A Case Study on Water Pollution Indicators in Ambala Cantt.

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Abstract

The study investigates the key pollution indicators such as total bacterial count alongside biochemical parameters including pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), and chemical oxygen demand (COD) of water samples collected from various locations in Ambala Cantt to understand regional variations and their implications for water quality. The results revealed significant spatial variations influenced by factors such as anthropogenic activities, land use, and proximity to pollution sources. Water quality in some locations exceeded permissible limits for safe drinking and utility purposes, highlighting potential health risks and the need for improved water management practices. This case study emphasizes the importance of regular monitoring and targeted interventions to ensure water safety and sustainability in semi-urban and urban regions like Ambala Cantt.

Keywords: water quality, microbial analysis, BOD, regional variations, pollution indicators

Introduction:

Water is an essential resource that sustains life and supports various ecological, agricultural, industrial, and domestic activities. Its quality directly impacts human health, environmental sustainability, and socio-economic development. However, the quality of water resources is increasingly being threatened by rapid urbanization, industrialization, and agricultural runoff, which introduce pollutants into water bodies (Goel,2006). Monitoring and assessing water quality are crucial to ensure its suitability for different purposes and to mitigate potential health risks.

The microbial and biochemical parameters of water serve as key indicators of its quality (Gupta *et. al.,* 2009). Microbial analysis provides insights into contamination by pathogenic microorganisms (Payment *et.al*.,2003) which can pose serious health hazards (Figueras & Borrego,2010) while biochemical parameters such as pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), and

chemical oxygen demand (COD) reflect the physicochemical conditions of the water (Kumar and Dua, 2009). Together, these assessments help evaluate the suitability of water for drinking, irrigation, and other applications.

Ambala Cantt., located in Haryana, India, is a semi-urban area with diverse water sources, including groundwater, municipal supply, and surface water. The region's water resources are influenced by a mix of urban and agricultural activities, making it essential to assess the impact of local environmental factors on water quality. Despite its importance, limited studies (Rout and Sharma, 2011 and Gupta *et. al.*, 2009) have been conducted on the water quality of this region.

This study aims to investigate the microbial and biochemical parameters of water samples collected from different locations in Ambala Cantt. to understand regional variations in water quality. The findings will provide valuable insights into potential sources of contamination, health risks, and the need for targeted interventions to ensure water safety and sustainability in the region.

Materials and Methods

Study Area and Sample Collection

The study was conducted in Ambala Cantonment, Haryana, a semi-urban region of Ambala District in the state of Haryana. The Ambala district of Haryana is located between 27° 39" 53' north latitude and 74° 33'' 53' to 76° 36'' 52' east longitude having an average altitude of 276.5 metre above sea level (Rout and Sharma, 2011). The district's total geographical area is approximately 1574 square kilometres. The district area is situated in the Yamuna sub-basin of the Ganga basin and is primarily drained by three non-perennial streams: Markanda and its tributaries, Tangri and its tributaries, and Ghaggar and its tributaries. The area has mixed land use that includes residential, commercial, and agricultural zones. Samples were collected from five different locations from Subhash Park, Tangri river, Pond (Shastri Colony), Markanda river, and tap water from SD College Ambala Cantt. Water samples were collected in sterilized polyethylene bottles to prevent contamination. Samples of microbial analysis were transported to the laboratory in an icebox to slow down microbial activity and processed within six hours of collection. Biochemical analysis was performed using fresh samples.

Biochemical and Microbial Analysis

The water samples were analysed for pH, BOD, COD, chloride ion strength, and bacterial count at biotechnology lab at Sanatan Dharma College Ambala and IAB Sciences, Kurukshetra. Methods for the analysis of water were referred from SAP manual compiled by Hydrology Project, GOI (1999) based on APHA (1998). Standard Plate Count method was used to estimate the microbial growth in water samples. Microbial growth assessment was made using Standard Plate Counting Method (Brown, 2009). For this serial dilutions of water samples up to 10^{-5} were prepared. For each dilution, 0.1 ml was transferred onto pre-solidified agar plates and spread evenly. The plates were incubated at 37°C for 48 hours. The colonies were counted on plates inoculated with the plates with less than 300 colonies but more than 30 colonies. The bacterial counts were expressed as:

