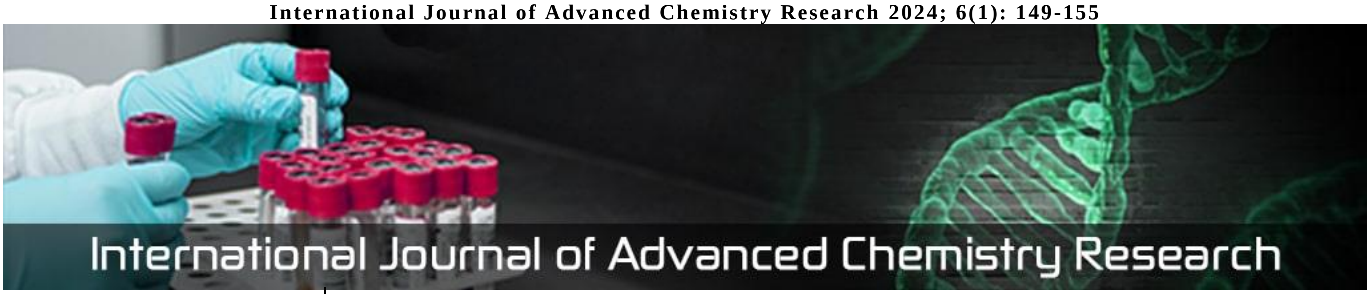

ISSN Print: 2664-6781
ISSN Online: 2664-679X
IJACR 2024; 6(1): 149-155
www.chemistryjournals.net
Received: 06-04-2024
Accepted: 11-05-2024

Sukhveer Singh
Department of Chemistry, Desh Bhagat University, Mandi Gobindgarh, Punjab, India

Manpreet Kaur Verma
Department of Chemistry, Desh Bhagat University, Mandi Gobindgarh, Punjab, India

Corresponding Author:
Sukhveer Singh
Department of Chemistry, Desh Bhagat University, Mandi Gobindgarh, Punjab, India

Quality assessment of groundwater of nearby areas of Lasara Dhanola drain water for drinking and irrigation purpose

Sukhveer Singh and Manpreet Kaur Verma

DOI: https://doi.org/10.33545/26646781.2024.v6.i1b.180

Abstract
With the growing concern over water scarcity and pollution, the utilization of alternative water sources such as drained water has gained traction. However, the safety and suitability of drain water for human consumption and agricultural use necessitate thorough evaluation. The study employs a multidimensional approach to assess the physical, chemical, and biological parameters of drain water. Parameters including turbidity, pH, dissolved solids, heavy metals, pesticide residues, and microbial contamination are analyzed to determine water quality. Sampling points along the drainage system are identified, and water samples are collected at regular intervals to capture variations in quality. Laboratory analysis of the samples is conducted following standardized protocols and guidelines. Results are compared with established water quality standards for drinking water and irrigation. The article discusses the implications of exceeding permissible limits and assesses the associated risks to human health and agricultural productivity. Recommendations are provided for treatment options, regulatory measures, and public awareness initiatives to address identified risks and promote safer water usage practices. An action plan outlines steps for implementing recommended measures, including treatment technologies, regulatory enforcement, and stakeholder engagement.

Keywords: Drain water, water quality assessment, drinking water, irrigation, contamination, risk mitigation

Introduction

Water quality assessment plays a pivotal role in safeguarding human health and environmental sustainability. With the increasing demand for water resources and the growing concerns over pollution, the evaluation of water quality parameters is imperative, particularly for alternative water sources like drained water. Drain water, originating from various sources including urban runoff, industrial discharge, and agricultural runoff, presents unique challenges due to its potential contaminants and varied composition.

This brief introduction aims to highlight the significance of assessing water quality parameters of drain water and the importance of understanding its characteristics for effective management and utilization.

Water is essential for life and numerous human activities, including drinking, agriculture, industry, and recreation. Ensuring its quality is paramount to prevent adverse health effects and environmental degradation. Water quality assessment provides insights into the physical, chemical, and biological properties of water, enabling informed decision-making and implementation of appropriate management strategies.

