http://chemistryjournal.kypublications.com/

International Journal of Chemistry and Aquatic Sciences (IJCA)

(A peer Reviewed, referred Journal)

ISSN: 2355-033X

©KY PUBLICATIONS
International Journal of Chemistry and Aquatic Sciences (IJCA)
Volume: 9, Issue 2, 2023 (April-June) Page 1-11
ISSN: 2355-033X
Research Article

ASSESSMENT OF GROUNDWATER QUALITY IN URBAN AREAS OF PRAKASAM DISTRICT, ANDHRA PRADESH, INDIA

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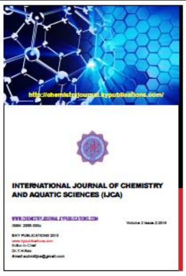
doi: 10.33329/ijca.9.2.1



ABSTRACT

A cross-sectional study was undertaken in two urban areas of Prakasam District, Andhra Pradesh, India to assess the physicochemical and bacteriological quality of groundwater used for human consumption. A proportionate stratified sample was chosen based on the size and geography of the research regions. The maximum permitted values for human consumption established by WHO guidelines were compared to the analysis results of the 120 water samples collected. 90.8% of the samples had total coliforms, 65.8% contained fecal coliforms, and 74.1% contained heterotrophic organisms with more than 500 CFU/mL. The pH, turbidity, chloride content, and color of the samples tested did not match WHO standards. Specifically, 82.8% of the samples had pH, 23.4% had turbidity, 12.5% had chloride, and 7.5% had color. 32.7% of the samples showed elevated ammonia levels, while 88.2% had nitrate levels above the allowed range. Water consumers may face health risks because a significant portion of the samples from this subsurface source do not meet potability standards.
Keywords: Urban water samples, Ongole, Chirala, Ground water; Human consumption; WHO standards; Health risk
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Introduction

Ensuring that human consumption of water meets adequate potability standards is an important issue for public health. In India, the WHO-approved Water Quality Standard for Human Consumption specifies the maximum permissible values for bacteriological, organoleptic, physical, and chemical properties of drinking water. The WHO[1] defines drinking water as water for human consumption whose microbiological, physical, chemical, and radioactive parameters meet the potability standard and do not pose a health risk.

Water for human consumption can be obtained from different sources. One of these sources, the underground spring, is a resource used by a large portion of the Indian population. Groundwater can be captured in the confined or artesian aquifer, which is located between two relatively impermeable layers, which makes contamination difficult, or it can be captured in the unconfined or free aquifer, which is close to the surface, and is, therefore, more susceptible to contamination. Due to the low cost and ease of drilling, capturing water from the free aquifer, although more vulnerable to contamination, is more frequently used in India[2].

Several factors can compromise the quality of groundwater. The final destination of domestic and industrial sewage in cesspools and septic tanks, the inadequate disposal of urban and industrial solid waste, gas and washing stations and the modernization of agriculture represent sources of contamination of groundwater by pathogenic bacteria and viruses, parasites, organic and inorganic substances.[3]

According to Schwaller, Christoph. (2018)[4], around 20% of the population in developing countries have septic tanks or other in situ treatment as a measure to protect the health of their homes. These techniques, however, can allow the release of pathogens, which infiltrate and reach groundwater, endangering the health of neighbours who consume water from this source.

In several Indian cities[5], it can be observed that hospitals, medical and dental clinics, schools, restaurants, bars, snack bars, daycare centers, food industries (in which water is used as raw material), and private homes use water from this spring, generally captured in shallow wells, in natura or inadequately treated.

The consumption of water contaminated by biological or physicochemical agents has been associated with several health problems. Some epidemics of gastrointestinal diseases, for example, have contaminated water as their source of infection. These infections represent a cause of high mortality rates in individuals with low resistance, especially affecting the elderly and children under five years of age[6].

Among the inorganic constituents harmful to health that can be found in water, nitrate is the one that presents the most widespread and problematic occurrence, due to its high mobility and stability in aerobic groundwater systems. Nitrate in concentrations greater than 10mg $N0_3$-N/L causes methemoglobinemia, which can have serious health consequences, including death, especially in infants[7].

Despite the increase in evidence about the harmful effects on health resulting from the use of water outside of adequate potability standards, the damage to health resulting from the consumption of contaminated water is difficult to be adequately assessed and measured. The aspects involved in this relationship are multiple and are not always based on direct associations. Factors such as nutritional status, access to health services and information can interfere with this association. Furthermore, individual factors can also establish different responses to contact with contaminated water.