CFU/ml= No. of Colonies x Dilution Factor ÷ Volume inoculated (mL)

Results and Discussion

Graph I depicts the biochemical parameters viz. BOD, COD, and Chloride ion strength of various samples. The biochemical assessment of various water samples collected from different places in Ambala Cantt indicated distinctive variations caused by the type and source of the water. Results were compared with water quality standards set by the Bureau of Indian Standards (BIS) to assess whether the observed water quality parameters align with the permissible limits and guidelines set by the Bureau of Indian Standards (BIS) **(**Table 1).

1. pH

pH is an important criteria in assessing water quality. pH is the concentration of hydrogen ions in a solution. pH determines the acidity or basicity of the solution. pH should be balanced for the well-being of the environment and living organisms. The water samples had pH value ranging from 9 (basic) to (7) neutral. This reflects the influence of natural and human activities on water chemistry. The water sample from Subhash Park had most basic pH of 9 which suggests contamination from alkaline wastes potentially from human activities or chemical run off followed by Markanda river with pH 8.5 and Tangri River with pH 8 indicating the presence of industrial waste in water. The pond water sample had pH 7.5 close to neutral however, high BOD of water suggests severe organic pollution. The tap water from SD College, with a neutral pH of 7, aligns with the ideal range for drinking water as per BIS standards, indicating proper treatment to maintain water quality.

2. Biochemical Oxygen Demand (BOD)

The Biochemical Oxygen Demand (BOD) of water samples from different locations of Ambala Cantt. ranged from 162 mg/L and 275 mg/L of Markanda River and Tangri River respectively indicating varying levels of organic pollution (Graph I). The Tangri River water sample had the highest BOD levels, which shows a high level of organic pollution due to open defecation, untreated sewage, industrial effluents and agricultural runoff. The readings also indicated high BOD levels at Subhash Park (206 mg/L) and pond water (205 mg/L), which could be attributed to stagnant water conditions of these water bodies and accumulation of organic waste over the time. Despite having the lowest BOD, the readings indicate that the Markanda River is also quite polluted. These results show that there is acute environmental stress across all water bodies in Ambala Cantt. and there is an urgent need for improved wastewater management, routine maintenance of stagnant water bodies such as ponds and small water bodies in parks and recreation places, and strict pollution regulations capable of safeguarding water quality and protecting aquatic ecosystems.

3. COD

COD for various water samples ranged from 309.5 mg/L to 830.2 mg/L (Graph I). Overall, the COD values in the Tangri River, Subhash Park, and Markanda River show moderate to significant levels of chemical contamination, reflecting the presence of both organic and inorganic pollutants. This investigation reveals variable amounts of chemical pollution among water bodies in Ambala Cantt., implying that factors like as urban runoff, untreated waste, and industrial activities contribute to the chemical load in these sources. Regular monitoring and control of these contaminants are required to enhance and sustain water quality in the region.

4. Chloride Ion

The strength of chloride ion in various water samples studied fall within the desirable limit for chloride ions under BIS guidelines which is 250mg/L (Graph I). Tap water sample from SD College Ambala Cantt. had highest value of chloride ions 0.798 mg/L followed by Tangri river 0.76 mg/L, Markanda River with 0.674 mg/L and Subhash Park 0.62mg/L. The pond water from Shastri Nagar had minimum value of chloride ions 0.54mg/L. Thus, based on the chloride content, all the water samples would be considered safe for consumption from a chloride perspective. However, when assessing the

overall water quality, the other factors such as microbial contamination, DO, BOD, COD, and pH would also have to be considered.