Drain water, often characterized by its diverse sources and complex composition, poses unique challenges for water quality assessment. It may contain pollutants such as heavy metals, organic compounds, pathogens, and nutrients, derived from various anthropogenic and natural sources. Understanding the specific contaminants and their concentrations is essential for evaluating the suitability of drain water for different purposes, including drinking and irrigation.

Water quality assessment involves the analysis of various parameters to determine its suitability for specific uses. Key parameters include physical characteristics such as turbidity, color, and odor, which provide indications of water clarity and aesthetics. Chemical parameters such as pH, dissolved oxygen, nutrients, and contaminants like heavy metals and pesticides, offer insights into water composition and potential risks. Biological parameters, including microbial indicators of fecal contamination, assess the presence of pathogens and microbial pollution. In the present study, an attempt has been made to investigate standards of water quality for drinking and irrigation purpose near Lassara-Dhanoula drain.

Results

Groundwater quality analysis for drinking purposes

Standards for the quality of drinking water have been set by different agencies like APHA [1], WHO [2, 3] and Indian drinking water specification [4].

pH

The pH range of all groundwater samples ranged between 6.8 to 7.9. All the water samples were found within permissible limits prescribed by BIS and WHO standards. It has been observed that pH values of one sampling station were found less than 7 and that the water was acidic in nature.

Electrical Conductivity

The values of conductivity in groundwater samples from different locations ranged from 560-1364 µs/cm. The highest value of EC was found at sampling site G_{14} and lowest value was recorded at G_8. According to Drinking Water Specifications IS 10500: 2012 and WHO (2012) value for electrical conductivity should be less than 300 µs/cm.

Total Dissolved Solids

The TDS values of groundwater samples were ranged between 390-900 mg/l. A maximum and minimum value of TDS was recorded at sampling sites G_8 and G_{14}. The range of TDS falls between 500 to 2000 mg/L is recommended by BIS standards. It has been studied that TDS in groundwater is mainly caused by rotting of vegetables, evaporation, contamination, disposal and chemical weathering and improper removal of solid waste from the municipality.

Total Hardness

Total hardness of groundwater samples at various locations varied between 272-456 mg/L. The desirable limit for total hardness should be 200 mg/L and the permissible limit for drinking water should be 600 mg/L as set by BIS standards. Most of the groundwater samples were higher than the desirable limit of BIS standards. During the investigation, it was found that total hardness was highly varied in groundwater samples than in surface water of the drain.

Turbidity

In present study, turbidity was recorded from 0.25 NTU to 9 NTU. The most of values were found below the detection limits. The permissible limit of turbidity is 5 NTU, at sampling site G_6 and G_7 turbidity was observed 0.8 and 0.6 NTU respectively. Rest all groundwater samples are suitable for drinking and domestic purposes as compared to surface water of Lasara-Dhanola drain.

Calcium

The calcium concentration in groundwater samples were ranged from 43-85 mg/L. Maximum value of calcium was registered at sampling station G_9. All groundwater samples were under the acceptable limit of BIS standards (75 mg/L) except 3 sampling stations (G_6, G_9 and G_{14}). The present study reveals that the calcium content is almost similar in groundwater and surface water of drain.

Magnesium

Magnesium contributes in both carbonate and non-carbonate hardness to water. The concentration of magnesium was found between 25 mg/L to 63 mg/L. It has been observed that the concentration of magnesium was high in most of groundwater samples according to the desirable limit of BIS standards (30 mg/L) and found within permissible limit of magnesium 100 mg/L. The present study reveals that the magnesium content is almost similar in groundwater and surface water of drain.

Total Alkalinity

The BIS standards prescribed range of total alkalinity in water is 200-600 mg/L. This study observed the range of total alkalinity from 260 mg/L to 528 mg/L. All the groundwater samples were recorded within the desirable limit of water. During the investigation of the surface water of Lasara-dhanola drain it was observed that groundwater is less alkaline than the surface water of the drain.

Chlorides

Chloride is a natural anion that almost found in all types of water. Chloride is the largest component of the earth's crust and a major dissolved component of most natural waters. All groundwater samples were found to be between 34-220 mg/L, which is above the permissible limits. The chloride content from the investigated region was high relative to the drain water samples.