Ensuring human consumption of drinking water, free from pathogenic microorganisms, substances and chemical elements harmful to health, constitutes an effective action to prevent diseases caused by water.

The objective of this study was to evaluate the bacteriological and physical-chemical quality of underground water, used for human consumption, collected through wells located in two areas (Ongole, Chirala) of Prakasam District, Andhra Pradesh, India. In his study, Reddy (2013)[8] provided an elucidation of the hydrogeochemical attributes present in the groundwater in the southeastern region of Prakasam district, located in the state of Andhra Pradesh, India.

Methodology

1) Type of study: Cross-sectional epidemiological study.

2) Sampling: Water samples collected from household wells located in two areas of the urban area Prakasam District, Andhra Pradesh, India. Two urban areas are as follows:

- Area 1: **Ongole,** Andhra Pradesh, India is situated in the Cities category in India, with GPS coordinates of 15° 30' 20.6028'' N and 80° 2' 59.7084'' E.
- Area 2: **Chirala,** Andhra Pradesh, India is located at a latitude of 15.812074 and a longitude of 80.355377. Chirala, Andhra Pradesh, India is situated in the Cities category in India, with GPS coordinates of 15° 48' 43.4664'' N and 80° 21' 19.3572'' E.

A cross-sectional epidemiological study identified all building units in the two areas studied (area 1 and area 2). The study was developed in two stages, during the year 2000. In the first stage, a survey was conducted to evaluate the frequency of households that used groundwater. After surveying the public places in each area, the streets to be studied were drawn using a random procedure[9]. All building units on the streets included in the study, in both areas, were visited. 1,646 building units were investigated, of which 1,579 were households. Human consumption of groundwater was observed in 368 households. In the second stage, 120 households were selected for collection and analysis of water from the underground spring. The sample size (n=120) was established depending on the cost of the analyses. Proportional samples were calculated per area studied, according to the percentage of wells found in each area. In area 1, in which 82% of household wells were found, samples from 98 wells were evaluated, and in area 2, in which 18% of the total wells were recorded, 22 households were studied. The selection of locations for collecting water samples was carried out using a random procedure (list of random numbers, generated by the Epi-Info Program, version 6.0), based on the numbers assigned to each household in which a well was found to capture groundwater. in the first stage.

3) Data collection instruments Characteristics of wells and households were obtained during the household survey, using a structured form containing information on socioeconomic conditions, sanitary indicators, household infrastructure and basic sanitation.

The bacteriological and physicochemical quality of groundwater samples was evaluated by the following parameters and methods: (a) total and fecal coliforms, analysis of the most probable number (MPN) of coliforms, multiple tube fermentation technique; (b) determination of heterotrophic organisms, pour plate technique; (c) ammonia, phenate method; (d) chlorides, Mohr's method; (e) color, colorimetric method; (f) hardness, volumetric method with EDTA; (g) nitrate, cadmium reduction method; (h) nitrite, N-naphthyl method; (i) pH, potentiometric method and (j) turbidity, spectrophotometric method. The analysis were carried out in the Bacteriological and Physical-chemical Water Quality Control laboratories. Nitrate, nitrite and ammonia analysis were carried out in Salvador, at the OPTQ Central Laboratory, which has ISO 9002 certification, and the other physicochemical and bacteriological parameters in the college laboratories.

The samples for nitrate and ammonia analysis were taken in amber glass containers, with a capacity of one litre, preserved with 2ml of sulfuric acid. For the analysis of other physical-chemical parameters, samples were collected in plastic containers with a capacity of two litres. Samples were collected for bacteriological analysis in glass containers (snap-cap), with a capacity of 125ml, sterilized at 180ºC for 1:30h. The collections were carried out according to the water sample collection procedures contained in the Standard Operating Procedure (SOP) of the laboratories where the analysis was carried out.

In households where water was collected by a pump, the samples were collected at a point where the water came from the well before reaching any reservoir. In households where water was collected by a bucket pulled by a rope, samples were collected for analysis of physical-chemical parameters in a virgin container (bucket that had never been used), pulled by a virgin rope (never used) and transported to the appropriate containers for each analysis. When collecting the sample for bacteriological analysis, the collection bottle was introduced into the well using a nylon basket made for this purpose. All samples were preserved on ice. All collection containers were identified with the sample data. Collection forms were filled out with data relating to the sample collected (address, time, sample number, weather conditions and type of collection - pump or bucket), which were sent to the laboratories, accompanying the samples.

