered a drinking water, the same must have the physical-chemical and microbiological parameters respecting the maximum limit of the portaria, and mainly free of fecal contamination and pathogenic microorganisms (Karbasdehi and colab, 2018). The main representative of this group of bacteria is Escherichia coli, being the main fecal indicator. It can be observed that in the analyzed samples the only one that had presence of fecal contamination was the water of the dam (Pérez-Rodríguez and colab, 2018). This result can be due to the action of animal waste and sewage that are drained to the dam, so it is unfit for human consumption, according to the Ministry of Health, consolidation nº 5, Annex XX. The great risk that the population is in contracting diseases to the

Table 1. Physical-chemical parameters values

Parameter	Samples			Reference values
	Rain	Toe Truck Pipe	Region Dam	
Conductivity Electrical	27.9	39.4	62.4	10.0 - 100.00 µS / cm
pH (pH meter) Temp. ° C	6.6	7.82	6.96	6.0 to 9.5
Resistivity Electrical	35.5k	2.551k	k 16.3	$2x10^1$ - $2x10^3\Omega m$
TDS	14.1	196	30.4	500.00 mg / L
Turbidity	0.39	0.46	699	40.0 FTU

Table 2. Total hardness values, Clconcentration$^-$ and Alkalinity of the samples

Sample	Hardness	Concentration Cl^-	Alkalinity
Rain Toe	30 Mg / L	0 G / L	15 Mg / L
Truck Pipe	48 Mg / L	70.97 G / L	94 Mg / L
Region Dam	57.2 Mg / L	5.49 G / L	44 Mg / L

Reference values: Total hardness - <60 mg / L = soft; 60 to 120 mg / L = moderately hard; > 180 mg / L = very hard. Concentration Cl^- => 250 mg / L; Alkalinity = 30 to 500mg / L

Table 3.

	Result		
	Coliforms Total	Escherichia Coli	VR
Water of the Toe	Presence	Absence	Absence in 100 Ml
Water of the kite truck	Presence	Absence	Absence in 100 Ml
Water of the Dam	Presence	Presence	Absence in 100 Ml

consumption with this water of the dam, in spite of being verified that they do not consume the water of the dam, however we cannot have this confirmation before the poorer classes that sometimes cannot have a box water at home to receive water from the truck kite or rain. The risk may be of diarrhea, nausea, and if used in the bath can trigger itching in the body, in addition, children have lower immunities being more susceptible to contracting diseases and may lead to pathogenicity and even death more easily than in adults (Mousinho *et al.,* 2014). In relation to the water of the rain-cap and the truck kite had the result with presence for total coliforms and absence for fecal coliforms. Total coliforms is a group of gram-negative, aerobic or facultative anaerobic, non-spore-forming and oxidase-negative bacilli bacteria (Medićand colab, 2018). These bacteria are said to be microbiological indicators of water quality, as they are eliminated every day by warm-blooded animals in reasonable quantities in the environment (Bortoli, 2016). In addition, it can be associated with the amount of sewage that can be in the place and be drained to the source, or have a relation with failure to treat the boxes available for storage of this water (Tortora *et al.,* 2012). Therefore, the water coming from the kite truck and the towing truck is not suitable for human consumption, according to Ministry of Health Attachment No. 5 of Annex XX.

Conclusion

With high turbidity values and presence of Escherichia coli in the water of the dam, it is a great risk to the health of the population if it is consumed because the turbidity is the presence of materials in suspension and these compounds in suspension besides difficult the action of direct contact with disinfectants serve as protection for Escherichia coli and other pathogenic bacteria. In relation to the water coming from the truck kite and rain toe, they had absence of Escherichia Coli, nevertheless had presence of total coliforms that according to the legislation are considered waters unfit for human consumption. The result of the research reinforces still more the action of the rulers in taking action with the condition of the water in order not to avoid greater damages to the population. It should be emphasized that although the region is an area with many inhabitants, but rural areas are precarious, lacking basic sanitation, some streets without pavement, absence of correct disposal of sewage, lack of treatment of boxes that are stored in water, therefore these factors may have influenced the results of the research. Further studies are also needed to have a more adequate proof of the region's water quality.

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