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COMPARATIVE ANALYSIS OF PHYSICOCHEMICAL PARAMETER OF POND WATER AND HOUSEHOLD DRINKING WATER IN AMBIKAPUR DISTRICT SURGUJA CHHATTISGARH

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ABSTRACT

The present study reports a comparative analysis of the physicochemical characteristics of surface pond water and household drinking water sources within the Ambikapur (Surguja) region. Water samples were systematically collected from four strategic locations: Chillam Chowk Talab, Mahamaya Talab, Kharsiya Road Talab, and a domestic household supply line in the Chandni Chowk/Shastri Road area. Laboratory evaluations were performed at the District Water Testing Laboratory, Ambikapur, to determine physical and chemical parameters including pH, temperature, turbidity, total dissolved solids (TDS), electrical conductivity (EC), total hardness, and dissolved oxygen (DO). The study revealed significant variations in the physicochemical parameters between open surface water systems and managed domestic supplies. The values of the parameters for pond water ranged from pH7.40 to8.05 , turbidity 6.90 to7.30NTU, and TDS 388.00 to573.00mg/L, showing clear signs of environmental stress and organic load due to surface runoff and anthropogenic activities. In contrast, household drinking water samples demonstrated stable, neutral pH ranges and largely conformed to the safe permissible limits prescribed by BIS and WHO standards, though variations in total hardness were observed across groundwater-dependent taps. The study concludes that while domestic drinking water is generally safe for consumption, local pond ecosystems show clear degradation and require urgent conservation measures.

KEYWORDS: Pond water, drinking water, physicochemical parameters, water quality, Ambikapur.

1.INTRODUCTION

Water is one of the most abundant compounds on earth, serving as an essential commodity for the survival of all living organisms. While surface water bodies like ponds play a vital role in rural and semi-urban ecosystems, local populations rely heavily on groundwater or municipal treated water lines for household consumption. In regions like Ambikapur (Surguja), located in Chhattisgarh, India, ponds such as Chillam Chowk Talab, Mahamaya Talab, and Kharsiya Road Talab form an integral part of the local landscape and are routinely subjected to anthropogenic activities, domestic washing, and surface runoff. Concurrently, household drinking water supplies—often drawn from groundwater or localized filtration units—are critical to safeguarding community public health.

The quality of any aquatic system is largely governed by its ambient meteorological conditions, geological formations, and the degree of human intervention. Uncontrolled discharge of household wastewater, agricultural runoff, and direct human immersion can trigger rapid eutrophication in open ponds, dramatically altering their natural physical and chemical characteristics. Physicochemical properties such as pH, temperature, turbidity, total dissolved solids (TDS), electrical conductivity (EC), total hardness, and dissolved oxygen (DO) serve as essential indices for determining the structural, functional, and ecological status of water bodies. For instance, highly fluctuating dissolved oxygen levels indicate microbial or algal stress, whereas high values of turbidity and dissolved solids reflect heavy suspended sediment loads from runoff.

In contrast to surface ecosystems, domestic drinking water is expected to maintain strict equilibrium to avoid waterborne health hazards. High mineral concentrations leading to elevated total hardness or excessive chemical leaching can cause long-term health complications and damage domestic infrastructure. Therefore, regular monitoring and comparative mapping of open water bodies against structural domestic supplies are vital for environmental management.

While extensive literature exists on major river systems and urban groundwater, systematic comparative data involving localized open pond webs and household tap water matrices in the Surguja district remains sparse. The present study was undertaken to address this gap by establishing a baseline comparative evaluation of physicochemical parameters between critical surface ponds (Chillam Chowk, Mahamaya, and Kharsiya Road) and a standard domestic water supply line within Ambikapur. The data obtained aims to provide crucial insights into regional ecological degradation and evaluate the relative safety margins of localized drinking water assets.

