Journal of the Kalash Science
Volume-10, Number-1, 2022 : 1-7

Website: www.kalashj.com
E-mail: saajjjan@rediffmail.com
ISSN: 2321-7634

Evaluation of water quality of a Galta Ji Temple pond in Jaipur, Rajasthan A multivariate study

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Accepted : 12 March 2022

Abstract

The goal of this study was to determine the physico-chemical and microbiological contamination levels of water samples obtained in Galta Ji, Jaipur, Rajasthan. Standard protocols were used to examine the physicochemical and microbiological analyses. In 2019, water samples were taken from the lake at four different times. Turbidity, pH, total hardness, dissolved solids, sulphate, nitrate, and total alkalinity are among the physicochemical characteristics studied in this study for the winter season. In addition, other parameters such as pH, dissolved oxygen, BOD, and COD were also computed in water samples. Therefore, water of these religious water bodies needed to be regularly changed time to time to protect the aquatic component from different contaminations.

Introduction

Water is the most basic requirement for life on earth. It is a necessary component for all kinds of life, from microbes to humans and important to numerous sectors of Indian economy (Bhatnagar *et al.* 2016, Dwivedi *et al.* 2018a). Human rely on renewable fresh water for drinking, irrigation of crops, and industrial uses as well as production of fish and waterfowl, transportation, recreation, and waste disposal. The dumping of residential sewage and industrial effluents into freshwater bodies pollutes around 70% of India's water supply. According to the World Health Organization, India loses 0.4 million lives per year owing to ashortage of safe and sanitary water (WHO 2007). India is a country with a diverse cultural heritage and several festivals. Religious activities are an important part of India's cultural history. Apart from idol immersion, numerous religious offerings such as flowers, decorative materials, polish, painted material, polythene bags, and food offerings are dropped in water bodies during the festival, causing pollution.

In temperate climatic zones, lake ecosystems are subjected to considerable leisure activity (Hatvani *et al.* 2018). Several studies have shown that anthropogenic activities are the primary cause of pollution in all ecosystems (Yunus *et al.* 2020). In many nations throughout the world, water pollution is one of the most serious environmental issues (Xu *et al.* 2020). Decades of industry and urbanisation have resulted in increased water pollution, mostly from agricultural runoff and toxic industrial effluents (Purohit *et al.* 2020).

Reports by the World Health Organization (WHO), suggested that water-borne diseases are one of the leading causes of death in the world, resulting in a mortality rate of 3.4 million every year, most of which occur in children under the age of five years. Further, the waterborne disease caused by pathogenic microorganisms led to over 600,000 deaths per year in low and middle-income countries, amounting to 1.5 million deaths worldwide. In developing countries, there is an obvious lack of suitable sanitary framework and sewage water treatment capacities, provoking the contamination of the environment and drinking water sources (Farkas *et al.* 2020). The quality of the lake or other surface water systems can be assessed by several physicochemical and biological parameters based on the Designated Best Use (DBU) of the lake water systems.

According to the WHO report, over 50% of the world population will be residing in water-stressed regions, by 2025 (WHO 2019). Over 5% loss in the gross domesticproduct (GDP) in developing countries is due to pollution. Pollution not only impedes public health and the economy, but can also jeopardize food security, drinking water availability and biodiversity (Yadav & Srivastava 2011, Tiwari *et al.* 2016, Akhtar & Mannan 2020). The present study was conducted to depict the effect of religious activities on water quality of Galta Ji Temple pond in Jaipur, Rajasthan.

Methodology

The description of the study area

Locating in a mountain pass at Aravalli Hill from the 18 th, Galta Ji temple complex encompasses water springs and holy 'kunds' or water tanks. Among these kunds, the 'Galta Kund' is the holiest one and believed to never get dry. A spring of water flows from the 'Gaumukh' - a rock shaped like a cow's head.

Galtaji is a historic Hindu pilgrimage located around 10 kilometres from Jaipur, Rajasthan, India. A succession of temples has been erected into a tiny fissure in the ring of hills that encircle Jaipur. A natural spring springs from the top of the hill and runs down, filling a succession of holy kunds (water pools) where pilgrims wash. Natural springs gather water in tanks at the Monkey Temple, also known as the Sun Temple (kunds). Heavy metal- accumulating monkey faeces are used as markers of heavy metal pollution in the environment, and they can also be a source of heavy metal pollution in the soil and water in Galta Ji, Jaipur (Ha *et al.* 2019).

