Original Article

Indian Journal of Agriculture Business
Volume 10 Number 1, January - June 2024
DOI: http://dx. doi. org/10. 21088/ijab.2454.7964.10124.3

Preliminary assessment of Quality of Drinking Water Samples in Jamdoli Area of Jaipur

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How to cite this article:
Gourab Basak, Akash Raut. Preliminary Assessment of Quality of Drinking Water Samples in Jamdoli Area of Jaipur. Ind. J Agri Busi 2024;10(1):21-27.

Abstract

Clean and safe potable water is the basic necessity for sustenance of healthy human life. Ground water considered to be the safest among various sources of water, ironically, has been polluted with variety of contaminants. In the present preliminary assessment, an attempt was made to verify the drinking water quality of samples collected from Chetak Vihar colony, Jamdoli, Jaipur. Parameters studied includes gross sensory examination and biochemical attributes of water like pH, chloride, total hardness, fluoride, nitrate, iron, and residual (free) chlorine contents present in the samples. The parameters were compared with the Indian Standard Specifications for drinking water (IS10500-1983). All the parameters evaluated were in the prescribed limit except, for total hardness, and nitrate contents of one sample. The values of total hardness and nitrate content were comparatively higher in one of the samples i. e. 625 mg/L, and 100 mg/L, respectively. The increased total hardness and nitrate content above the recommended level may leads to severe health complications in humans and animals and is a matter of great concern from the public health point of view. Therefore, we suggest regular screening of drinking water samples particularly for possible contaminants with a need to take appropriate measures to safeguard human and animal health.

Keywords: Drinking water; Indian Standard Specification; pH; Chloride; Total hardness.

INTRODUCTION

Water is an indispensable natural resource on earth. The belief of ground water being the safest water for drinking has become a myth now; this is because of increasing pollution of water bodies due to rapid industrialization, over-population, and various anthropogenic activities (*Simpi et al., 2011*; *Shyamala et al., 2008*). Such contaminations gradually may cause physical, chemical, and/or biological hazards and serious health problems to the common people, if consumed untreated or undetected. In the most part of India, neither the community nor the government is involved actively in regular assessment of quality of potable water.

Mostly, drinking water quality deteriorates because of over exploitation of available water sources and pollution. Therefore, monitoring of available drinking water resources becomesthe foremost step, specially, when it serves a large number of people. This aids in safeguarding community health by reducing health risks and by prevention and control of any health hazards, particularly water borne illness. All this demands a collective effort by the society at various levels. In

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Received on: 01. 04. 2024 **Accepted on:** 10. 05. 2024

such circumstances, the need for user involvement in maintaining the quality of water and different aspects involving environmental sanitation, hygiene, disposals *etc*. become the critical elements of considerations (*Khare et al., 2013*). There are many parts of India, where more than 90% of the population is entirely dependent on groundwater for drinking purpose as well as for other domestic purposes (*Datta, 2005*). Potable water should be free from any type of hazards that threatens health (*Lamikaran, 1999*). Considering the importance of the problem, present study was conducted in light to assess the drinking water quality and advices the public health department and the community to have periodical examination of drinking water quality.

MATERIALS AND METHODS

Sample Collection

Water samples were collected from two drinking water sources around Chetak Vihar Colony, Jamdoli, Jaipur in a sterilized glass sample container. The samples W1 and W2, were assessed for physiochemical parameters immediately in the Department of Veterinary Public Health and Epidemiology, Apollo College of Veterinary Medicine, Jaipur, Rajasthan.

Experimental Parameters

There are various physiochemical parameters that depicts the quality of drinking water. For the current study, pH, turbidity, chloride, total hardness, fluoride, nitrate, iron, and residual (free) chlorine content weredetermined using WT015 Multi-Parameter Water Testing Kit (HiMedia, Mumbai). Conventional water analysis necessitates an established analytical laboratory; besides, laboratory analysis is expensive, and time consuming. On the other hand, the kit used in this study includes readymade, user-friendly analytical test systems for extended chemical analysis of water using specific reagents for volumetricand colorimetric analysis. In fact, these simple, and rapid testsrequire no instrumentation, making it less expensive. The parameters assessed were described in brief.

