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Microbiological analysis of water for human consumption of the population of the Pachapiriana population center, chontalí district, jaén province – 2019

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ABSTRACT
The present research work called "Microbiological analysis of water for human consumption of the population of the Pachapiriana Populated Center, District of Chontalí, Province of Jaén - 2019" whose objective was to determine the level of microbiological contamination of the water for human consumption in the Populated Center Pachapiriana, District of Chontalí, Province of Jaén - 2019, of 120 homes, 40 homes and 4 water supply wells were considered for the study. In the investigation we worked with the Most Probable Number Technique in which we obtained results that the samples have to be < 1.8/100 ml; while the results obtained are > 6.8/100 ml high for total coliforms, for fecal coliforms it resulted in > 4/100 ml and for E. Coli; If three samples were obtained (9 – 18 and 31) with the indicated value of DS Nº 031-2010, which is < 1.8/100 ml, the remaining 37 samples have the presence of E. coli because the result is > 2/ 100ml It is concluded that, based on the presumptive, confirmatory and complete tests carried out, it was determined that the water supplied to CP Pachapiriana does not meet the microbiological conditions to be considered fit for human consumption because all the samples have an MPN significant number of fecal, total coliforms and E. coli which indicates that the water is contaminated with fecal matter.

Keywords: Water pollution, fecal coliforms, total coliforms, harmless

1 INTRODUCTION

The World Health Organization (WHO), in its 2004 guidelines for the quality of drinking water, points out that the most common and widespread risk that drinking water carries with it are infectious diseases caused by bacteria, viruses, protozoa and helminths. .(1)

Globally, about 1.8 million people die each year from diarrheal diseases (including cholera); 90% of these people are children under the age of five, mainly from developing countries. In addition, it has been estimated that 88% of diarrheal diseases are caused by unsafe water supply, sanitation and poor hygiene.(2)

In 2013 in Peru, (3)Domínguez et al (3) identified more than 20 diseases in which water is a direct or indirect vehicle for contagion, some of which have a high impact in terms of morbidity and mortality, due to contamination with sewage and human or animal excreta; indicating at the same time that the population that lives in human settlements does not have adequate sanitary conditions, nor access to quality water and is calculated at 40.6%.

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Gutiérrez Feliciano (4), indicated that in Puno the population still consumes water contaminated with fecal matter; and it is that there are only about 49 thousand 900 home connections in the drinking water system, according to the Drinking Water and Sewerage Service Provider Company (SEDA-Juliaca). In other words, around 50% of the population does not have this vital service, which is why they consume contaminated water from wells.

The procedure by which water is inspected is microbiological analysis, which determines whether or not it has pathogens and, if positive, its load (quantity) and degree of pathogenicity. Microbiological analyzes are usually based on the cultivation and counting of microorganisms. (5)

The management of the quality of water for human consumption guarantees its innocuousness and is governed specifically by the following guidelines; prevention of diseases transmitted through the consumption of water of doubtful or poor quality. Development of promotion, education and training actions to ensure that the supply, monitoring and control of the quality of water for consumption are efficient, effective and (6).

The control of the sanitary quality of environmental resources can be carried out through the enumeration of bacteria that indicate fecal contamination. These bacteria can be used to assess the quality of food, sediments and water intended for human consumption, agriculture, industry and recreation, since there is no universal indicator, so the most appropriate for the situation must be selected. study specific. The most widely used faecal contamination indicators are total and thermotolerant coliforms, Escherichia coli and enterococci.(7)

Total coliforms are Gram-negative rod-shaped bacteria that ferment lactose at a temperature of 35 to 37 oC, producing acid and gas (CO_2) in 24 hours, aerobes or facultative anaerobes, are oxidase negative, do not form spores and have enzymatic activity of the B-galactosidase. Among them are the different Escherichia coli, Citrobacter, Enterobacter and Klebsiella.(8)

Klebsiella aerogenes are Gram-negative bacteria, facultative anaerobes, of the Enterobacteria family, many are pathogenic and cause opportunistic infections in compromised hosts, generally hospitalized, causing urinary tract and respiratory tract infection. (9)It is found in the human digestive tract, but also freely in soil and water; their colonies are large and mucous, some strains form a capsule, they can use glucose and lactose as a carbon source, they do not form hydrogen sulfate. (10)

Thermotolerant coliforms, withstand temperatures up to 45 oC, comprise a very small group of microorganisms which are quality indicators, since they are of fecal origin. They are mostly represented by the microorganism E.coli but, among others less frequent, Citrobacter freundii and Klebsiella pneumoniae can be found. The latter are part of the thermotolerant coliforms, but their origin is normally associated with surveillance and they only occasionally appear in the intestine (11).