Fluoride

In the present study, the concentration of fluoride was recorded in water samples within permissible limits as prescribed by BIS and WHO standards. Maximum fluoride content was found at sampling site G_{10} with a value of 0.97 mg/L. It has been analyzed that fluoride concentration in groundwater samples was found to be above the surface water of Lasara-Dhanola drain. Residual Chlorine in groundwater samples, the residual chlorine concentration was detected below the permissible limit of BIS standards. All groundwater samples were found to be below the detection limit.

Biochemical Oxygen Demand

BOD is an important parameter that finds the pollution status in the water bodies. In the present study period, the concentration of BOD was found to be below the permissible limit prescribed by CPCB. All groundwater samples were recorded with values were less than one and identical to values of surface water.

Chemical Oxygen Demand

In present investigation of groundwater samples close to the Lasara-dhanola drain, COD values in water samples were ranged from 6.2 mg/L to 24.8 mg/L. According to WHO standards, the high value of COD was found in most of selected study sites of groundwater, above of permissible limit (10 ppm). Maximum value of COD was encountered at sampling site G_{10}. Result data of groundwater samples showed the variations among surface water of drain.

Nitrate: Nitrate is an essential nutrient for plants. During the study period, maximum variation of nitrate content was observed between groundwater samples and surface water samples of Lasara-dhanola drain. The permissible limit of nitrate given by BIS standards is 45 mg/L. The range of nitrate concentration in groundwater samples were 12 mg/L to 48.2 mg/L recorded. High values of nitrate were found at one location G_5 and it was more than BIS permissible limit. This study revealed that groundwater is not safe for drinking and irrigation purposes in selected study region.

Table 1: Physico-chemical characteristics of groundwater of Lasara-Dhanola drain

Sample ID	pH	TDS (mg/l)	Conductivity (µs/cm)	Total Hardness (µg/l)	Turbidity (NTU)	Calcium (µg/l)	Magnesium (mg/l)	Total Alkalinity (mg/l)	Chlorides (mg/l)	Fluorides (mg/l)	COD (mg/l)	Nitrate (mg/l)
G_1	7.2	630	1090	320	BDL	70	35	400	124	0.38	8.9	16.5
G_2	7.7	440	658	260	BDL	48	34	320	34	0.24	6.2	12.0
G_3	7.9	460	670	276	BDL	69	25	316	54	0.26	7.0	18.0
G_4	7.2	500	840	312	BDL	45	48	340	118	0.35	7.8	40.0
G_5	7.2	430	640	308	BDL	48	50	304	24	0.46	8.2	48.2
G_6	7.4	590	984	392	0.80	80	47	296	136	0.44	7.4	35.6
G_7	7.7	400	584	280	0.60	43	42	248	60	0.42	10.2	24.8
G_8	7.1	390	560	292	BDL	43	50	272	44	0.49	12.4	28.2
G_9	6.8	580	1024	380	BDL	85	41	284	142	0.84	20.4	32.4
G_{10}	7.5	870	1214	272	BDL	38	43	528	124	0.97	24.8	38.8
G_{11}	7.2	610	994	336	BDL	38	58	260	156	0.82	18.2	30.2
G_{12}	7.7	590	990	338	BDL	44	44	280	160	0.42	16.2	32.7
G_{13}	7.8	610	1210	380	BDL	49	54	276	122	0.46	15.4	34.4
G_{14}	7.3	900	1364	456	BDL	78	63	452	220	0.48	16.4	16.0
G_{15}	7.0	600	998	300	BDL	54	40	260	140	0.56	14.6	18.5
Mean	7.38	573.33	921.33	326.8	0.7	55.46	44.93	322.4	110.5	0.50	12.94	28.42
SD	0.32	151.68	251.61	54.50	0.41	16.24	9.68	79.17	55.46	0.21	5.60	10.50
SE	0.08	39.16	64.96	14.07	0.10	4.19	2.50	20.4	14.3	0.05	1.44	2.71

Discussion

Methods and Methodology

The methods of sample collection and analytical procedures adopted for the analysis of water samples of the Lasara-Dhanola drain using different analytical methods. To evaluate the impact of drain water on contaminated groundwater of the Malwa region of Punjab, water samples of the Lasara-Dhanola drain were collected from various sites for comparative assessment of the physicochemical status of groundwater of the Lasara-Dhanola drain near villages. The study illustrates the qualitative analysis of water from the Lasara-Dhanola drain its suitability for drinking and irrigation purposes and its impact on health.

