EXCELLENT PUBLISHERS

International Journal of Current Research in Biosciences and Plant Biology

ISSN: 2349-8080 Volume 2 Number 4 (April-2015) pp. 86-91

www.ijcrbp.com

Original Research Article

Physico-Chemical Analysis of Drinking Water and Hudiara Drain Water in Amritsar District, Punjab, India

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Abstract

This paper deals with physico-chemical analysis of drinking water and hudiara drain water in Amritsar district Punjab. Different physico-chemical parameters were analyzed including pH, Electrical conductivity (EC), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Dissolved Solids (TDS). All the parameters were found to be out of the limit and it indicated that the drain is highly polluted and it also affects the water table of the surrounding area.

Keywords

Biological Oxygen Demand
Chemical Oxygen Demand
Drinking water
Hudiara drain

Introduction

Human beings always equate their well being with consumption; therefore every nation, rich or poor, is in a race to increase its production. This in turn is putting a burden on the environment due to misuse or overuse of natural resources. Few centuries/decades back when population was small, energy was inexpensive and natural resources were abundant, waste management and recycling of materials was not considered an important issues. Water is one of the most important compounds of the ecosystem, but due to increased human population, industrialization, use of fertilizers in the agriculture and man-made activity, the natural aquatic resources are causing heavy and varied pollution in aquatic environment leading to polluted water quality and depletion of aquatic biota (Simpi et al., 2011). Water pollution is dangerous to the health of living organisms, but sea and river pollution can be especially detrimental to the health of humans and animals. Rivers and seas are used as primary sources of potable water by populations all over the world.

Another serious consequence of this pollution is the effect of this pollution on trade in the polluted areas. According to WHO (2007), nearly 1.8 million deaths are due to diarrhea and cholera per year and are attributed to drinking unsafe water, poor sanitation but hygienic conditions, improvement in water supply can help to reduce mortality by 6 to 25% (Hamid et al., 2013). Long term exposure to different chemical contaminants also causes human health problems, in contrast to immediate effects of biological or bacteriological contamination. Whenever different species of human pathogens are present in drinking water like *Salmonella*, *Yersinia enterocolitica*, *Shigella* and *Campylobacter* cause serious risk of ailments like gastroenteritis, diarrhea, dehydration etc. Various viruses such as Rota virus, Hepatitis A and E virus and parasites like *Giardia lamblia* and *Entamoeba histolytica* also cause different health problems (Park and Park, 1991; Geldreich, 1992; Bridges, 2007; Pommervilli, 2007).

During the last decades, water quality of many rivers in India has been checked using standard measurement techniques. Rapidly increasing urbanization and industrialization of Amritsar has not only adversely impacted the quality of ambient air in the city but also has affected the city water resources. The ground water pollution in Amritsar is the result of seepage of polluted water from the drains (Tungdhab, Hudiara and Ganda Nallah), release of industrial effluents and heavy metals, leaching of agricultural chemicals, pesticides and fertilizers to groundwater aquifers. The Hudiara Drain, which at once was a fresh water drain used for irrigation purpose, is now carrying disposed untreated industrial and sewage effluents of the city Amritsar. The water of hudiara drain is polluted due to the influx of effluents of different industries. The water of this had polluted the ground water of the nearly areas by leaching of various chemicals and heavy metals. These harmful substances cause a variety of health problems in the people living around this drain. The numbers of residential colonies developed along the nallah face the problem of foul smell. Due to continuous flow of sewage water in drains, the condition of hudiara nallah has been deteriorated and its rehabilitation/ rejuvenation are necessary. At many places, the water from the drain is used for irrigating the fields, which is harmful for consumption. In the primary survey, the residents of the colonies or villages situated along the nallah had claimed to be suffering from various diseases such as gastroenteritis, jaundice, diarrohea and dysentery due to consumption of contaminated water. After this primary feedback, the present study was undertaken to access the physico-chemical analysis of drinking water of colonies situated along the hudiara drain and polluted water of hudiara drain flow in Amritsar district.