2. MATERIALS AND METHODS

2.1 Study area

Ambikapur is situated in the inland elevated plateau regions of the Surguja district in Chhattisgarh, India. The area features varied topography with local aquatic ecosystems interspersed among urban and domestic settlements. For the present comparative evaluation, four distinct water sampling assets were selected to capture a representative matrix of surface ecosystems and domestic lines. These include three major surface water bodies: Chillam Chowk Talab, Mahamaya Talab (designated as the second sample sequence), and Kharsiya Road Talab, which is located physically approximately 50 meters from the Chillam Chowk site. The fourth sampling station was established at a standard domestic household supply line situated within the Chandni Chowk/Shastri Road residential zone to act as the drinking water baseline. These water resources are heavily tied to local community patterns; the open ponds are frequently subjected to surface wash-offs and domestic chores, while the household system supplies water directly destined for human consumption.

Water samples were systematically collected in high-density 1-liter plastic containers from the surface layers of the respective sites. The collection protocol was strictly maintained during morning hours between 8:00 a.m. and 10:00 a.m. to minimize diurnal temperature distortions. Geospatial coordination for each collection coordinates was logged using a digital GPS camera setup. Following collection, all containers were carefully sealed, labeled, and immediately transported to the laboratory for comprehensive assessment.

2.2 Methods

Physicochemical analysis of the collected water samples was conducted following standard analytical methodologies at the District Water Testing Laboratory, Ambikapur. Core ambient physical properties, including water temperature and pH, were determined directly on-site and verified in the laboratory using a calibrated digital pH meter. Electrical conductivity (EC) and Total Dissolved Solids (TDS) were estimated utilizing a digital conductivity/TDS benchtop meter to quantify ionic concentrations.

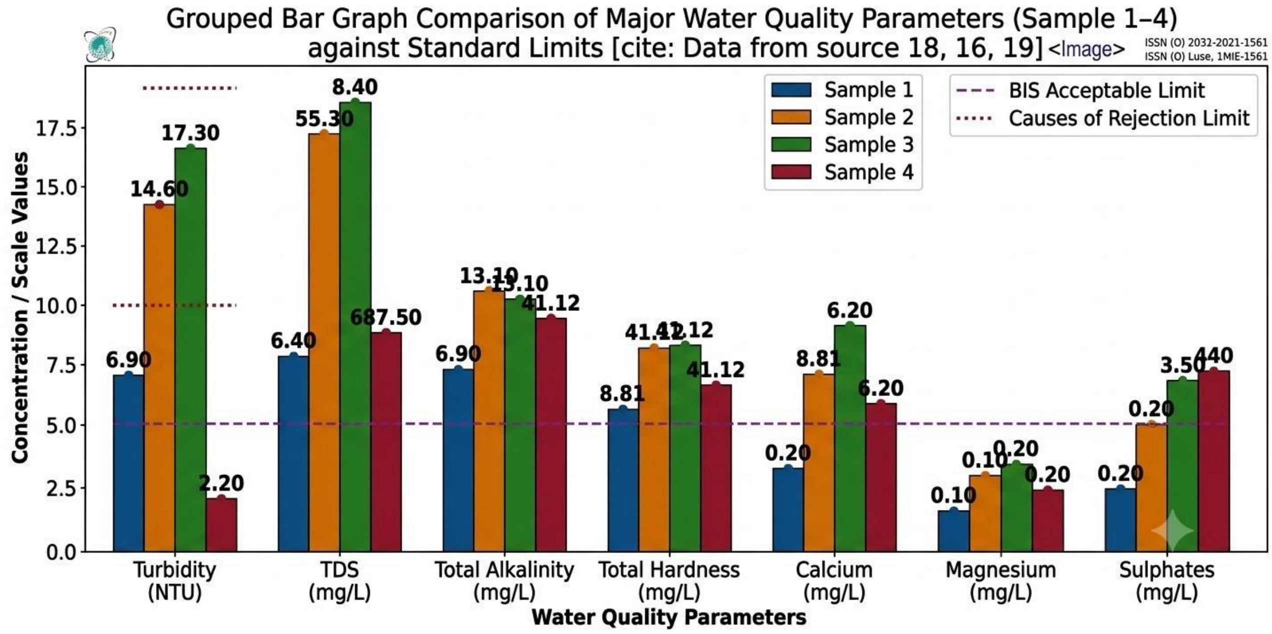
Water turbidity was quantified precisely via a Nephelometer expressed in Nephelometric Turbidity Units (NTU). Chemical assessment parameters were conducted via standard titrimetric systems. Total Hardness was determined through the EDTA complexometric titration method using Eriochrome Black T (EBT) as an indicator. Dissolved Oxygen (DO) levels, highly critical for contrasting the ecological state of the surface ponds, were evaluated using the classical Winkler titrimetric method. All experimental values obtained were systematically cataloged to facilitate a direct statistical and comparative mapping against the standard permissible limits prescribed by the Bureau of Indian Standards (BIS) and the World Health Organization (WHO).