E. coli is the only species within the Enterobacteriaceae that presents the enzyme B - DGlucoronidase , which degrades the substrate 4-methylumberiferyl-β-D-glucuronic acid (MUG),

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forming 4-methylumbelliferone, this product has the priority of emitting blue fluorescence /green when illuminated with ultraviolet light. (12)

There are pathogenic indicators of fecal-oral transmission which may be present in raw water (natural water that has not been subjected to treatment processes for its purification), including bacteria such as *Salmonella* spp. *, Shigella* spp., total and fecal coliforms, which have been found in water supplies (13).

The regulation of the quality of human consumption (DS N° 031-2010-SA), through its 10 titles, 81 articles, 12 complementary, transit and final provisions and 5 annexes; It not only establishes maximum permissible limits, in terms of microbiological, parasitological, organoleptic, chemical, organic and inorganic parameters and radioactive parameters, it assigns new and greater responsibilities to the Regional Governments, regarding the surveillance of the quality of water for human consumption. ; in addition to strengthening the DIGESA, in its position as a health authority regarding these issues. This regulation establishes general provisions in relation to the management of the quality of water for human consumption, in order to guarantee its safety, prevent health risk factors, as well as protect and promote the health and well-being of the population; Likewise, they indicate the microbiological parameters and other organisms(14)

As National background, Sotomayor Cobos was studied (15); In his research carried out in Ecuador, where he obtained 38 monthly samples for 4 months, the results obtained total coliforms were 1800 NMP/100ml, the maximum permissible being <2 NMP/100ml. In E. coli, 700 MPN/100ml was found, the maximum permissible being <1 MPN/100ml. Yeast and mold count. As we do not have an established standard for yeasts, we cannot determine if the microorganism count meets quality standards. In conclusion, it is said that some samples with high concentrations show the need to take some measures from different areas.

Chong Rengifo (16), in his research carried out in Peru in 12 samples (6 samples from artisanal wells and 6 from reservoirs), as results, heterotrophic bacteria were obtained, the maximum value found was 1300 CFU/ml. In total coliforms, 1.6x105 NMP/100ml was found. thermotolerant coliforms 5.4x104 NMP/100ml; announcing that the well water and the waters of the distribution network of the La Libertad Minor Population Center are contaminated with fecal coliforms.

Chambi Choque (17), in his study of the Water for Human Consumption of the Populated Center of Trapiche- Ananea - Puno, considered 54 samples of water distributed in 10 pools, 20 ditches and 24 artisanal wells, obtaining numbers of contaminated and non-contaminated supply sources; the same ones that were analyzed through the chi-square statistical test, and the NMP of coliforms and *Escherichia coli* , obtaining higher contamination results in the pools 70%, wells 54% and ditches 40%; being the most likely number of Escherichia coli higher in wells 11.46 ± 3.36 compared to ditches and pools that had 7.75 ± 2.43 and 6.28 ± 2.21 MPN of *Escherichia coli* , respectively (P≤0.05); determining that the three water supply sources are NOT SUITABLE for human consumption.

According to everything mentioned above, it is necessary to carry out a study that will indicate the microbiological quality of the water in the catchment wells and the homes of the residents of the Pachapiriana Populated Center, Chontali District, because there is the possibility that is contaminated with coliform bacteria, due to the state of its wells and the color of the water that reaches the houses, establishing the following problem to investigate: What is the level of microbiological contamination of the water for human consumption in the Populated Center Pachapiriana – 2019?

The main beneficiaries of this research will be for the workers of the water plant and the consuming population, since it will help to determine the presence of coliform bacteria, which is the main objective. However, as noted above, wastewater quality guidelines and reuse standards are often expressed in terms of the maximum allowable number of total coliform bacteria. Since there is no doubt about the faecal origin of the wastewater, it is assumed that these microorganisms can be used as indicators of pathogenicity and that there is at least a semi-quantitative relationship between the concentrations of pathogenic and indicator microorganisms.

2 MATERIALS AND METHODS

2.1 KIND OF INVESTIGATION

The present study is descriptive, because it fundamentally characterizes specific phenomena or situations indicating their most peculiar or differentiating features.