(a) Gross appearance, odour, and taste: The samples were observed for gross appearance visually and subjected for detecting any offensive odour, and taste through subjective organoleptic assessment.

(b) pH: pH of a solution is the negative logarithm of hydrogen ion activity which is approximately equal to the hydrogen ion concentration in diluted form. It is the measure of acid-base equilibrium; pH test strips ranging from 2. 0 to 10. 5 were used to measure pH of the samples in this study.

(c) Chloride: The chloride test followed titration procedure following the manufacture's instruction. The test detection limit was ranged between 10–200 mg/L (ppm)as chloride. The titration was continued till the appearance of bluish violet colour in the mixture. Counting the drops of the reagent C, chloride (mg/L) was calculated as 10 (10 is the dilution factor) × number of drops of chemical C.

(d) Total hardness: It was again determined with titration methodology with the capacity of detection being 25-600 mg/L as $CaCO_3$. According to the manufacturer, on addition of reagent B, blue colouration of the solution indicates soft water, and red as hard water. On appearance of redcolour, reagent C needs to be added till the colour of the solution turned blue. It was then calculated by multiplying the number of drops of reagent C added with 25.

(e) Interpretation of fluoride, nitrate, iron, and residual (free) chlorine are based on visual colour comparison method for which colour comparator chart has been provided by the manufacturer along with the kit. The range of fluoridedetection capacity of the employed kit was 0. 0 – 2. 5 mg/L (ppm) as fluoride; for nitrate it was 0 to 250 mg/L (ppm) as nitrate-N andfor both iron and residual (free) chlorineit was 0. 0to 2. 0 mg/ Las iron, and as chlorine, respectively. The obtained/developed colour been matched with the correct colour in the comparator chart to obtain the concentration (mg/L) of the respective present in the test samples.

Results and Discussion

The water samples (sample W1 and sample W2) were transparent, odourless, and taste was acceptable which apparently indicate acceptable water for human consumption. Moreover, it indirectly indicates absence of colloidal, and decomposed vegetative matter. Change in colour, odour and other sensory parameters indicates possible contamination of drinking water with organic matter, chemicals and microorganisms.

A good correlation between odour and taste exist for the water. No health based guidelines have been proposed for taste but it is fact that drinking water must have an agreeable taste (*Dietrich and Burlingame, 2015*).

pH of water helps to determine the corrosiveness of the water. pH of pure water ranges from 6. 5 to 8. 5. In this study, pH of sample W1 was detected to be 6. 5, and sample W2 was of 7. 0 which satisfied the prescribed desirable limit of 6. 5 to 8. 5, specified by Indian Standard Specification for drinking water 10500-1983 [Bureau of Indian Standard (BIS)] (*https:// pcb. assam. gov. in/*). Moreover, pH, ranging from 6. 5 to 8. 5, is also Guidelines for drinking water quality (Vol. I), issued by World Health Organisation (WHO), 1984. Alteration in pH on both sides will affect the mucous membrane, and/or water supply system. A lower pH implying an acidic water aid in increasing its corrosiveness; whereas anmore alkaline pH indicates a contamination of the waterwith basic chemical substances (*Gupta et al., 2009*). Moreover, higher pH indicates the disturbance of equilibrium between carbon dioxide, carbonate, and bicarbonate because of change in physiochemical circumstances (*Karanth 1989, Arulnangai et al., 2021*). Alkaline water may cause gastric disorders, waterborne diseases and can lead to incrustation, sediment deposits, and chlorination problems.

Various studies analyzed water samples for pH. Results of *Shittu et al. (2008)*were in the range of 6. 8 to 7. 3. In a similar study by *Pandey and Tiwari (2009)*, detected pH of water in the range of 6. 8 to 8. 3in areas of Ghazipur city. *Saravanakumar and Kumar (2011)*while analysingthe quality of groundwater near Ambattur industrial area in the Indian state of Tamil Nadu, found pH was ranged between 7. 2 and 8. 5, which were slightly alkaline in nature but fell under the prescribed desirable limit for drinking purpose of water. Likewise, *Arulnangai et al. (2021)*, found apparent increase in the pH of ground water samples in Ariyalur area of Tamil Nadu, in the range of 8 to 9. 4.