Materials and methods

Study area

The Hudiara Drain, starting from the Majitha Fort and entering into the Amritsar from North Eastern side crosses a number of villages along its course i.e. Nangal Pannuwan, Sohian Kalan, Birbalpura, Loharka Kalan, Miran Kot Kalan, Sehchandar, Rudala, Kotla Dal Singh, Dhaul Khurd, Kaler, Khiala Khurd, Khiala Kalan, Boparai Khurd, Kaulowal, Nurpur, Chhiddan, Lohorimal, Gharinda, Achint Kot, Hoshiar Nagar, Mahawa, etc. (Disaster Management Plan 2010-11). It leaves the Amritsar from the South Western side and enters into TarnTaran district and finally to the Lahore District of Pakistan, collecting the city sewage from the Ganda nala on its way (District Disaster management plan Amritsar Draft). Hudiara Nallah having length 39.94 km falls into river Ravi after entering Pakistan boundary. All these drains are storm water drains but at present are used for discharging untreated domestic and industrial effluents. The level of pollution in this drain is extremely high. Apart from these, there are number of industrial units which are existing along the Gandha Nallah and discharging their untreated industrial effluents into it. Gandha Nallah at present not only carries untreated industrial and domestic effluents, but also dense weeds, shrubs, dumped industrial ash/soils, polythene bags, plastics, other domestic refuse, hazardous waste, biomedical waste, heavy silts, mud, cow dung etc.

Water samples were collected from the hudiara drain at different intervals. Drinking water was also sampled (Municipal water supply, Bore well and hand pump) from the resident colonies of urban and rural areas along the side of the hudiara drain. The different sampling sites along with their GPS locations are listed in Table 1.

Physico-chemical analysis

Collected samples of drinking and polluted water were analyzed for pH, Total Dissolved Salts (TDS), Electrical Conductivity (EC), Biological oxygen demand and chemical oxygen demand. Total dissolved salt, Electrical conductivity and pH was measured by Digital meter (Eutech Instruments, PCSTestr 35 series). BOD and COD of water were measured by the method of APHA (2012).

Table 1. Different location site with GPS location.

S. No.	Location site	GPS Location
1	Wadala	N-31 39' 9.5" E-074 46' 20.7"
2	Gamtala	N-31 39' 07.6" E-074 46'58.3"
3	Vill.Kala factory	N-31 38' 52.5" E- 074 48' 03.9"
4	Vill.Malhan	N-31 38' 44.6" E-074 48' 34.0"
5	Vill.Chidhan	N-31 37' 52.6" E- 0.74 41' 41.4"
6	Vill.Lahori malh	N-31 36' 30.3" E- 074 40' 57.4"
7	Vill.Ghrind	N-31 36' 49.5" E- 74 41' 02.0"
8	Vill.Chintan kot	N- 31 35' 44.1" E- 074 40' 17.0"
9	Vill. Kaler	N- 31 36' 49.5" E- 074 41' 02.1"
10	Royal nursery	N- 31 40' 06.4" E- 074 52' 52.9"
11	Ranjit avenue	N- 31 39' 55.8" E- 074 51' 52.9"
12	Gamtala	N-31 39' 42.5" E- 074 51' 07.8"
13	Gamtala chowk	N-31 39' 41.8" E- 074 50' 46.0"
14	Holy city	N- 31 39' 21.8" E- 074 49' 43.2"
15	Swiss city	N- 31 39' 08.5" E- 074 49' 34.2"
16	Vill. kala	N- 31 38' 47.5" E- 074 48' 20.7"

Results and discussion

The physico-chemical analysis of drinking water and hudiara drain are given in Table 2 and Table 3.

pH

The term pH is a measure of the concentration of hydrogen ions in a diluted solution. U.S environmental protection agency classifies pH as a secondary drinking water standard and recommends a pH 6.5 to 8.5 for drinking water. pH of hudiara drain water collected from different sites ranged from 6.83- 8.53. The factors like air, temperature bring about changes the pH of water. The high pH value in the drain water was due to influx of industrial effluents and sewage water. In the present study the fluctuation in the pH sample of drinking water collected from sites around the hudiara drain was recorded with minimum range of 7.3 and maximum range of 8.2. According to World Health Organization (2007), health effects are related with pH of the water. Drinking water with pH above 11can cause skin, eye and mucous membrane irritation and the pH below 4 can cause irritation due to corrosive effects. The New York state department of health explains that load exposure can lead to different neurological and reproductive problems such as seizures, hearing loss and miscarriages.