At the time of collection, the depth between the beginning of the well and the water depth was measured. All samples were collected by a single person, qualified and experienced in water collection procedures for analysis.

4) Data analysis Water quality was assessed by comparing the results obtained in bacteriological and physical-chemical analysis with the maximum permissible values (MPV) recommended by WHO Water Quality Standard Water for Human Consumption. Next, the association between the characteristics of the wells (depth, type of catchment, nearest well-to-septic tank distance and studied area) and the water quality parameters studied was evaluated. To assess the statistical significance of the associations studied, proportion ratios and their respective confidence intervals were calculated, with a confidence level of 95%.

RESULTS

Socioeconomic conditions of the studied population

Table 1: Characteristics of the wells where water samples were collected for laboratory analysis by area.

	Ongole		**Chirala**		**Total**	
Characteristics	n	%	n	%	n	%
Type of well drilling						
Manual excavation	77	78.6	10	45.4	87	72.5
Drilling with a drill	18	18.4	8	36.4	26	21.7
Ignored	3	3	4	18.2	7	5.8
Well depth						
Up to 5 meters	35	35.7	4	18.2	39	32.5
> 5 to 10 meters	26	26.5	5	22.7	31	25.8
> 10 to 20 meters	32	32.7	12	54.6	44	36.7
> 20 meters	1	1	–	–	1	0.8
Ignored	4	4.1	1	4.5	5	4.2
Type of water capture						
Pumping	53	54	19	86.4	72	60
Manual with bucket	45	46	3	13.6	48	40
Distance between the well and the nearest pit						
Up to 5 meters	1	1	–	–	1	0.9
> 5 to 10 meters	9	9.2	1	4.5	10	8.3
> 10 to 20 meters	28	28.6	4	18.2	32	26.7
> 20 meters	13	13.3	12	54.6	25	20.8
Ignored	47	47.9	5	22.7	52	43.3
Total	98	100	22	100	120	100

The socioeconomic conditions related to the population and household infrastructure were more precarious in area 1. In this area, in 73% of the households investigated, the family income was up to 3 minimum wages and no household was found in which the family income was more than 20 minimum wages; the level of education observed was also low, with the predominance of heads of families with a level of education up to complete primary school. In 11.6% of households, children contributed to the family income. In area 1, the proportion of households in which groundwater was consumed was 34%.

In area 2, family income of up to 3 minimum wages was found in 40.6% of the households studied and in 12.3% this income was greater than 20 minimum wages. The level of education of heads of families living in this area was high, with a predominance of those who had a high school degree or higher. In 3.6% of households, children contributed to the family income. The proportion of households in which groundwater was consumed was 16.5%. In area 2, access to material goods and household appliances was greater than in area 1.

Characteristics of wells used to capture groundwater

There was a higher percentage of shallow wells, dug manually, up to 10 meters deep, whose water was collected by pumping. Attention was drawn to the high percentage of households in which interviewees were unable to inform the distance between the well and the nearest septic tank (Table 1). As for the final destination of domestic sewage, 100% of the households analysed, in area 2, disposed of it in septic tanks. In area 1, 63.3% used the public domestic sewage service, 35.7% disposed of it in septic tanks and 1.0% did not know the final destination of the sewage.

Laboratory analysis of the quality of groundwater consumed

The percentage of samples with total (90.8%) and fecal (65.8%) coliforms was significant, ranging from 2 to more than 1,600/100ml (Table 2). Samples with total coliforms were more frequent among those collected in area 2 (95.5%) than in area 1 (89.8%). High percentages of samples with fecal coliforms were found in both areas (area 1: 66.3% and area 2: 63.6%).

Table 2: Bacteriological analysis of water samples from the wells studied.

Analysis			**Total Coliform**						**Coliform fecal**			
	Area 1		Area 2		Total		Area 1		Area 2		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Most Likely Number (MPN)												
coliforms/100ml												
< 2*	10	10.2	1	4.5	11	9.2	33	33.7	8	36.4	41	34.2
2 to 100	34	34.7	10	45.5	44	36.6	45	45.9	6	27.3	51	42.4
> 100 to 1600	43	43.9	9	40.9	52	43.4	20	20.4	8	36.3	28	23.4
> 1600	11	11.2	2	9.1	13	10.8	–	–	–	–	–	–
Total	98	100	22	100	120	100	98	100	22	100	120	100

Samples that did not meet potability standards						
for coliforms**						
Total Coliform	88	89.8	21	95.5	109	90.8
Coliform fecal	65	66.3	14	63.6	79	65.8