Presence of chloride in water indicates the contamination of groundwater with wastewater. The maximum desirable limit of chloride as Cl (mg/L), according to Indian Standard Specification for drinking water 10500-1983 is 250 mg/L (*https:// pcb. assam. gov. in/*). In this study, sample W1 contained 30 mg/L, and sample W2 contained 150 mg/L of chloride as Cl which satisfied the required limit of drinking quality. Beyond the prescribed highest limit, it affects taste, palatability, and corrosion (*https://pcb. assam. gov. in/*). In a study by *Rawat and Siddiqui (2019)*, they mentioned the range of chloride content in the samples collected from 20 most densely populated and vulnerable wards of Allahabad city, varied between 18. 47 mg/L and 93. 73 mg/L. The presence of chloride in water acts as an indicator of water contamination with waste water, and/or percolation of sewage into the water (*Rawat and Siddiqui, 2019*). High level infers the contamination of wastewater due to the presence of organic waste in water. Faecal matter of humans and animals carry high amount of chloride, and nitrogen compounds and are the prominent source to raise the chloride content of water. A higher amount of chloride in water imparts bitter taste, and facilitates cardiovascular diseases. Natural water, hence, have no source of chloride in it (*Rani et al., 2003*). In contrast, *Shraddha et al. (2011)* evaluated the quality of Narmada River water considering various parameters at Hoshangabad city of Madhya Pradesh, India. Pre-monsoon water samples collected had chloride concentration in the range of 270-289 mg/L; while water samples collected in monsoon had even more chloride content in the range of 320-342 mg/L. Based on the findings, authors concluded presence of sediments, trade, industrial effluents, sewage consisting urine, as the main sources of chloride in the river water.

Generally, hardness of water is concerned primarily for its domestic use and commonly expressed as $CaCO_3$ (mg/L). We found 75 mg/L and 625 mg/L ($CaCO_3$) of total hardness,respectivelyin the water samples collected. In contrast, Indian standards specified the maximum required desirable limit for total hardness as $CaCO_3$ (mg/L)to be 300 mg/L. In sample (W2)total hardness was more than double the prescribed limit, indicating very hard nature of water. Published reports describes hardness up to 75 mg/L falls under soft water, 76 to 150 mg/L hardness counts for moderately soft, 151 to 300 mg/L counts for hard water and beyond 300, waters are very hard in nature (*Dufor and Becker, 1964*; *Ravisankar and Poogothai, 2008*). Thus, sample W1 is suitable for drinking water on the basis of hardness assessment.

Moreover, according to the specifications, the range of hardness may be extended up to 600 mg/L in the absence of other sources. But the observed hardness levels are still high and might contribute to illness like stones and cardiovascular complications in the exposed population. Encrustation in water supply chain, a factor contributing to total hardness can also be other possible way contributing to total hardness pool (*https://pcb. assam. gov. in/*). Hardness may also result from the discharge of toxic heavy metals in water. Thus, such water is advised for washing and cleaning purposes only (*Lalitha et al., 2004*). *Saravanakumar and Kumar (2011)* analysed the quality of groundwater near Ambattur industrial area, with total hardness ranged between 220 and 310 mg/L, *Pund and Ganorkar (2013)*, detected total hardness of water samples from five drinking water sources in Tembhurkheda, and Jarud regions of Amravati, Maharashtra to be in the range of 102. 8 to 198. 42 mg/l.

