IJBPAS, October, 2023, 12(10): 4781-4790

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

PHSICO-CHEMICAL AND BIOLOGICAL ASSESSMENT OF SEWAGE WASTE WATER, USED IN IRRIGATION PURPOSE, OF JODHPUR, RAJASTHAN, INDIA

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Received 10th Sept. 2022; Revised 6th Oct. 2022; Accepted 14th Feb. 2023; Available online 1st Oct. 2023

https://doi.org/10.31032/IJBPAS/2023/12.10.7517

ABSTRACT

Quality of sewage waste water is assessed, used in irrigation purpose, to get the suitability of water for agriculture. Water samples were collected and analysed for various parameters: pH, odour, colour, turbidity, total hardness, iron (Fe), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Dissolved Oxygen (DO), Total Suspended Solids (TSS), and various metal ions. Biological assessment such as E-coli, total coliforms and faecal coliforms were also done. All the physicochemical parameters determined were found within FAO/WHO standard limit for irrigation water except higher values of COD, BOD and TSS, which were present much above the acceptable limits. *E-coli* were found present in all samples. Total coliforms and faecal coliforms were found in very high concentration than the standard limit. The treatment of raw sewage waste water is necessary otherwise the entry of this polluted water in ground water shall be highly harmful to the flora and fauna of the region and will affect the human health. Based on the experimental outcomes, it is suggested that quality measures of sewage waste water should be considered while using such water for irrigation.

Keywords: Sewage water, Irrigation, Biological oxygen demand, Chemical oxygen demand

INTRODUCTION

Rapid industrialization and urbanisation is posing serious concern regarding the disposal of waste water in Jodhpur city. There is no perennial river in the district.

The main source of irrigation besides the rainwater is wells and tube-wells. Jojari river is an ephemeral stream in the area which flow in response to monsoon rainfall. The city sewerage is directed to Jojari through various drains. Jodhpur city have no proper network to collect entire sewage **[1]**. Drainage and Sewerage system in this city is quite old. Due to inadequate collection system major part of untreated sewage is discharged directly or indirectly in open drains which lead to surface water bodies and are used for various purposes. Sewage often untreated/raw or diluted is used to irrigate 10% of the world's crops according to first ever global survey of waste water irrigation **[2]**. Farmers especially of urban areas use this effluent because it is free and chiefly available. There are number of open and covered channels spreading within and around the Jodhpur city, which carry untreated city effluents. In Jodhpur the waste effluents from different sources and rainwater flows away by the same drainage systems **[3]**. These channels pass through or near by the farming land where farmers divert or pump out the drainage for irrigating their crops and vegetables. Local farmers also pump the effluent and use as such without any treatment for irrigation. It is inferred by study of various research and review papers that the continuous use of untreated/raw sewage waste water used in irrigation practices makes the soil unproductive, hazard and toxifies the grown crop or vegetable by metal ion load and pathogenic micro-organism contamination and other agricultural products and ultimately has adverse effects on environment and human health **[4]**.

MATERIAL AND METHODS

Study Area

The Jodhpur city of state Rajasthan is selected for the study. Jodhpur is the second largest town of Rajasthan State. It is located between latitude 26°15' N to 26°20' N and longitude 73°0'E to 73°4'E **(Figure 1)**. The standard urban area of Jodhpur town is 208.31 Sq.km comprising 78.60 Sq.Km area of urban component and 120.71 km sq. area of rural component. The Jodhpur Urban/Metropolitan area includes Jodhpur, Kuri Bhagtasani, Mandore Industrial Area, Nandri, Pal Village and Sangariya. The main sewage waste water drainage areas are Banad, Nandri, Basni Benda, Shikargarh, Jhalamand and Salawas **(Figure 2)**. The seepage from these open drains and sewerage lines is continues throughout the year and is polluting the adjacent land **[5]**.