Electrical conductivity (EC)

Electrical conductivity reflects the capacity of water to conduct electrical current and is directly related to the concentration of salts dissolved in water. EC of drinking water and hudiara drain samples showed variation in all the sites. EC of hudiara drain and drinking water ranged from 959 to 2850 µS and 487 to 1351 µS/an respectively. These reading do not comply with the ISO standards.

Total Dissolved Solids (TDS)

TDS are the total amount of mobile charged ions, including minerals, salts or metals dissolved in a given volume of water, expressed in units of mg per unit volume of water, also referred to as parts per million. The most common chemicals constituents in dissolved form in water are Calcium, Phosphates, Nitrates, Sodium, Potassium and Chloride (Pradhan and Pirasteh, 2011). TDS of the drain water and drinking water ranged from 681 to 9970 mg/L and 346 to 1130 mg/L respectively. Only four samples had ranges less than 500 mg/L. TDS from natural sources have been found to vary from less than 30 mg/L to as much as 6000 mg/L. High TDS level greater than 500mg/L result in excessive scaling in water pipes, water heaters, boilers, and households applicants such as kettles and steam ions. Such scaling can shorten the service life of these appliances. Water containing TDS concentrations below 1000mg/L is usually acceptable to consumers, although acceptability may vary according to circumstances. Water extremely with low concentration of TDS may also be unacceptable to consumers because of its flat, insipid taste. Moderate to high TDS contents can affect taste of water. The TDS more than 500ppm make the water bitter in taste, salty or metallic and may have unpleasant odors. High TDS water is also less thirst quenching. High TDS also interferes with the taste of food and beverages and makes them less desirable to consume. Some of the individual's minerals salts that make up TDS pose a variety of health hazards. The most problematic are nitrates, sodium, sulphates, barium, calcium, copper and fluoride. If a person drinks 2 glass of water a day, his body will have processed 4500 gallons of water over a 70 year span. If the water is not totally pure, this 4500 gallons will include 200-300 pounds of rock that the body cannot utilise most of which will be eliminated through excretory channels, but some of this will stay in the body, causing stiffness in the joints, hardening of arteries, kidney stones, gall stones, and blockage of arteries, microscopic capillaries and other passages in which liquid flow through our entire body [The water (prevention and control of pollution) amendment act, 1988].

Table 2. Physico-chemical analysis of Hudiara Drain water.

S. No.	Location site	pH	EC (µS/cm)	TDS (mg/L)	SALT (mg/L)	BOD (mg/L)	COD (mg/L)
1	Pandori labana	6.83	1552	1090	728	100	250
2	Gumtala	7.96	2070	1450	998	5000	12500
3	Holy city	8.11	1618	1140	791	6500	12500
4	Ranjit avenue	8.53	959	681	492	6800	17000
5	Nursery bye pass	7.89	2850	2020	1360	800	2000
6	Khanna Paper mill	8.05	1166	8250	583	7500	18750
7	Swiss city	8.35	1315	9550	656	3000	7500
8	Pandori warriach	8.03	1242	9150	657	8600	21500
9	Gumsawad	7.83	1545	1110	764	3900	9750
10	Jeevanjot hospital	8.04	2810	2000	1360	7800	19500
11	Pandori warriach Pingalwada	8.27	1485	1060	725	5600	14000
12	Malhan in front of dairy farm	7.80	1993	1410	958	1500	3750
13	Malhan bye pass	7.96	1262	890	627	4900	12250
14	Kala factory	7.83	1264	8950	634	5700	14250
15	Vill. Wadala	7.90	1418	9970	701	3700	9250
16	Sant Baba Kutian vale	7.95	1268	8810	618	800	2000
17	Khana paper mill opposite metro	8.05	1569	1110	767	6500	16250
18	Vill.Chintan kot	7.40	1386	983	686	5200	18400
19	Vill.Chidhan	7.60	1762	1540	885	4500	12000
20	Vill.Lahore malhan	7.40	1396	994	695	4800	17600

Table 3. Physico-chemical analysis of drinking water from different sources.