5. Microbial Count

Water bodies worldwide are contaminated with microbes such as bacteria, viruses, and parasites. The sources of contamination can be sewage and wastewater, agricultural run-off, and industrial discharge. Assessing microbial safety of water is essential for considering it safe for drinking and bathing. Table II shows the microbial assessment of studied water samples. All the water samples studied showed microbial growth in varying amounts indicating pollution of every water body studied. The results of BOD and microbial growth in the water samples are comparable indicating the link between organic pollution and microbial growth. The Tangri river water having BOD (27.5 mg/L) showed moderate microbial growth (80 colonies), probably because of non-biodegradable organic waste whereas Shastri Nagar pond water sample with BOD (20.5 mg/L) and Subash park water sample with BOD (20.6 mg/L) had the highest microbial growth (250 and 210 colonies respectively) indicating the presence of high content of biodegradable organic waste. The Markanda river BOD (162 mg/L) had slightly lower microbial growth (150 colonies) due to its lower BOD than Tangri river. The presence of bacterial growth (5 colonies) in the tap water of SD College Ambala Cantt indicating clean and potable water.

Conclusion

The biochemical and microbial assessments of water samples from different locations of Ambala Cantt reveal significant variations in water quality indicating the environmental pollution across the region. High BOD levels of water samples from the Tangri and Markanda rivers along with water sample of pond in Shastri Nagar indicate high levels of organic matter in these water bodies mainly contributed by dumping of untreated sewage, industrial waste, and agricultural runoff in them. The pH and COD analysis further indicate chemical contamination in the water bodies of Ambala Cantt. While chloride ion concentration in all samples is within permissible limits, the overall water quality based on other parameters such as BOD, microbial growth, and COD underscores the urgent need for aggressive wastewater management, stricter regulation on industrial and domestic discharge, regular monitoring, and public awareness.

Table 1. Standard BIS water quality parameters

Parameters	Acceptable Limit (BIS)	Permissible Limit (BIS)
pH	6.5-8.5	No relaxation
BOD	<3	<3
COD	-	-
Chloride ion strength	250 mg/L	1000mg/L
E.coli presence or absence	Shall not be noticeable in any 100ml sample	Shall not be noticeable in any 100ml sample

Graph I: BOD, COD, Chloride ion strength of water samples

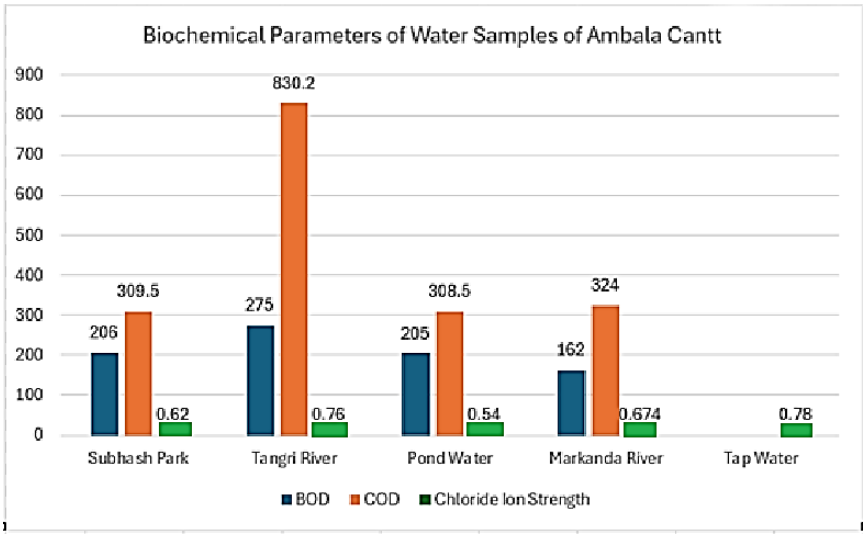

Table 2: Standard Plate Counts in Water Samples at 37°C

Sample	Observed Colonies (10^{-5} Plate)	CFU/ml
Subhash Park	210	2.1×10^{8} CFU/ml
Tangri River	80	8.0×10^{7} CFU/ml

Pond Water	250	2.5×10^8 CFU/ml
Markanda River	150	1.5×10^8 CFU/ml
Tap Water	5	5.0×10^6 CFU/ml

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