Neither of the samples in this study possessed any traces of iron content in them as per detection of iron using the said kit. Both the samples, sample w1, and w2 contained 0. 0 mg/l of iron. The desirable limit as Fe (mg/l) is 0. 3 mg/l, but it may be extended up to 1. 0 mg/l in absence of alternative sources. Beyond this level, taste and appearance get affected with adverse effects on domestic uses. Besides, the elevated limit may facilitate the growth of iron bacteria, *viz*., *Crenothrix*, and *Gellionella* (*Sherikar et al., 2013*). *Crenothrix*, abstracts iron from water where it thrives, and deposits in mucilaginous sheath in the form of ferric hydroxide; whereas, *Gellionella*, forms slimy coating leading to hard rusty nodules on inner surface of iron pipes through oxidation process. Near Fazalpur industrial area in Moradabad district of Uttar Pradesh state, *Kumar et al. (2019)* detected the concentration of iron as 6294 ppb. This high concentration of iron content was attributed to the adjoining alloy manufacturing industries where iron is added to brass to prepare the alloy. In Sir Sayyad Nagar, the concentration detected was 3820 ppb in the groundwater samples, where people extract metals from industrial wastes which led to the lead contamination. In a study at northeastern region of the country, *Singh et al. (2008)* mentioned that the amount of iron is relatively higher in this region, and almost all the states possess iron above the permissible limit.

Both the samples, w1, and w2, found to contain 0. 5 mg/l of fluoride; which were slightly lower than the prescribed desirable limit of 0. 6 to 1. 2 mg/l as f. According to the Indian specifications, low fluoride level is linked with dental carries; in fact, if the limit lies below 0. 6mg/l, that particular water should be rejected with adoption of suitable public health measures. The upper limit could be extended maximum up to 1. 5 mg/l in case no better alternate source is available; nevertheless, above 1. 5 mg/l, it may lead to fluorosis. *Sakthivadivel et al. (2020)* tested potable water samples of six different places of Chennai city for fluoride along with other physiochemical parameters with observed fluoride in the mean range of 0. 4 – 1. 5 mg/l, which is comparatively a little more than this study's findings. Fluoride often gets entry into water as hydrogen fluoride or silicon fluoride, which are the constituents of effluents from super phosphates, glazed bricks, enamel, glass, *etc*. factories. Though the level of daily fluoride exposure in India depends on the geographical areas; in many areas of the country deep ground water contain high fluoride level of up to 14 mg/l; which directly results into dental, and/or skeletal fluorosis, mottled teeth, constipation, and different skin ailments (*Sherikar et al., 2013*). *Asadi et al. (2007) detected concentration of fluoride to be more than 1. 5 mg/l near*Jubilee hills, Sheik put, Erragadda, and Sanathnagar whereas, the concentration was 3. 15 mg/l at Yellareddyguda; which are again higher than this study's observations. The researchers discussed the reason that groundwater in that area usually contains high contents of fluoride which gets dissolved by geological formation. They also mentioned that industrial activities, and weathering of fluorine bearing minerals (fluoride, apatite) were responsible for the high concentration of fluorine in the samples of water collected.

Nitrate content determination is very essential for water quality testing, because as per Indian Standard Specificationfor drinking water, beyond the maximum desirable limit (45 mg/l) of nitrate as No_3, might leads to methemoglobinemia. More importantly, no relaxation in its limits has been permitted, which itself underlining its severity. On examination, sample w1, contained 25mg/l of nitrate,which satisfied the prescribed limit whereas, sample w2 contained 100 mg/l of nitrate, which was much higher in concentration compared to the prescribed desirable limit. The nitrate content in water, possibly,be derived from organic matter of animal origin wastes, sewage, and buried carcasses. Excess of nitrates along with excess of chloride in water is the clear indication of contamination of the particular water with sewage pollution (*Sherikar et al., 2013*). The applications of animal manure, and inorganic fertilizers in agriculture have contributed in the increased level of nitrate in water resources. In fact, the regulatory limit for nitrate in drinking water was set considering only infant methemoglobinemia instead of taking in account all other health effects. Formation of *N*-nitroso compounds *in situ*on ingestion of nitrate may cause specific cancers and birth defects (*Ward et al., 2018*). Epidemiologic studies withnitrate contaminated water consumptionsuggested positive association of increased nitrate levels with colorectal cancer, thyroid diseases, and neural tube defects beyond methemoglobinemia (*Ward et al. 2018*). Moreover, in Iowa, a cohort of post-menopausal women had lower exposure through drinking water but were in positive association with the dietary nitrates (*Ward et al., 2010*).