Sample collection

The Indian Standard Methods IS 3025 (Part 1) and the American Public Health Association, 23rd Edition were used to collect about 400 cc of water samples from the two lake sites (2017). The samples were collected in sterile 500 ml vials with dimensions of 43 mm 69 mm 208 mm. During January 2019, three water samples were taken from each site utilising the grab sampling approach using a bucket sampler at a depth of roughly 1 m below the water's surface. The bottles were sealed and secured to prevent air from getting into them, and they were delivered to the study lab within 8 hours of being collected. The samples were stored in a dark room for 4 h, before further processing. The laboratory analysis of samples was done using standard methods (APHA 2005).

Physiochemical characterization

Analytical method used for determination of different physicochemical parameters for waters of Galta Ji and ground water at near site is listed in Table 1. The water samples were collected from different sites in plastic bottles and transported to the laboratory in an icebox jars to avoid unpredictable changes in different physicochemical parameters. The selected parameters including Water pH, Turbidity, Total alkalinity (TA), Total dissolved solids (TDS), Total hardness (TH), NO_3, SO_4^{-2} were analyzed at regular intervals. The observed values of various physicochemical parameters of water samples were compared with standard values recommended by World Health Organization (WHO, 1993) for drinking purposes. Apart from these parameters Winkler's method (Zhang *et al.* 2019) was employed to evaluate the Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD) for 5 days. COD is also a measure of pollution in aquatic ecosystems. It estimates carbonaceous factor of the organic matter

Results and Discussion

A) Hydrogen Ion Concentration (pH)

The pH of water is important because many biological activities can occur only within a narrow range. Thus, any variation beyond an acceptable range could be fatal to a particular organism. Present study shows pH is alkaline in most of samples and it ranges from 7.0 to 7.8 and mean value was 7.883 ± 0.08050. The pH value of different studied in different samples is within highest desirable limit (HDL) prescribed by WHO which is 6.5 to 8. The pH affects the dissolved oxygen level in the water, photosynthesis of aquatic plants, metabolic rates of aquatic organisms (Ruhela *et al.* 2018).

B) Turbidity

The turbidity is a major problem in the river water of all states. The turbidity value was found higher during monsoon season. Present study results show that turbidity of pond sample has increased tremendously to 10.27 NTU. During festival season immersion of idols in urban water bodies have grown in number and size over the years and therefore urban water bodies are facing an increasing nutrient load (Vyas *et al.* 2006, Dwivedi *et al.* 2016).

C) Chloride ion

The chloride value was 63.30 mg/l in pond water samples, which was found within the permissible limit for drinking water (250 mg/L) prescribed by IS: 10500 and BIS, FAO. The high organic matter and pollution load of pilgrims on the water bodies like bathing, adding ashes, flour, floral offerings, and urination may increase the chloride contents of water in conformity with the findings of Gupta *et al.* (2011).

D) Total Alkalinity

Alkalinity of water is important for aquatic life in a fresh water ecosystem as it equilibrate pH changes resulting from photosynthesis. We measured TA of 153.5 mg/l in surface GW compared to 159.6 mg/l respectively for same period. The variation of TA is in accordance with fluctuation in pollution load (Parashar *et al.* 2006). Total alkalinity for all seasons for treated water and GW is within permissible limit of WHO which is 200 mg/l. Total Alkalinity in water is due to salts of weak acids and bicarbonates of highly alkaline water. Alkalinity values of 20-200 ppm are common in freshwater ecosystems (Venkatesharaju *et al.* 2010, Ruhela *et al.* 2018).

E) Total Hardness

Hardness is an important parameter in decreasing the toxic effect of poisonous element. The measured value of TH increased to 170.7 mg/l compared to 153.5 mg/l respectively of GW samples. These high value may be due to the concentration of carbonate and bicarbonate salt of calcium and magnesium. Tiwari *et al*. (2016) stated that the water hardness refers to the concentration of divalent calcium, Magnesium, Strontium, Ferrous, and Manganese ions. It is derived largely from soil and rock erosion.

F) Total Dissolved Solids

TDS indicate the total amount of inorganic chemicals in solution. Total dissolved solids consists majorly all of the inorganic and organic substances in the water body that are generally found in the suspended form. Total solids cause ecological imbalance in the aquatic ecosystem by mechanical abrasive action (Ruhela *et al.* 2018). Mishra & Dwivedi (2020) reported that the TDS was increased due to browsing nature of fishes in the water bodies. A high content of dissolved solid element affect the density of water influence osmoregulation of fresh water organism, reduce solubility of gases and utility and water for drinking (Dwivedi *et al.* 2017, 2018b).