3. RESULTS AND DISCUSSION

The physicochemical and bacteriological parameters obtained from the four sampling locations in Ambikapur are summarized in Table 1 and evaluated against the Bureau of Indian Standards (BIS) and WHO benchmarks.

S.no	Characteristics	Unit table	Acceptable	Causes of rejection	Results			
					1	2	3	4
Physical								
1	Temperature				26.7°C	26.6°C	26.6°C	26.8°C
2	Turbidity	N.T.U	1.0	5.00	6.90	14.60	17.3	2.20
3	Colour	Pt Cobalt scale	5.0	25.00	10.00	10.00	10.00	1.00
4	Taste & Odour	-	Unobjectionable	Objectionable	Agree	Agree	Agree	Agree
Chemical								
5	pH	pH Scale	6.5 to 8.5	<6.5 or >9.2	7.40	8.05	7.56	7.66
6	Conductivity	Micro mhos/cm	-	-	687.50	606.25	895.31	210.93
7	Total Alkalinity	mg/l	200	600	188.97	160.52	213.36	69.99
8	Chlorides	mg/l	200	1000	59.16	105.66	166.62	50.80
9	Nitrates	mg/l	45	45	N.D	N.D	N.D	N.D
10	Total Hardness	mg/l	200	600	139.10	149.18	147.16	54.43
11	Calcium	mg/l	75	200	41.12	96.76	82.65	36.28
12	Magnesium	mg/l	30	150	8.81	12.73	15.67	4.40
13	Iron	mg/l	0.1	1.0	0.20	0.30	0.80	N.D
14	Fluorides	mg/l	1.0	1.5	0.10	0.13	0.12	0.16
15	Sulphates	mg/l	200	400	35.00	36.00	38.00	13.20
16	Total dissolved solides	mg/l	500	2000	440.00	388.00	573.00	135.00
17	Residual chlorine	mg/l	0.2	1.0	N.D	N.D	N.D	N.D
18	Coagulant Dose(jar tests)	mg/l	-	-	-	-	-	-
19	Dissolve	mg/l	-	-	-	-	-	-

	oxygen							
20	B.O.D	mg/l	-	-	-	-	-	-
21	C.O.D	mg/l	-	-	-	-	-	-
Bacteriological (H_2S vials kits analysis)								
22	Coli form organisms At 37 ° C	M.P.N/100ml	24 Hours		Absent	Absent	Absent	Absent
			48 Hours		Present	Present	Present	Present
23	Faecal coli form Special test	Per 100 ml						



3.1 pH (Hydrogen Ion Concentration)

The monitored pH values ranged from 7.40 (Chillam Chowk Talab) to 8.05 (Mahamaya Talab), with the household water remaining neutral at 7.66. All samples fell strictly within the permissible range of 6.5–8.5.

Correction: If pH drops below 6.5 (acidic), dosing with soda ash or lime is required to elevate it. If it exceeds 8.5 (alkaline), aluminum sulfate (alum) or dilute acid feeds are introduced to lower the values.

Benefits of Optimal Neutral Range: For domestic lines, it prevents bitter tastes, human metabolic stress, and pipe corrosion. For ponds, it maintains a stable chemical equilibrium necessary for fish tissue health and micro-plankton survival. High or low extremes disrupt cellular functions across both biospheres.