Study of Lasara-Dhanola drain

In order to assess the water quality of the Lasara-Dhanola drain in Malwa region of Punjab State. The area comprises of several districts of Malwa region including Ludhiana, Malerkotla, Sangrur, Barnala and Bathinda to find out whether the water sources are suitable for health and irrigation. The location of the fieldwork started from Jargari a village in the Ludhiana district and end point of Lasar-Dhanola drain was the village Pathrala in Bathinda district. Moreover, the water quality of groundwater in Malwa region was also evaluated. The description of various studies conducted on drain water and groundwater is as under.

Geology

Lasara-Dhanola drain was built 48 years ago to create a sewerage canal and to solve the problem of seasonal water logging (Wet lands), but recently it is being used as a dumping drain by some industries in the adjoining areas. It is the longest drain of 225 kms starting from Jargari in district Ludhiana to Dabwali in district Bathinda. It covers several districts of Malwa region including Ludhiana, Malerkotla, Sangrur, Barnala and Bathinda.

Presently, it is the most toxic drain of Malwa region as industrial waste of Malerkotla, Barnala, Dhanula, Rampuraphool, Tapa and Talwandi Sabo is constantly being dumped in this drain. This drain causes several health issues of in the population residing nearby. This drain affects the surface as well as groundwater in the Malwa region. The water from this drain is also used for irrigation by farmers which directly affects the soil fertility and affects the health of consumers who consume the toxic vegetables. The present situation is such a worse condition that if ample rainfall occurs and a flood-like situation is created, the toxic water will overflow affecting the flora-fauna as well as the human population of the region.

Sampling and sampling procedure

The field study was conducted to examine the water quality of nearly selected villages around the Lasara-Dhanola drain. The scope of sampling was to handle the water sample very carefully to breakout any content changes before the tests are made. Total 30 samples of water were collected from different sites of drain and groundwater for determination of physicochemical quality and heavy metals. Groundwater is the basic source for both drinking and irrigation purpose. For determination of physicochemical parameters, ions, heavy and trace metals concentration in groundwater of different villages that were close to the Lasara-Dhanola drain. The water samples were obtained directly from ground through tube wells, bore wells and hand pumps. Water was collected from depth of about 290-330 feet below the surface. The pipelines of hand pumps and tube wells were flushed before collection of sample which performs the actual quality of water. Samples were collected in polyethylene bottles with a capacity of 2 litres without any air bubbles. Water bottles were tightly closed after being filled & stored at 4 °C in refrigerator. Observations such as sampling number, sampling location, time and date were noted at the time of sample collection.

Sampling sites

To carry out this study, Total 15 groundwater samples were collected from Lasara-Dhanola drain and nearby hand pumps/bore wells of the selected area around the drain. The following is the map and lists of the spots from the water samples were collected:

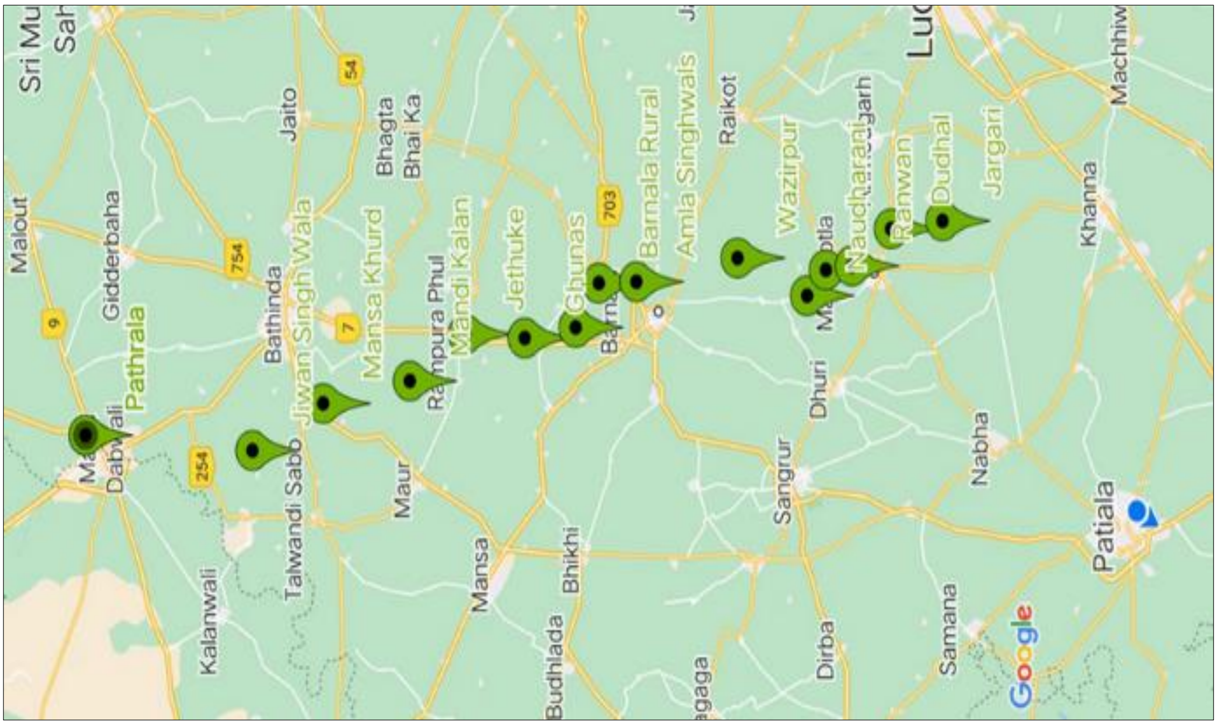

Fig 1: Map of sampling sites

Table 2: Sampling locations of Groundwater of drain.

Sample No.	Source	Area/Village	District
G-1	Private Submersible	Jargari	Ludhiana
G-2	Private Submersible	Dudhal	Ludhiana
G-3	Private Submersible	Ranwan	Malerkotla
G-4	Private Submersible	Malerkotla	Malerkotla
G-5	Private Submersible	Naudharani	Malerkotla
G-6	Private Submersible	Wazirpur	Sangrur
G-7	Private Submersible	Amla Singh Wala	Barnala
G-8	Private Submersible	Barnala	Barnala
G-9	Private Submersible	Khudi Kalan	Barnala
G-10	Private Submersible	Ghunas	Barnala
G-11	Private Submersible	Jethuke	Bathinda
G-12	Private Submersible	Mandi kalan	Bathinda
G-13	Private Submersible	Mansa Khurd	Mansa
G-14	Private Submersible	Jiwan Singh Wala	Bathinda
G-15	Private Submersible	Pathrala	Bathinda

Examination of samples

The samples of various locations were examined for determination of degree of pollution with respect to the following physicochemical parameters consists of heavy metals opted for investigation.

1. pH.
2. EC (Electrical Conductivity).
3. T.D.S (Total Dissolved Solids).
4. T.H (Total Hardness).
5. Calcium.
6. Magnesium.
7. T.A (Total Alkalinity).
8. Turbidity.
9. Chlorides.
10. Fluoride.
11. Residual Chlorine.
12. Nitrate.
13. And Heavy Metals and Radioactive Elements *viz*:.
14. Arsenic
15. Lead
16. Zinc
17. Manganese
18. Iron
19. Chromium
20. Mercury
21. Cadmium
22. Nickel

Standard method for analysis: Samples collected from various selected spots were analyzed for physicochemical parameters in order to find out the water quality of the Lasar-Dhanola drain. Standard methods given in 'Standard Methods for the Examination of Water and Wastewater' 22nd Edition, 2012 by the American Public Health Association and 'Indian Standards Method of Sampling and Test (Physical and Chemical) for water and Wastewater' by Bureau of Indian Standards (1984) were used for determination of various physicochemical parameters.