G) Sulphate

Value of SO_4^{-2} contents for ground water and pond water is far below the maximum allowable concentration for sulphate ions in drinking water prescribed by WHO which is 250 mg/l. For the surface pond water samples show higher values of pH, turbidity, TA, TDS, TH, NO_3, SO_4^{-2} than values of respective parameters for ground water samples. This quality deterioration in pond water is due to various reasons like extent of pollution occurring due to urbanization and anthropogenic activities. Chavan *et al.* (2006) observed minimum sulphate 5.34 mg/l at winter, whereas maximum value 13.95 mg/l in monsoon season in which both season have lower value compared to present work.

H) Nitrate

In present study NO_3 levels are below 45 mg/l according to WHO, in ground water it is 30.06 mg/l, whereas the level of nitrate observed high (32.64 mg/l) in pond water. In surface waters nitrogen may exist as particulates or dissolved forms. Organic nitrogen decays to produce ammonia via anaerobic bacteria decayed process. Ammonia in turn converted to nitrites and ultimate to nitrates via the process of nitrification, an aerobic bacteria procedure. Algae readily take up dissolved inorganic nitrogen, which consist of ammonia and nitrate with a typical preference for ammonia. Nitrates added into the river water mainly by agricultural runoff (Tiwari *et al.* 2016).

I) Chemical Oxygen Demand (COD)

COD is a method to determine the organic load of water body i.e., susceptible to oxidation. COD as a result of pollution is largely determined by the various organic and inorganic materials as like calcium, magnesium, potassium, sodium etc. The levels of COD seem to be the appropriate indices for assessing the pollution level of water bodies. The high COD values are found mainly in water, which may be due to the mixing of domestic and industrial wastes. It was observed that in all the effluents are very much higher than 30.0 mg/l which have maximum permissible limit according references. Tripathi *et al.* (1991) recorded higher mean values of COD 520 ± 180 mg/l at Varanasi compared to present findings

J) Dissolved Oxygen (DO)

DO play an important role in water quality determination. The dissolved oxygen amount in waste water sample is very less, due to high amount of BOD and COD. DO values indicate the degree of pollution in water bodies (Ruhela *et al.* 2018). DO levels between 5.0 and 8.0 mg/l are satisfactory for survival and growth of aquatic organisms (Yadav & Srivastava 2011, Tiwari *et al.* 2016). The value of DO increased in winter due to circulation of cold water as well as high solubility of oxygen at low temperature (Kamal *et al.* 2007, Dwivedi & Pathak 2007, Dwivedi *et al.* 2018a).

K) Biochemical Oxygen Demand (BOD)

The mean BOD was recorded 5.410± 0.05294. Khwaja *et al.* (2001) provides mean BOD value 2.8 ± 0.4 in summer and 3.5 ± 0.4 mg/l in winter at Kanpur from the Ganga River. BOD may be defined as rate of removal of oxygen by microorganisms in aerobic degradation of the dissolved organic matter in water over a 5-day period. Increases in BOD can be due to mix of unwanted religious offerings in pond water. BOD values are thus use full in evaluation of self-purification capacity of a water body and for possible control measure of pollution (Tiwari *et al.* 2016).

Galta ji is a water fall and water flows from one side to another. Large type of *Synedra* and *Melosira* along with some other varieties of diatoms i.e. *Rhoicosphenia* and *Cyclotella* were also reported in previous study done by Singh R. and their colleague. Diatomswere found in abundance in this water body.

The results of the present investigation point out that the water is not good for human consumption and also struggling for their existence. So there is an immediate need to implement advances and improvement in waste water treatment methods and implementation of various compatible policies and objectives for the human and environment.

Table 1. Different physicochemical parameters used for waters samples analysis and their permissible range.

S.r. No.	Parameters	Unit of Measurement	IS 10500 : 2012 Requirement Acceptable Limit
1	pH	-	6.5-8.5
2	Turbidity (NTU)	NTU	5
3	Odor	-	-
4	Color	HZN	5
5	Chloride (as Cl)	mg/l	250
6	Alkalinity	mg/l	200
7	Total Hardness (as $CaCO_3$)	mg/l	200
8	Total Dissolved Solids	mg/l	500
9	Total Solids	mg/l	500
10	Sulphate (SO_4)	mg/l	200
11	Nitrate (NO_3)	mg/l	45
12	COD	mg/l	30
13	Dissolve Oxygen (DO)	mg/l	4.00-6.00
14	BOD	mg/l	5(ICMR)

Fig 1. Compare analysis of various parameters for measuring pollution of Galta ji in winter season