S. No.	Location	Source of water	pH	EC (µS/cm)	TDS (mg/L)	Salt (mg/L)
1	Vill.Pandori Labana	Borewell	8.2	918	629	448
2	Vill.Verka Pandori	Borewell	7.8	914	645	441
3	Samreela farm, Attari road	Borewell	7.7	995	707	487
4	Holy city	Borewell	7.7	1025	731	507
5	Swiss city	Borewell	7.9	548	388	264
6	Gamtala	Borewell	7.4	1260	894	626
7	Majitha bye pass	Tap water	7.6	1351	960	664
8	Ranjit avenue	Tap water	7.9	500	355	241
9	Majitha bye pass	Hand pump	7.8	1055	744	515
10	Vill. Kala	Hand pump	7.5	1254	886	623
11	Gumtala chowk	Hand pump	7.4	1590	1.13	790
12	Vill. Nangli near Khanna mill	Tube well	8.2	856	608	417
13	Fatehgarh churian road	Tap water	8.06	517	367	248
14	Vill. Lahori malhan	Tube well	7.3	1040	740	509
15	Royal nursery	Tube well	7.6	995	705	492
16	Vill. Chint kot	Borewell	8.3	487	346	233
17	Vill. Kaler	Borewell	7.4	1125	796	554
18	Vill. Chidhan	Borewell	7.6	1200	851	591
19	Vill. Ghrinda	Tube well	7.6	979	695	479

Biological Oxygen Demand (BOD)

Biological oxygen demand refers to the amount of oxygen that would be consumed if all organic compounds in one litre of water were oxidized by bacteria and protozoa. The range can vary considerably. Clear lake might show BOD of less than 2 ml/L of water. Raw sewage may give reading in the hundreds and food processing wastes may be in thousands. BOD is a measure of the oxygen used by micro-organisms to decompose this waste. If there is large quantity of organic waste in the water, there will be a lot of bacteria present to decompose this waste. Its demand for oxygen is high, so BOD level will be high. The BOD of hudiara drain water ranged from 100-8600mg/L. The high range indicated that drain is highly polluted with influx of sewage and industrial pollution. On the other hand, the increment of BOD and *E. coli* and Total Coliform level can be mainly attributed to the organic and micro biological pollution resulting from land use characteristics such as domestic waste water discharges, plant debris and animal waste (Athukorala et al., 2013).

Chemical Oxygen Demand (COD)

The COD of hudiara drain water ranged from 250 to 21500 mg/L. The high range indicated that drain is rich in organic matter and is highly polluted. The chemical oxygen demand test is commonly used to measure the amount of organic compound in water. COD determine the amount of organic pollutants found in surface water and is expressed in milligram per litre. COD is a measure of the capacity of water to consume oxygen during the decomposition of organic matter in which closed water samples is incubated with strong chemical oxidant under specific condition of temperature and for particular period of time. This is further confirmed by the findings of Mohan et al. (2007) who noted that high values of COD due to accumulation of domestic sewage at Naya Talab lake, Jodhpur, India.

Conclusion

The present study indicated that all the physico-chemical parameters of drain water and drinking water were out of the permissible limit. Water of this drain has polluted the ground water of the nearby areas due to leaching of various chemicals and heavy metals. The harmful substances present in the drain were also found to be associated with a variety of health problems in the people living around this drain.

Acknowledgement

We are thankful to Punjab State Council for Science and Technology, Chandigarh for encouragement and financial assistance in the form of Eco-water Literacy Campaign letter no. PSCST/2744, dated 19.6.2014.

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