2.2 POPULATION

The study population is made up of 100 homes that consume piped water that use it for different purposes, the homes that served for study belong to the Pachapiriana Populated Center, and is located in the District of Chontalí.

2.3 SAMPLE

The study of the samples was carried out in a systematic random manner where 1 out of every 2 samples arrived at the laboratory was chosen.

3 METHODS, TECHNIQUES, INSTRUMENTS AND PROCEDURES FOR DATA COLLECTION.

According to the "Protocol of procedures for the taking of samples, preservation, conservation, transport, storage and reception of water for human consumption" - RD September 24, 2015 - MINSA.(21)

Sampling procedure

Location and sampling points

The location and number of samples to be taken must be programmed.

fixed points

- in the uptake
- At the outlet of the water treatment
- At the exit of the storage infrastructure

Points of collective interest

- In sectorized distribution networks

Sampling

- The sampling was carried out by personnel authorized for the activity, in order to ensure that the samples are representative of the water.
- The sampling point must be identified.
- Take into account: that when taking samples from the faucets, it must be taken into account that there is no leak from the seals and gaskets of the pipe, remove any device foreign to the faucet, then we proceed to disinfect the faucet internally and externally prior to the sampling with cotton or hyposo with alcohol at 70% after opening the faucet and letting it flow for 2 minutes before taking the sample; and to take the sample in the wells, a nylon sampling cord must be secured by means of the fastener located at one end and submerged 30 cm, taking care that it does not rub against the walls of the structure and withdraw.

Labeling and identification of water samples

The bottles must be identified before taking the sample with a label, written in clear and legible handwriting, preferably using indelible ink, without erasures or amendments, which must be protected with transparent adhesive tape containing the following information precisely:

- Field identification code
- Town, district, province, region
- Sampling point
- Matrix
- Sampling date and time
- sampler

Storage and shipment of samples

- The samples that we collected were kept in thermal boxes (coolers) at temperatures of 4 ºC (but not frozen).

- The glass containers were carefully packed to avoid breakage, spills and contamination; we move in thermal boxes, isolated from the influence of light solar and with availability of space for the placement of the cooling material.

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Data Collection Techniques

1. Surveys were conducted to verify their opinion about the water provided for their consumption.

2. Field stage: In this stage of the investigation, 44 water samples were collected in sterile glass containers with a lid of 250 ml capacity, a volume of 150 ml according to the selected sampling points, using for a better identification of the samples taken the data record sheet. It will be transported in refrigerated conditions to be analyzed later.

3. Laboratory stage: In this stage of the investigation, the bacteriological analysis of the water samples was carried out through the Most Probable Number (NMP) method, the analysis will be carried out in the laboratory of the Morro Solar Health Center - Jaén; microbiology area.

4 RESULTS

a. The sample of the catchment area is 79/100 ml of contamination by total coliforms, 9.3/100 ml of fecal coliforms, because it is not covered; In addition, it is located in an area where there are plants. The sample from the sedimentation zone found 49/100 ml of contamination by total coliforms, 6.8/100 ml of fecal coliforms, since they do not have adequate cleaning and disinfection. The sample from the reservoir area with 27/100 ml of contamination by total coliforms, 6.8/100 ml of fecal coliforms , since the reservoirs do not have a fixed lid and are exposed to the elements that allow dust, garbage to enter. ; and, the sample taken in the supply well for the houses with 49 /100 ml of total coliform contamination, 9.3 /100 ml of fecal coliforms, this reservoir is at an average height but does not have a lid that covers people do not introduce contaminating material, the samples do not exceed the maximum permissible limits of the Regulation on the quality of water for human consumption.

b.

A= catchment area

B= Settling chamber

C= Filtration chamber

D= Reservoir

Sample of wells	TOTAL COLIFORMS				MOST LIKELY NUMBER	
	Confirmatory Test			MPN	100g	MPN
	10	1	0.1	100ml	Post* 10;1;0.1	100ml
A	5	3	0	79	530	79
B.	5	two	0	49	520	49
C	4	3	0	27	430	27
D	5	two	0	49	520	49

	Sample of wells	FECAL COLIFORMS				MOST LIKELY NUMBER	
A= catchment area		**Confirmatory Test**			**MPN**	**100g**	**MPN**
		10	**1**	**0.1**	**100ml**	**Post* 10;1;0.1**	**100ml**
B= Settling chamber	A	two	two	0	9.3	220	9.3
	B.	two	1	0	6.8	210	6.8
C= Filtration chamber	C	two	1	0	6.8	210	6.8
D= Reservoir	D	two	two	0	9.3	220	9.3

c. Table 2 presents the evaluation of the quality of water according to the processing of data from the surveys carried out on each head of family of the 40 homes, which indicated that the water they consume is not of good quality, determining in the averages of their answers that 100% are located in the "bad" category, this indicates that the water of the Pachapiriana Populated Center is not treated correctly.