1. Measurement of pH: pH was measured using a pH meter by electrometric method as standard IS - 3025 (P-11-2022) was used. The pH electrode was initially rinsed with distilled water and then calibrated by placing the pH electrode into buffer solutions. The instrument was adjusted to read the pH value of the buffer solution. This procedure was used to standardize the reading of instrument before doing the sample testing. The pH value was determined by measurement of the electromotive force of a cell consisting of an indicator electrode (Such as a glass electrode) immersed in the test solution and a reference electrode (Usually mercury electrode). Contact between the test solution and the reference electrode is usually achieved by means of a liquid junction, which forms part of the reference electrode. The electromotive force is measured with a pH meter, that is, a high impedance voltmeter calibrated in terms of pH.

2. Electrical Conductivity: The conductivity of the samples were determined by laboratory method 2510B (Page no-2/59- 61) was used. Electrical conductivity of was measured with the help of a conductivity meter. The instrument was initially standardized by rinsing with the standard reference solution (0.01 M KCl) which at 25 °C has a conductivity of 1412 µS cm^{-1}. The adjusting knob on the conductivity meter was adjusted to make sure the read out matched this value. The electrode of conductivity meter was rinsed with 3 portions of 0.01 KCl solution for calibration. After calibration, 3 parts of each sample was used to rinse the electrode and then dipped in the sample for the actual measurement. Values of conductivity were in Siemens per centimeter.

3. Total Dissolved Solids

The Gravimetric method as per standard IS-3025 (P-16-2023) was used to determine the total dissolved solids or filterable residue. Samples were stored in the refrigerator at 4 °C to minimize the microbiological decomposition of solids. The samples were filtered through a glass fibre filter in the evaporated dish. Evaporation was done in a drying oven at 98 °C. After complete evaporation of water, the residue was dried to constant mass at 103 °C-105 °C and weighed the dish. Calculation: Calculate the total dissolved solids (filterable residue) from the following equation: Filterable residue, mg/l = 1000M/V Where M = Mass in mg of filterable residue, and V = Volume in ml of the sample.

4. Total Hardness

EDTA (Ethylene diamine tetraacetic acid) method for determination of total hardness was used given in method IS-3025(P-21) (RA-2019) using a standard calcium solution for standardization. Solution of hydroxylamine hydrochloride with addition of buffer solution and indicator Erichrome Black T was done in sample. Solution was titrated with standard EDTA solution and stirred continuously to remove the red colour of the solution. At end point, blue colour appeared and a procedure was followed to find out the hardness. Calculate the hardness as follows: Total Hardness = $[1000(V_1-V_2)/V_3] \times CF (CaCO_3)$, mg/l Where V_1= volume in ml of the EDTA standard solution used in the titration for the sample. V_2= volume in ml of the EDTA solution used in the titration for blank. V_3= volume in ml of the sample taken for the test. CF= X_1/X_2 =correction factor for standardization of EDTA. X_1= volume in ml of standard calcium solution taken for standardization, and X_2= volume of ml of EDTA solution used in the titration.

5. Calcium

Calcium was determined by using EDTA titration method as per standard IS-3025(P-40). EDTA solution was standardized by standard zinc solution. Water samples were pre-treated with concentrated nitric acid and used for determination of calcium. Due to high pH, Solution was titrated immediately by EDTA solution with addition of sodium hydroxide solution and indicator murexide. Solution was continuously stirred with slowly addition of EDTA solution. Solution changed from pink to purple at the end point and noted the final reading of the solution. Calculations: Calcium (Ca), mg/l= A×B/V×1000 Where A= volume in ml of EDTA solution used for titration. B= mass in mg of calcium equivalent to 1ml of EDTA solution, and V= volume in ml of the sample taken for the test.