Determination of heterotrophic organisms/(CFU/ml)*						
< 500	31	32	3	13.6	34	28.6
> 500	66	68	19	86.4	85	71.4
Total	97	100	22	100	119	100

<2 bacteria/100ml indicates analyses where there is no growth of coliform bacteria, according to the MPN table for quantitative results, with a 95% confidence limit
*** WHO determines that the presence of total coliforms is tolerated in individual well samples in the absence of thermotolerant coliforms.*
****WHO establishes a limit of 500 CFU/ml. Exceeding this limit, actions must be taken to correct any irregularities found.*

WHO establishes that in water for human consumption, including individual sources such as wells, the presence of faecal or thermotolerant coliforms is not permitted in 100ml of water. In relation to total coliforms, it determines that in samples from wells the presence of total coliforms is tolerated, in the absence of *Escherichia coli* and thermotolerant coliforms, and the origin of the occurrence must be investigated and immediate corrective and preventive measures taken and a new analysis carried out. According to WHO[10] and BSI[11], for the use of supplies without prior disinfection, total coliforms must be absent in any sample. Therefore, more than 90% of the samples indicated water unfit for human consumption. The frequency of samples with more than 500 heterotrophic colony forming units (CFU)/ml was also significant (71.4%) in both areas (Table 2). Table 3 shows that in 7.5% of the samples a color greater than 15 Pt-Co/L (Hazen-uH unit) was found, VMP established in ordinance no. 1,469/00. In the samples analysed, the color varied between 5 and 137.5 uH.

Table 3: Physicochemical analyses of water samples from the studied wells.

	Ongole		**Chirala**		**Total**	
Characteristics	n	%	n	%	n	%
Cor						
< 15 (uH)*	91	92.9	20	90.9	111	92.5
> 15 (uH)	7	7.1	2	9.1	9	7.5
pH						
< 6.0	73	83	9	81.8	82	82.8
> 6.0 to 8.5*	15	17	2	18.2	17	17.2
Turbidity						
< 1 NTU*	24	24.5	7	31.8	31	25.8
> 1 to 5 NTU	51	52	10	45.5	61	50.8
> 5 NTU	23	23.5	5	22.7	28	23.4
Chloride						
Up to 250 mg/L Cl*	86	87.8	19	86.4	105	87.5
> 250 mg/L Cl	12	12.2	3	13.6	15	12.5
Nitrate						
Up to 10mg NO_3-N/L*	5	5.1	9	40.9	14	11.7
> 10MG NO_3-no/l	93	94.9	13	59.1	106	88.3
Ammonia						
up to 1.5mg/L NH3*	71	76.3	7	31.8	78	67.8
> 1.5mg/L NH_3	22	23.7	15	68.2	37	32.2

* Acceptance standard for human consumption

For groundwater treated by the disinfection process, ordinance no. 1,469/00 establishes that in up to 95% of the samples analysed, the VMP for water turbidity must be 1.0 turbidity unit (Jackson or nephelometric unit). In the remaining 5%, up to 5.0 NTU is allowed. When turbidity above 1.0 NTU was considered, a high percentage of samples outside the recommended range was found (74.2%). Turbidity above 5.0 NTU was found in 23.4% of the samples. The turbidity of the water in the wells analysed ranged from 0.16 to 132 NTU. A higher percentage of samples with turbidity above the recommended level was found in area 1 (75.5%) than in area 2 (68.2%) (Table 3).

82.8% of samples were found to have an acidic pH, below 6.0, not meeting the legally recommended values. In 12.5% of the samples analysed, chloride was found above that established in the Ministry of Health ordinance (250mg/L Cl). These percentages were similar for samples collected in both areas (Table 3).

In 88.2% of the samples analysed, nitrate was found above that recommended by WHO limits (10mg NO3-N/L). The maximum nitrate values found ranged from 92 mg NO3-N/L in area 1 to 34 mg NO3-N/L in area 2. In area 1, the frequency of samples with nitrate above the recommended level (94.9%) was higher than that found in area 2 (59.1%) (Table 3).

The percentage of samples with ammonia above 1.5mg/L NH3, a legally established standard, was high. Samples with up to 106mg/L NH3 were found in area 2 and 22.8mg/L NH3 in area 1. In area 2, samples with ammonia above the recommended level were 2.9 times higher than that found in area 1 (68, 2% in area 2 and 23.7% in area 1) (Table 3). In 100% of the samples, the hardness and nitrite parameters met those recommended by current limits.