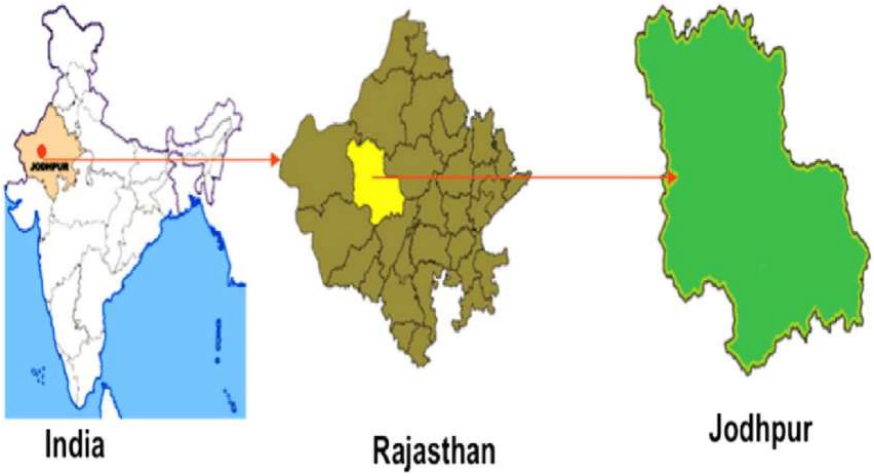

Figure 1: Location of Jodhpur

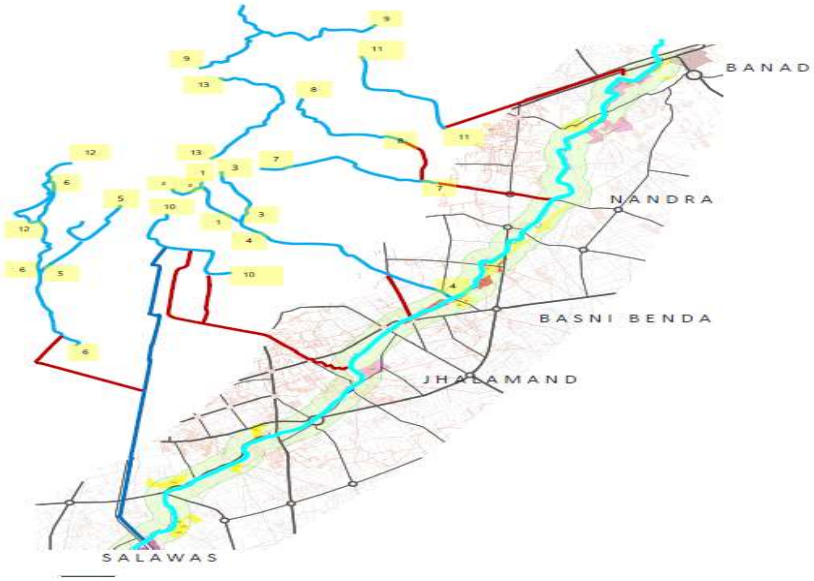

Figure 2: Map showing Drainage in located areas

Collection Samples

Field survey of Jodhpur urban area which includes, Kuri Bhagtasani, Mandore Industrial Area, Nandri, Pal Village, Banad, Salavas, Jhalamand and Sangariya was done for the selection of appropriate samples. Samples were collected from three locations of Banad Area in November month 2022 **(Figure 2)**. Samples were collected in pre-cleaned polypropylene screw capped bottles of one litre capacity. The standard methods and procedures were used for collection and quantitative estimation of water quality parameters **[6]**. Waste water samples for biological analysis (*E.coli* and Coliforms) were collected in pre-sterilized glass bottles and were covered in brown paper **[7, 8]**.

Physico-chemical and Biological Analysis

Determination of pH was carried out at site. Physical parameters of the collected water samples that were measured in this study were temperature, pH, TSS and TDS. The chemical analysis of the collected water

samples measured in this study were DO, BOD, COD, and alkalinity. Biological analysis (*E.coli* and Coliforms) were carried out as per standard method of APHA (2005) and WHO (2006) **[7, 8]**. All results were compared with standardized levels for wastewater quality used in irrigation in accordance with ISI (1986) **(Table 1)**.