6. Magnesium

Volumetric method using EDTA was used to determine the magnesium. Standard method IS3025 (P-46) was adopted. Water samples were titrated against with standard EDTA solution using Erichrome Black T indicator. Addition of hydroxylamine solution, potassium cyanide and triethanolamine solution were used. Indicator was used after the addition of buffer solution in dilute solution. Solution was titrated with 0.01M EDTA solution and slowly stirred at end point. Colour was changed from red to blue and reading was noted in the notebook. Calculations: Magnesium (as Mg), mg/l percent by mass = $0.024\times1000\times (V_2-V_1)/ V$ Where V= volume in ml of the sample taken for the test. V_1= volume in ml of EDTA consumed in titration for calcium determination in the same aliquot of the solution of sample. V_2= volume in ml of EDTA solution consumed in the titration.

7. Total Alkalinity

The standard method IS-3025(P-23) was followed for the analysis of alkalinity. The potentiometer was used for the determination of alkalinity. Samples were titrated with standard solution of sulphuric acid to pH 8.3 to pH 3.7 using a potentiometer. Calculations: Alkalinity in the sample as follows: Total alkalinity (as mg/l of $CaCO_3$) = (A+B) × N × 50,000/V Where A = ml of standard sulphuric acid used to titrate to pH 8.3, B = ml of standard sulphuric acid used to titrate from pH 8.3 to pH 3.7, N = normality of acid used, and V = volume in ml of sample taken for test.

8. Turbidity

Turbidity was analyzed as per the standard method given in IS 3025 (P-10). Turbid meter was used to determine the turbidity of the water sample. Stock standard suspensions of hydrazine sulphate and hexamethylene tetramine solution were used for calibration. A standard calibration procedure was performed for accurate reading. The values of water samples were expressed in Nephelometric Turbidity Units in the range of 0-40. Higher values were obtained by dilution of the sample. Calculations: Turbidity of diluted samples by using the following equation: Turbidity units = A × (B+C)/C Where: A= turbidity units found in diluted sample. Volume in ml of dilution water used C = volume of sample in ml taken for dilution.

9. Chlorides

The standard method IS-3025(P-32) was followed for determination of chlorides. Potentiometric method with silver nitrate solutions with a glass and silver-silver chloride electrode system were used. For standardization, sodium chloride solution using concentrated nitric acid was titrated with standard silver nitrate titrant. The end point of the titration was occurred due to greatest change in voltage by small and constant increment of silver nitrate. Calculation: Chloride (as Cl), mg/l = $(V_1-V_2) \times N \times 35450/ V$ Where, V_1= Volume in ml of silver nitrate titrant used in sample V_2= Volume in ml of silver nitrate used in blank N= Normality of titrant V= Volume in ml of the sample used

10. Fluoride

A fluoride of sample was determined by Zirconium alizarin method. Procedure was followed as per standard IS 3025 (P-60).The minimum detection limit of fluoride was 0.05mg/l. Water sample was taken with addition of standard sodium fluoride solution and zirconium alizarin reagent. The sample and standards were at the same temperature (1 °C to 2 °C). Mixed and compared colors after 1 hour standing. The volume of standard sodium fluoride solution contained in the tube was noted in which the match of the sample under test was obtained. Calculation: Fluoride (as F), mg/l= 1000W/V Where W = weight of fluorides (as F) in the standard solution matched by the sample. V = volume of the sample taken for the test in ml.

11. Residual Chlorine

The iodometric method was used for the determination of residual chlorine as per the standard method given in IS 302 (P-26). Acetic acid was used in the water sample to decrease the PH of the solution. Potassium iodide crystals were also added in the solution. Titrated the solution against sodium thiosulphate until the yellow colour of librated iodine was almost discharged. Starch was also needed in the solution before titration to find out the lowest residual chlorine in the water. Calculations: Residual chlorine, mg/l = $V_1 \times N \times 35450/V_2$ Where, V_1 = Volume of standard sodium thiosulphate used V_2 = volume of sample taken for test, and N = normality of sodium thiosulphate used.

12. Nitrate

The ion chromatography technique as per the standard method APHA 4110 was followed to determine the nitrate in a water sample. A method detection limit of the sample was 0.5 mg/l. An ion chromatograph including syringes, analytical columns, gases, detector and data system was followed. During analysis, the sample merged with the eluent stream and was pumped through the ion chromatographic system. A water sample was injected into a stream of carbonate bicarbonate eluent and passed through a series of ion exchangers for separation. The separated anions and their acids were measured by conductivity. They were identified on the basis of retention time as compared to standards. Peak height and retention time were recorded on a strip chart recorder. The concentration of nitrate anion was expressed in mg/l.