Category	Frequency	
	Quantity	**Percentage**
Bad	40	100.00%
Good	0	0.00%
Excellent	0	0.00%
Total	**40**	**100.00%**

d. Table 3 shows that of the 40 samples, 2 have the highest MPN: sample 10, in which 350/100 ml of total coliforms were found, and sample 9, with 220/100 ml of total coliforms, homes are located at a distance of 3 meters from the distribution well. The other samples taken and processed also do not comply with the maximum permissible limits, according to the regulations on the quality of water for human consumption. (Supreme Decree No. 031-2010-SA).

Total coliforms		fecal coliforms	Maximum allowable limit
MPN	**Number of houses**	**Number of houses**	
2 - 12	16	30	< 1.8/ 100 ml
13 - 23	14	10	< 1.8/ 100 ml
24 - 34	7	0	< 1.8/ 100 ml
35 - 45	1	0	< 1.8/ 100 ml
220	1	0	< 1.8/ 100 ml

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350	1	0	< 1.8/ 100 ml

e. Table 4 shows the 40 samples taken from the homes of CP Pachapiriana, where the results were positive for total coliforms, fecal coliforms and *Escherichia coli* , since they exceeded the established limit, which is <1.8/100 ml. MPN this means that they do not comply with the maximum permissible limits, according to the regulation of quality of water for human consumption. (Supreme Decree No. 031-2010-SA)

MPN	Total coliforms Number of houses	fecal coliforms Number of houses	Escherichia coli Number of houses	Maximum allowable limit
< 1.8	0	0	3	< 1.8/ 100 ml
2 – 12	16	30	35	< 1.8/ 100 ml
13 - 23	14	10	2	< 1.8/ 100 ml
24 - 34	7	0	0	< 1.8/ 100 ml
35 - 45	1	0	0	< 1.8/ 100 ml
220	1	0	0	< 1.8/ 100 ml
350	1	0	0	< 1.8/ 100ml

f. Table 5 shows the results of the 4 samples taken from the water supply wells at CP Pachapiriana, where it can be seen that they do not meet the established limit <1.8/100 ml. MPN this means that the samples are positive for total, fecal *and E. coli coliforms* ; not complying with the maximum permissible limits, according to the regulation of quality of water for human consumption. (Supreme Decree No. 031-2010-SA)

Sample of Wells	Total coliforms MPN	fecal coliforms MPN	Escherichia coli MPN	Maximum allowable limit
A	79	9.3	2.0	< 1.8/ 100 ml
B	49	6.8	4.0	< 1.8/ 100 ml
C	27	6.8	4.0	< 1.8/ 100 ml
D	49	9.3	4.0	< 1.8/ 100 ml

5 DISCUSSION

According to the processed samples of the 4 wells, the result indicates that they are contaminated, as shown in table 01, where it can be seen that the contamination catchment area is 79/100 ml of total

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coliforms, 9.3/ 100 ml of fecal coliforms; being a possible contamination factor the abandonment in which it is found, the remains of plants inside, high concentration of green freshwater algae. The sample taken in the sedimentation area, resulted in 49/100 ml of contamination by total coliforms, 6.8/100 ml of fecal coliforms, a possible effect being the lack of adequate cleaning and disinfection. The sample taken in the filtration area yielded the result of 27/100 ml of contamination by total coliforms, 6.8/100 ml of fecal coliforms , being a possible source of infection that the well is exposed to the elements of dust, trash, and other debris; and, the sample taken in the reservoir, resulted in 49 /100 ml of total coliform contamination, 9.3 /100 ml of fecal coliform, being a possible factor that the well does not have coverage that protects it from contaminating effects, for which it resulted that the 04 samples taken in the water supply wells of the Pachapiriana Populated Center do not exceed the maximum permissible limits of the Regulation of the quality of water for Human Consumption; results that are similar to the study carried out by Chong (16)where he indicates that the well water and the water from the distribution network of the La Libertad Minor Population Center contained samples contaminated with total coliforms 1.6x105 NMP/100ml; thermotolerant coliforms 5.4x104 NMP/100ml; as well as what was determined by Sotomayor(15) because 38 monthly samples were obtained for 4 months, as a result total coliforms were obtained 1800 NMP/100ml being the maximum permissible <2 NMP/100ml. In *E. coli* , 700 MPN/100ml was found, the maximum permissible being <1 MPN/100ml.