Problems of nitrate in the Indian state of Rajasthan is not uncommon; in several parts of the state, people consume water containing high concentrations of nitrate, even the level reach up to 500 mg/L of NO_3 ions which is definitely not a usual matter (*Gupta et al., 2000*). A study was conducted by *Gupta et al. (2000)*, in which they considered 50 villages from the entire state and out of which five areas or village units were selected where the environmental, social, and nutritional conditions were similar except for the nitrate content. The average concentrations of nitrate content in the drinking water sources of those five units were 26, 45, 95, 222, and 459 mg/L of NO_3ion. Alongside, they also selected a total of 178 persons of all age-group from these five areas, and blood examination was conducted for methaemoglobin (represented as %Hb) estimation. The results revealed thatmethaemoglobinaemia was present not only in infants but also in elderly people, and 76% (136/178) of the subjects possessed clinical cyanosis. Hence, their study evidenced the higher quantity of nitrate in the waters of the state, and its consequences. In this present study also, sample W2 contained more than double the desirable limit of nitrate. Hence, to cure it from the roots, appropriate mitigativesteps need to be empowered by the concerned authorities.

Because nitrate is very soluble in water, and as it dissolved easily; it becomes very difficult to remove it. Moreover, it becomes very expensive, and complicated in its removal. According to Rossana Sallenave, an Extension Aquatic Ecology Specialist at New Mexico State University, three methods can aid in removing or reducing the nitrate contents in water, *viz*., demineralization by distillation or reverse osmosis, ion exchange, and blending. Distillation being the oldest process involves only three steps, boiling ofwater, capturing of steam, and condensation of the steam to turn these back into water. In reverse osmosis, water is put under pressure, and forced through a membrane in which minerals, and nitrate get trapped. But this method is not that much efficient to remove all nitrates present in the water. In the ion-exchange method, nitrate is exchanged with chloride with the help of special resin beads in ion exchange unit. Lastly, the blending is the method of diluting nitrate rich water with water from another source having low or no nitrate concentration (*aces. nmsu. edu/pubs*).

Residual (free) chlorine in drinking water should not be more than 2. 0 mg/L as per Indian Standard Specification. It is ratherapplicable essentially, only when the water is chlorinated. In case of protection against viral infections, the concentration should be minimum of 0. 5 mg/L (*https://pcb. assam. gov. in/*). Both the samples of this study were under the prescribed level. Sample W1, was found to contain 0. 1 mg/L of residual (free chlorine), and sample W2, had a concentration of 0. 2 mg/L of the same. *Ahmed et al. (2015)* undertook a study for assessing the residual chlorine content with distance in water distribution system in Gwalior city of Madhya Pradesh. Therefore, they collected a total of 56 water samples from the exit of the treatment plant and taps of consumers at an interval of 1-2 kms. Their analysis showed an average concentration of residual chlorine were between 0. 08 to 0. 98 mg/L from all the sampling sites which comply the findings of this study. They also mentioned that with distance, residual chlorine was completely diminished after covering a certain distance; this in turn facilitates microbial growth, which was again not acceptable. Thus, maintenance of residual chlorine in water up to its recommended limit should be entertained.

CONCLUSION

The preliminary assessment of collected water samples utilized for drinking purpose revealed that most of the parameters were satisfying the standards recommended by Indian standard specification for drinking water. Only one sample was found to contain comparatively a higher concentration of total hardness, and nitrate; even exceeding the maximum extended limit. As a result, this might not be ideal for drinking purpose, but might be used for other household activities. Further, regular monitoring, and frequent testing of this particular source of water, specially, for these two parameters could vividly execute its actual occurrence trend in order toprevent, and control the nuisance, and ultimately promote safe public health.

ACKNOWLEDGEMENT

The authors are highly obliged to Dean and authorities of Apollo College of Veterinary Medicine, Jaipur, for providing the necessary facilities to perform the water quality testing.

CONFLICT OF INTEREST

The authors declared no conflict of interests with respect to the work, authorship and/or publication of this article.

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