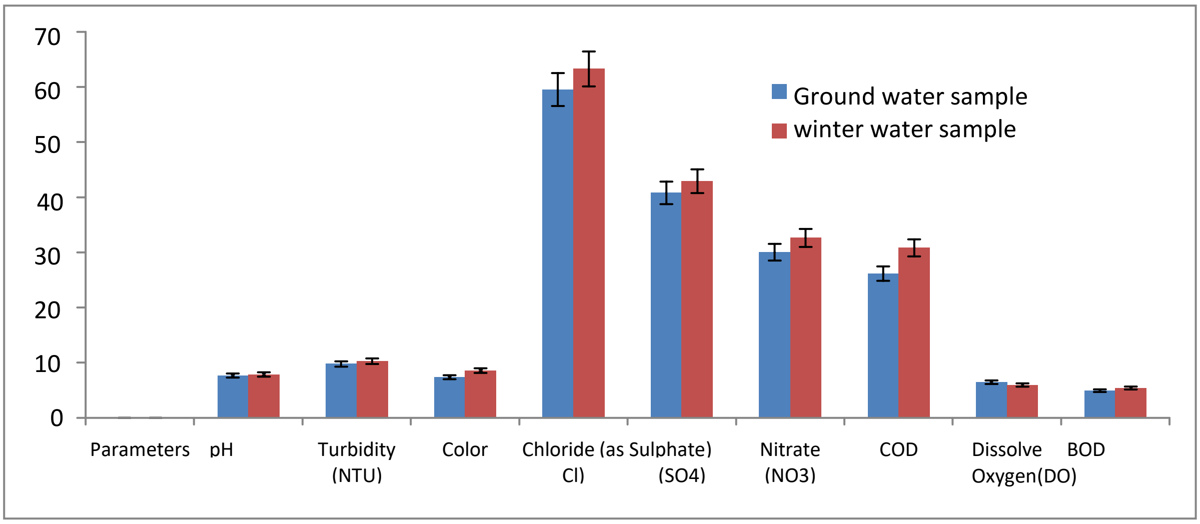

Table 2 Analysis of ground water and compare with Galta ji pond water in winter season.

S.r. No.	Parameters	Unit	Ground water sampleMean ± SEM	Galta Ji water sample Mean ± SEM	Protocol
1	pH	-	7.669 ± 0.03417	7.883 ± 0.08050*	IS: 3025 (pt-11)-1983, Reaff.2017
2	Turbidity(NTU)	NTU	9.778 ± 0.2078	10.27 ± 0.1416^{ns}	IS: 3025 (pt-10)-1984, Reaff.2017
3	Odor	-	Agreeable	Agreeable	IS: 3025 (pt-5)-1983, Reaff.2017
4	Color	HZN	7.365 ± 0.4268	8.579 ± 0.2895*	IS: 3025 (pt-10)-1984, Reaff.2017
5	Chloride (as Cl)	mg/l	59.56 ± 1.801	63.30 ± 0.7972 ^{ns}	IS: 3025 (pt-32)-1988, Reaff.2019 (Argentometric Method)
6	Alkalinity	mg/l	140.9 ± 4.827	159.6 ± 10.50^{ns}	IS: 3025 (pt-23)-1986, Reaff.2019
7	Total Hardness (as CaCO3)	mg/l	153.5 ± 7.452	170.7 ± 7.478^{ns}	IS: 3025 (pt-21) Reaff.2019 (EDTA TitrimetricMethod)
8	Total Dissolved Solids	mg/l	431.3 ± 4.593	447.4 ± 6.025*	IS: 3025 (pt-16)-1984, Reaff.2017
9	Total Solids	mg/l	452.3 ± 7.393	466.0 ± 9.058^{ns}	IS-3025(Pt- 15)1984,Reaff.2019
10	Sulphate (SO4)	mg/l	40.83 ± 0.9330	42.94 ± 0.1541*	IS: 3025 (pt-24)-1986, Reaff.2019 Turbidity Method
11	Nitrate (NO3)	mg/l	30.06 ± 0.9396	32.64 ± 0.3024*	IS: 3025 (pt-34)-1988, Reaff.2019 (Chromotropic AcidMethod)
12	COD	mg/l	26.17 ± 0.8124	30.85 ± 0.9876***	IS: 3025 (pt-58)-2006, Reaff. 2017
13	Dissolve Oxygen (DO)	mg/l	6.479 ± 0.06449	5.978 ± 0.1847*	IS: 3025 (pt-38)-1989, Reaff. 2019 (Titrimetric Method)
14	BOD	mg/l	4.926 ± 0.1283	5.410 ± 0.05294**	IS: 3025 (pt-44)-1993, Reaff.2019

(Mean ± SEM of 25 Samples)
*** = highly significant ($p \leq 0.001$)
** = significant ($p \leq 0.01$)
* = significant ($p \leq 0.05$) ns
= non-significant

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