Regarding the evaluation of the quality of water according to the data processing of the survey carried out on each head of the family of the 40 houses, it indicates that the category "bad" has a percentage of 100%, this indicates that the water of the Center Poblado Pachapiriana is not treated correctly; results that are identical with the study conducted by Chong (16) where it indicates that human health is one of the main concerns of man, given the negative consequences of its neglect; in this context is that societies as a whole add capacities to monitor the quality of water sources for human consumption, managing, on many occasions, to reverse counterproductive consequences in a timely manner, through precise actions that entailed enormous efforts. human and economic. However, there are places where this health is not a priority, as is often the case in communities far from urban areas.

From the results obtained in the tests carried out on the 40 samples taken in the houses, it can be indicated that none of them complies with the maximum permissible limits of the water quality regulation for human consumption, the most outstanding results being sample 9, which has 220/ 100 ml and sample 10 with 350/100 ml for total coliforms; and, for fecal coliforms, samples 10 and 12 resulted in a MPN of 21/100 ml, houses that are located at a distance close to the distribution well. These results are similar to the study carried out by Chambi (17), who considered in his study 54 water samples that were obtained from 10 pools, 20 ditches and 24 artisanal wells, resulting in greater contamination in the pools 70%, wells 54% and ditches 40. %, determining that the three water supply sources *are not suitable* for human consumption; In addition, it was determined in the evaluation of the sanitary state of the water supply infrastructure, they are deteriorated due to the fact that maintenance is not scheduled for the

infrastructure, as happens in the water supply infrastructure system, which is the reason for the present investigation.

It was also possible to determine that the samples of the houses and the wells do not comply with the maximum permissible limits for total coliforms, fecal coliforms and *Escherichia coli* established in the Regulation of the Quality of Water for human consumption (DS N° 031-2010- SA); data that are similar to the study carried out by Sotomayor (15)where he obtained results higher than the maximum permissible limit for total coliforms and for *E. coli* , evidencing the need to take immediate measures; There is also a similarity with the study carried out by Chambi Choque (17)where it was determined that the processed samples were contaminated and exceeded the Most Probable Number of coliforms and *Escherichia coli* , considering the water supply as unfit for human consumption.

Regarding the objective and the hypothesis raised in the investigation, it was determined that the level of contamination of the water for human consumption does not meet the parameters, the 44 samples worked had an incidence greater than 1.8/100 ml. This indicates that the results obtained in the distribution network and in the houses are contaminated because the maximum permissible limit does not comply with the Regulation of the quality of water for human consumption (DS Nº 031-2010-SA), being the causes more importantly, the lack of maintenance and that they do not contain a lid, which is why it is exposed to environmental contamination.

6 CONCLUSION

1.   Based on the presumptive, confirmatory and complete tests carried out, it was determined that the water supplied to CP Pachapiriana does not meet the microbiological conditions to be considered fit for human consumption because all the samples present an important MPN of fecal coliforms. , total and *E. coli* .

2.   According to the applied survey, it was concluded that the quality of water consumed by the population is not adequate according to the data processing carried out on each head of family of the 40 homes.

3.   From the evaluation carried out on the samples taken in the 40 houses, it was determined that there is contamination in all of them for total coliforms and for fecal coliforms; while for *E. coli* 37 samples were higher than what is allowed by Supreme Decree No. 031-2010 SA.

4.   According to the NMP technique, 100% of household water samples are not suitable for human consumption, according to Supreme Decree No. 031-2010, which indicates that the samples must be < 1.8/100 ml; while the results obtained are > 6.8/100 ml high for total coliforms, while for fecal coliforms it resulted in > 4/100 ml and for *E. coli* ; if three samples were obtained (9 – 18 and 31) with the indicated value of DS Nº 031-2010 which is < 1.8/100 ml, the remaining 37 samples have the presence of *E. coli* because the result is > 2/ 100ml

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