13. Determination of Heavy metals

Heavy metals and radioactive elements were analyzed by the Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS) method as per standards 3125B. Water samples were carried out by the Punjab Water Supply and Sanitation Department, Mohali and analyzed in their Regional Advance Water Testing Laboratory using state-of-the-art instrumentation including ICPMS (Inductively Coupled Plasma Mass Spectrometry). The instrument model was Agilent Technologies 7700. Nitric acid (5% acidified) was acted as a reagent. Milli Q water is used for the preparation of blank solutions and standard stock solutions. Prepared the standard solutions at known concentrations (in ppb) for calibrations. Followed the manufacturer's standard operating procedure for initialization, mass calibration, gas flow optimization and other instrument operating conditions. Data was collected in Excel form and values were expressed in ppm (parts per million).

Table 3: List of methods used to calculate various physiochemical parameters of water.

S. No.	Parameter	Reference Method
1.	pH	IS 3025 (Part 11-2022) Electrometric Method
2.	Colour	IS 3025(Part 4-2021) visual Comparison Method
3.	Odour	IS 3025 (Part 5-2018) (Second revision)
4.	Taste	IS 3025 (Part 8-2023)
5.	TDS	IS 3025 (Part 16-2023) Gravimetric Method
6.	Turbidity	IS 3025 (Part 10-2023) Nephelometric Method
7.	Alkalinity	IS 3025 (Part 23-2023) Indicator Method
8.	Hardness	IS 3025 (Part 21-2009) (RA 2019) EDTA Method
9.	Calcium	IS 3025 (Part 40-1991) EDTA Titrimetric Method
10.	Magnesium	APHA (24th Ed.2023) method:3500-Mg+2 B by Calculation Method
11.	Iron	Spectrophotometric Titrations
12.	Fluoride	APHA 4500 F-(23rd Ed. 2017)/IS-3025 (Part-60)
13.	Nitrate	Spectrophotometric Method/ APHA 4500 NO3-(23rd Ed. 2017)
14.	Total Coliform	IS-1622 MPN Method
15.	*E. coli*	IS-1622 MPN Method
16.	BOD	APHA 5210 (23rd Ed. 2017)
17.	COD	APHA 5220 (23rd Ed. 2017)

Following is the list of laboratories that we have approached for testing various physiochemical parameters water.

1. District water testing laboratory Malerkotla.
2. Regional water testing lab Sangrur.
3. Industrial testing laboratory 2 consulting house.
4. Department of water supply and sanitation.

Conclusion

In conclusion, the quality assessment of drain water for drinking and irrigation purposes is crucial for ensuring public health and sustainable agriculture. By employing rigorous evaluation methods and implementing appropriate measures, risks associated with drain water use can be mitigated, contributing to water security and environmental health. Assessing water quality parameters of drain water is essential for understanding its characteristics, identifying potential risks, and ensuring its safe and sustainable use. By employing rigorous assessment methods and monitoring protocols, stakeholders can effectively manage drain water resources, mitigate pollution, and safeguard public health and the environment. In the subsequent sections, this article will delve deeper into the methodologies, parameters, findings, and recommendations of a quality assessment study focused on groundwater of nearby areas of Lasara-Dhanola drain for drinking and irrigation purposes.

References

1. APHA. Standard Methods for the Examination of Water and Wastewater. 17th ed. Washington, DC: APHA; c1995.
2. World Health Organization. Guidelines for Drinking Water Quality. 2nd ed. Geneva: WHO; c1993. p. 1-4.
3. World Health Organization. Guidelines for Drinking Water Quality. 4th ed. Geneva: WHO; c2011. p. 1-4.
4. Bureau of Indian Standards. Indian Standard Drinking Water Specification. New Delhi: Bureau of Indian Standards; c2012. p. 2-4.
5. BIS IS. 10500 Indian standard drinking water specification, first revision. Bureau of Indian Standards, New Delhi, India; c1991.