Association between well characteristics and water quality

No association was found, at levels of statistical significance, between the area where the sample was collected and the growth of coliform-type bacteria. The growth of fecal coliform was positively associated with wells up to 10 meters deep and manual water collection using a bucket (Table 4). Evaluating samples collected in wells that were up to 10 meters away from the nearest pit (n=11), it was observed that in 100% of these samples there was growth of total coliforms; in 90.9% fecal coliforms grew and in 72.7% more than 500CFU/ml were counted.

The presence of more than 500CFU/ml of heterotrophic organisms was significantly associated with samples collected in area 2 (Table 4).

Table 4: Assessment of associations between water samples that did not meet the bacteriological standards recommended by WHO

Variables	**Proportions (%)**	**Proportion ratio**	**Confidence interval (95%)**
Fecal Coliform/Well Depth			
Well up to 10 meters deep	76	1.37	1.02-1.83
Well >10 meters deep*	55.6	1	–
Fecal coliform/Water capture type			
Manual collection using a bucket	77.1	1.32	1.03-1.69
Pumping capture*	58.3	1	–
More than 500CFU/ml/Collection location			
Samples collected – Area 2	86.4	1.27	1.02-1.57
Samples collected – Area 1*	68	1	–

** Reference group*

Turbidity greater than 1.0 NTU was significantly associated with wells with depths of up to 10 meters (Table 5).

In relation to pH, the percentage of samples outside the legally recommended standard increased according to the depth of the well: greater depth corresponded to a greater frequency of samples outside the standard. Of the samples that presented a pH lower than 6.0, 27.8% were collected in wells with a depth between more than 5 and 10 meters and 41.8% in wells with a depth of more than 10 meters.

As for chloride levels, 93.3% of the samples that did not meet the WHO recommendations (250mg/L) were collected in wells up to 10 meters deep. A positive association was found, at statistically significant levels, between nitrate greater than 10mg NO_3-N/L and samples collected in area 1 (Table 5). The association between nitrate above 10mg NO_3-N/L, well depth and distance between the well and the nearest pit was not significant.

Ammonia above that recommended in WHO standards was strongly associated with samples collected in wells located in area 2 (Table 5).

Table 5: Assessment of associations between water samples that did not meet the physical-chemical standards and characteristics of the wells.

Variables	**Proportions (%)**	**Proportion ratio**	**Confidence interval (95%)**
Turbidity >1NTU/Well depth			
Well up to 10 meters deep	87.1	1.57	1.19-2.07
Well >10 meters deep*	55.5	1	–
Nitrate >10mg NO_3-N/L/Collection location			
Samples collected – Area 1	93.8	1.59	1.12-2.26
Samples collected – Area 2*	59.1	1	–
Ammonia >1.5mg/L NH_3/Collection location			
Samples collected – Area 2	68.2	2.88	1.81-4.58
Samples collected – Area 1*	23.6	1	–

** Reference group*

Discussion

The wells studied were superficial, shallow, manually drilled, located in the free aquifer, situated above the relatively impermeable rock layer that protects the water table from infiltration and contamination.

A high percentage of samples with the presence of coliforms was found, indicating water unfit for human consumption. The presence of fecal coliforms indicates the possibility of contamination by feces and, consequently, of pathogenic microorganisms present in them, which, as they are rarer and more fragile to environmental conditions, become difficult to identify. Total coliforms are bacteria that are scarce in feces and indicate soil contamination.

Sulehria et al. (2011)[12], comparing coliform levels in drinking water and cases of gastroenteritis, observed that the incidence of gastroenteritis increased as the percentage of acceptable samples (fit for consumption) decreased. The incidence of gastroenteritis was 116/1,000 inhabitants. in areas where no sample was considered acceptable for total coliforms and fecal coliforms were observed in 42.9% of samples; the incidence fell to 49/1,000 inhabitants. in areas where 41.5% of samples were found to be acceptable for total coliform and which had 5.7% of samples with the presence of fecal coliform.

Abramovich et al. (1998)[13], studying the association between consumption of groundwater and transmission of enteroparasitosis in a population composed of children aged 4 months to 12 years, living in three cities in the Province of Santa Fé, Argentina, found positive samples for oocysts of *Cryptosporidium* spp. in water samples from one of the wells investigated and subjected to the disinfection process, with chlorine dosage varying from 1 to 2mg/L. Among the population that consumed this water, it was observed that 47.1% of the stool samples analysed were positive for enteroparasites, of which 20.6% for oocysts of Cryptosporidium spp.