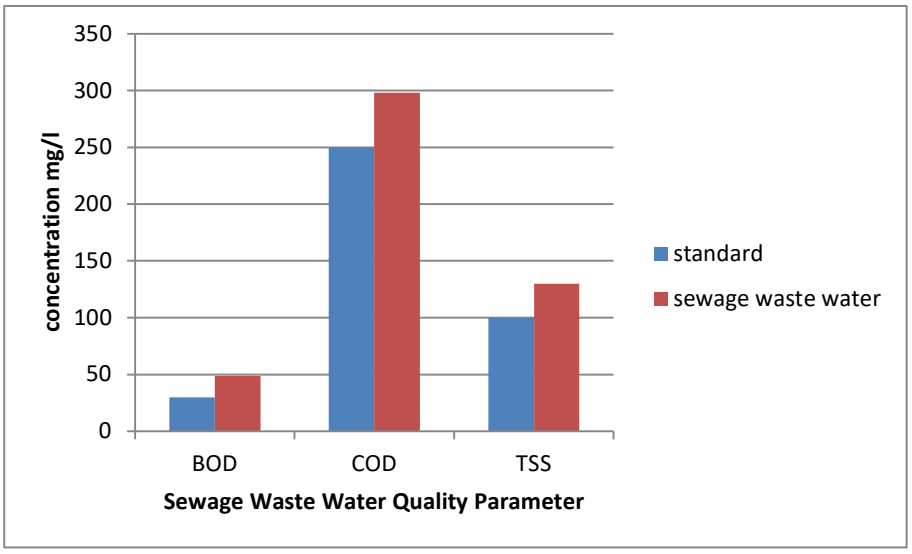

Figure 3: Comparison of BOD, COD and TSS of sample-1 with standard parameters

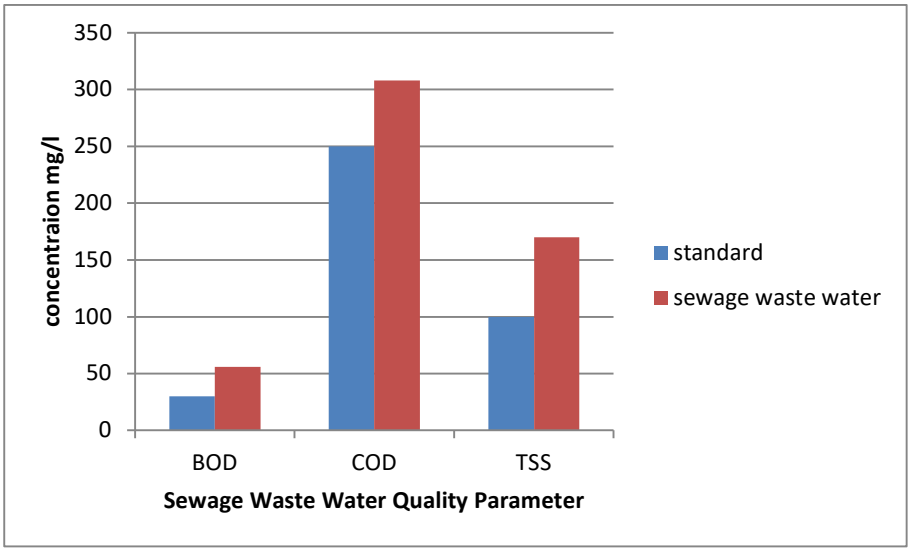

Figure 4: Comparison of BOD, COD and TSS of sample-2 with standard parameters

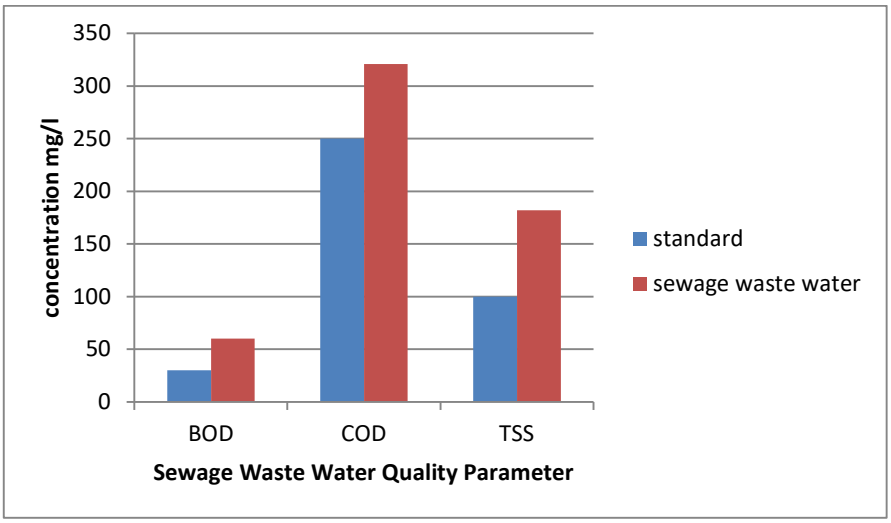

Figure 5: Comparison of BOD, COD and TSS of sample-3 with standard parameters

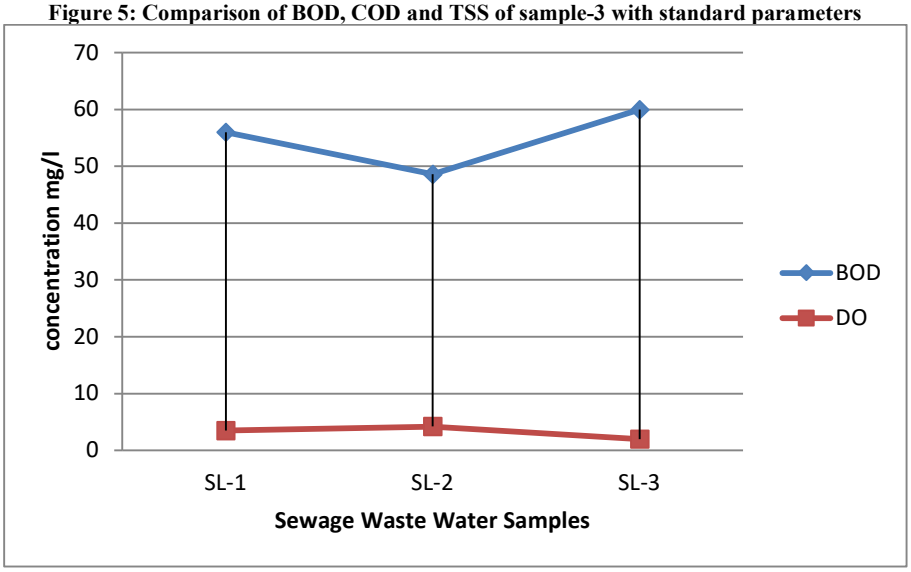

Figure 6: Correlation of BOD with DO of sewage waste water

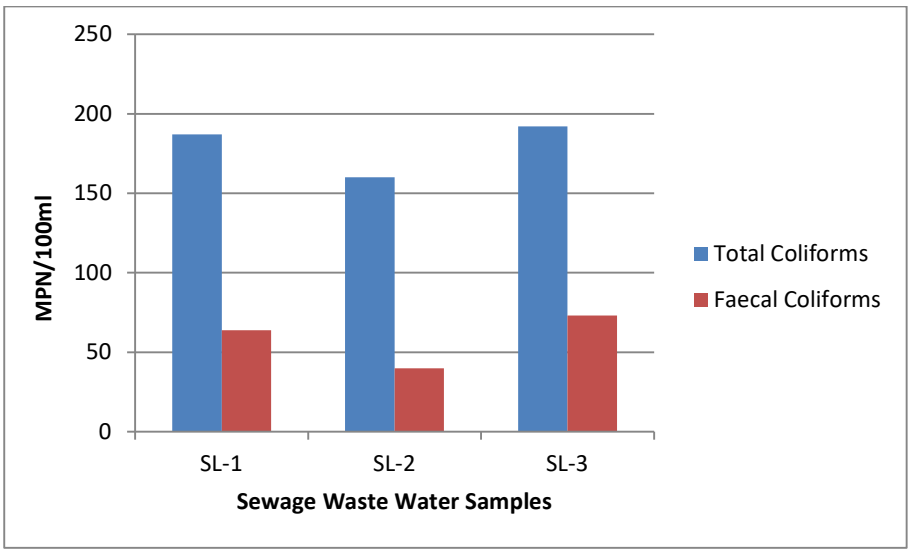

Figure 7: Biological assessment of sewage waste water

RESULTS AND DISCUSSIONS

pH: It is the concentration of hydrogen ions. It measures the acidity or alkalinity of water on a scale of 1-14. A pH value of 7 is neutral; a pH less than 7 is acidic, and a greater than 7 represents base saturation or alkaline. pH is an important parameter in evaluating the acid-base balance of water. The pH of the water is known to influence the availability of micro-nutrients as well as trace metals **[9]**. The principal component regulating ion pH in natural waters is the carbonate, which comprises CO_2, H_2CO_3, and HCO^-_3 **[6]**. Alkalinity measures the amount of carbonate in water and reflects the ability of water to neutralize the acidity of soil. Alkalinity also serves as pH reservoir for inorganic carbon. It is usually taken as a productive potential of water **[10]**. All the three samples analysed for pH was found was found alkaline, with values 7.2, 6.93, 7.8 of sample-1, sample-2, and sample-3 respectively **(Table 1)**.

BOD: BOD is defined as the amount of oxygen needed by the micro-organisms while stabilizing biologically decomposable organic matter in waste water under aerobic conditions. The degree of pollution in waste water can be determined by BOD testing **[11]**. It is an important parameter that indicates the magnitude of water pollution by the oxidisable organic matter and the oxygen used to oxidize inorganic material such as sulphides and ferrous ions **[12]**.

High BOD values during summer induce the high growth of bacteria. Low BOD values in winter due to lesser quantity of total solids as well as to the quantitative number of population. The highest BOD value during monsoon was possibly due to high quantity of organic matter and industrial effluents **[13]**. Present investigation revealed high concentration of BOD in waste water that ranges from 48.6-60 mg/l in comparison to permissible limit that is 30 mg/l **(Figure 3, 4 and 5)**.

DO: The DO is a measure of the extent of pollution by organic matter, the destruction of organic substances, and the self-purification capability of the water body. Therefore, higher values of DO are desirable in wastewater to decompose organic contents into it **[14]**.

The amount of DO is directly influenced by BOD. The greater the BOD, the more rapidly oxygen is depleted in the water. This means that less oxygen is available to higher forms of aquatic life. In order to oxidize the organic content properly, it is desired to have a sufficient amount of DO **[15]**. BOD and DO are related inversely i.e., when DO is minimum BOD rates are higher **[14]**. It is also confirmed by the present study that the sample-3 with maximum BOD (60 mg/L) have least DO (2 mg/L) **(Figure 6)**. The DO in

wastewater in this study was found ranging between 2.55-3.30 mg/L, which is lower than the standard value 4.5–8.0 mg/L.

COD: COD is the measurement of the amount the oxygen equivalent of that portion of the organic matter in a sample that is susceptible to oxidation by a strong chemical oxidant. The amount of oxygen required is useful in specifying toxic condition and presence of biologically resistant substances. COD is also one of the most common measures of pollutant organic material in water **[16]**.

COD values are always higher than BOD values for the same sample **[17]**. It is confirmed by observed analytic data of the study **(Table 1)**. The standard value of COD is 250 mg/L and was found very high in collected samples varying from 298 mg/L to 321 mg/L **(Figure 3, 4 and 5)**.

TSS: TSS is one of the major indicators of water quality. It is the amount of total solids that can settle gravitationally in the waste water. TSS is further classified into organic (volatile) and inorganic (fixed) fractions. Organic matter is present either in dissolved or colloidal form **[18]**. High value of TSS affects the life of aquatic inhabitants as it reduces the natural DO level in water and raises the temperature **[19]**. The standard value of TSS is 100 mg/L and the sample analysis reported increased value of TSS ranged from 110 mg/L- 182 mg/L **(Figure 3, 4 and 5)**.

Biological parameters: Coliforms are very important biological indicator of water pollution. As coliforms exist in intestinal system of humans, they get excreted with body wastes. As a result, sewage will always contain coliforms. *Escherichia coli* are particular form of species of coliforms generally found in sewage waste water. Coliform bacteria are aggressive organisms and survive in the water longer than most pathogens **[17]**. *Escherichia coli (E.coli)* are a group of gram negative, facultative anaerobic, rod-shaped bacteria colonizing intestinal tract of warm blooded animals including human beings. They are the members of faecal coliform group. Along with other similar bacteria like *Enterobacter* sp, *Citrobacter* sp, *Klebsiella* sp, they form a group called Escherichia. Several strains of *E. coli* are non-pathogenic and do not cause any disease but some of them can cause diarrhoea, urinary tract infections, respiratory illness and pneumonia **[20]**. The samples tested positive for presence of *E. coli* whereas number of the coliform and faecal coliforms were found between 160-192 MPN/100 ml and 40-73 MPN/100 ml respectively **(Figure 7)**.

Table 1: Standard and Observed value of physico-chemical and biological parameters

Parameters	Units	Standard value as per ISI	SL 1	SL 2	SL 3
pH	-	6.5–8.5	7.2	6.93	7.8
BOD	mg/L	30	56	48.6	60
COD	mg/L	250	308	298	321
TSS	mg/L	100	170	130	182
DO	mg/L	4.5-8	3.5	4.2	2.0
E.coli	P/A	-	Present	Present	Present
Total Coliform	MPN/100 ml	11-32	187	160	192
Faecal Coliforms	MPN/100 ml	1-26	64	40	73

CONCLUSION

This experimental study was conducted to measure and assess the physico-chemical and biological characteristics of municipal wastewater from three locations of Banad Area, Jodhpur Rajasthan, used for agricultural purpose. The observed data reveals that some of the parameters such as BOD, COD, TSS surpassed the accepted values.DO values were found lower than the standard limit. pH values of all the samples meet the standard acceptable limit of India. The fallouts of biological results show the presence of *E. coli* and increased population of faecal coliforms and total coliforms.

Such waste water could pose a potential environmental risk particularly to receiving soil, grown crops/vegetables and finally the health of human being. So, it is recommended that necessary analytic test should be performed before discharging and using the waste water into agricultural fields. Treatment of waste water prior to use in irrigation should be considered to improve the water quality, so that it meet the required acceptable standards and also meet the assumptions of consumers and common public to protect the environment.

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