According to Mirdha, Bijay. (2021)[14], several studies demonstrate that *Cryptosporidium* circulates between waterborne transmission routes in India. Anbazhagi,et al. (2007)[15] detected *Cryptosporidium* oocysts in eight out of ten shallow wells analysed in Itaquaquecetuba (SP). The authors identified septic tanks as the most likely source of contamination.

In the present study, the percentage of samples with turbidity was increased above that legally established, recording higher percentages in area 1. Turbidity, material suspended in water, can attach to existing pathogens, protecting them and even hindering the action of the chlorine on them. Schwartz et al. (2000)[16] found an association between turbidity indices and hospital admission for gastrointestinal diseases, among the elderly population in Philadelphia, United States, in the period 1992-1993.

The presence of Cryptosporidium is also associated with water turbidity. For treated water, in properly operated rapid filtration systems, producing effluents with turbidity < 0.3 UNT, 99% removal of Cryptosporidium oocysts can be achieved.

The percentage of samples with acidic pH, less than 6.0, was also high. The acidity of the water can contribute to the corrosion of the structures of hydraulic installations, adding constituents to the water. The biggest changes in this indicator are caused by evictions of industrial origin. The final disposal of industrial waste in cesspools or septic tanks may be contributing to the acidification of groundwater in the areas investigated. The percentage of wells with chloride levels above the recommended level was more frequent in samples collected in area 2. High concentrations of chloride impart flavor to the water and laxative effects on those accustomed to consuming water with low concentrations[17].

One of the most worrying aspects in the samples analysed in this study was the high percentage of samples with nitrate above 10mg NO_3-N/L. Nitrate is the end product of aerobic stabilization of organic nitrogen, indicating ancient contamination. The results found in area 1 may be related to the presence of a domestic sewage collection network. In this area, 63.3% of the households surveyed reported using this service.

High levels of nitrates also indicate contamination due to inadequate disposal of human, industrial or food waste, in addition to the use of nitrogen fertilizers in agriculture. Nitrate contamination in drinking water can have serious health consequences. In the human body, nitrate is converted into nitrite, which, in turn, combines with hemoglobin to form methemoglobin, preventing the transport of oxygen in the blood. Especially in very young children and the elderly, it can cause intense cyanosis (methemoglobinemia) and lead to death.

Rehman (2001) [18] reports that more than 2,000 cases of methemoglobinemia, with fatal cases around 8%, were described in the literature until 1970, and cites the existence of several studies linking high levels of nitrate in well water with the incidence of cancer gastric. According to Cortazzo, et al.

(2013) [19] studies carried out in Australia and Canada showed a significant increase in congenital malformations associated with ingestion of high concentrations of nitrate.

The percentage of non-standard ammonia was substantially higher among samples collected in area 2 (68.2%), when compared to that in area 1 (23.7%). The occurrence of high concentrations of ammonia may be the result of nearby pollution, as well as nitrate reduction by bacteria or ferrous ions present in the soil. As ammonia nitrogen is one of the first steps in the decomposition of organic matter, its presence indicates recent contamination and may be related to poor well construction and lack of aquifer protection.

The results found for ammonia in samples collected in area 2 may be related to the fact that 100% of the households surveyed dispose of domestic sewage in septic tanks, thus contaminating the underground water supply.

Conclusion

In summary, the study carried out, based on bacteriological and physical-chemical analysis of water samples collected from wells in the two areas of the urban area of Andhra Pradesh state, points to important contamination of water from the underground source. The water does not meet the potability standards recommended by WHO. Therefore, human consumption of this water can pose risks and harm to health. Considering that the areas studied were located at opposite points, at a considerable distance, some parameters analysed, such as nitrate, for example, may be indicating greater contamination. Therefore, it is necessary to evaluate the quality of the underground water supply in other areas of Andhra Pradesh state, mainly due to the high human consumption of groundwater in this municipality. Groundwater fulfils an important function and, in many cases, is vital for the supply of drinking water. Therefore, its protection is recommended, with the elimination of the causes of possible contamination, as well as the use of filtration, before disinfection, to reduce, to a significant level, the risk of transmission of parasites through water. Human consumption of drinking water is one of the public health actions with the greatest impact on preventing diseases and mortality rates. Therefore, human consumption of water from underground sources that do not meet recommended potability standards needs to be avoided, mainly through access to information and the promotion of public policies that guarantee widespread access to water suitable for human consumption.

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