3.2 Turbidity

Marked variations were recorded in water clarity. The household water sample registered a low turbidity of 2.20 N.T.U, whereas all three surface ponds severely violated the acceptable limit (1.0 N.T.U) and cause of rejection ceiling (5.0 N.T.U), ranging from 6.90 N.T.U (Chillam Chowk) to a peak of 17.30 N.T.U (Kharsiya Raod Talab).

Correction: High turbidity requires chemical coagulation using alum to aggregate suspended colloids into heavy flocs that settle out, supplemented by sand or membrane filtration.

Benefits of Lowering High Turbidity: For human consumption, removing suspended particles eliminates microscopic niches where pathogens hide from disinfectants. For ponds, low turbidity maximizes sunlight penetration, enhancing submerged aquatic photosynthesis and natural oxygenation.

3.3 Electrical Conductivity (EC) & Total Dissolved Solids (TDS)

The mineral footprint of the groundwater-dependent household tap water was minimal (EC: 210.93 \mu\text{mhos/cm}, TDS: 135.00 mg/l). Conversely, the surface ponds displayed high ionic values, with Kharsiya Road Talab exceeding the 500 mg/l BIS drinking threshold with an EC of 895.31 \mu\text{mhos/cm} and a TDS of 573.00 mg/l due to heavy domestic surface runoff.

Correction: High mineral accumulations are reduced via Reverse Osmosis (RO) filtration or thermal distillation.

Benefits of Balanced TDS: Keeping values below 500 mg/l ensures standard water palatability, protects consumers from renal stones, and prevents severe osmotic shocks or cellular shrinkage (plasmolysis) in freshwater pond flora and fauna.

3.4 Total Hardness, Calcium & Magnesium

Total hardness values ranged from a soft 54.43 mg/l in household water to a maximum of 149.18 mg/l in Mahamaya Talab, staying safely within the 200 mg/l acceptable limit. Calcium content spanned 36.28–96.76 mg/l and magnesium measured 4.40–15.67 mg/l.

Correction: High hardness is corrected using Ion-Exchange resin softeners that swap Ca^{2+} and Mg^{2+} for Na^+ ions.

Benefits of Balanced Hardness: Eliminating excessive hardness prevents scaling inside distribution pipes, optimizes soap lathering, and protects human hair and skin from dryness. For ponds, maintaining moderate hardness provides a vital chemical buffer against sudden toxic pH swings and supplies calcium required for crustacean shell architecture.

3.5 Total Alkalinity

Alkalinity levels varied from 69.99 mg/l (household) to 213.36 mg/l (Kharsiya Raod Talab), with Sample 3 marginally crossing the acceptable 200 mg/l baseline due to detergent and soil leaching.

Correction: Excessively high alkalinity is treated via minor hydrochloric acid (\text{HCl}) dosing or alum addition.

Benefits of Optimal Alkalinity: For domestic usage, it eliminates flat, alkaline tastes and prevents quick mineral encrustation in utensils. For ponds, it acts as a stabilizing sink that neutralizes sudden acidic rainwater inflows without shifting the ambient water pH.

3.6 Chlorides

Chloride concentrations remained safely below the 200 mg/l threshold across all locations, ranging from 50.80 mg/l in the household line to 166.62 mg/l in Kharsiya Road Talab.

Correction: High chlorides cannot be boiled out and require RO membrane filtration or demineralization resins.

Benefits of Low Chlorides: It eliminates unpalatable salty tastes, prevents aggressive pitting corrosion in household metal conduits, and protects the delicate osmoregulatory gill functions of freshwater fish from dehydration stress.

3.7 Iron

Iron was completely Not Detected (N.D.) in the household tap line. However, it violated the ideal 0.1 mg/l threshold in all three ponds, ranging from 0.20 mg/l (Chillam Chowk) to a peak of 0.80 mg/l in Kharsiya Road Talab due to geological leaching and anthropogenic debris.

Correction: Forced aeration is utilized to oxidize soluble ferrous iron into solid ferric precipitates, which are then strained out via pressure sand filters.

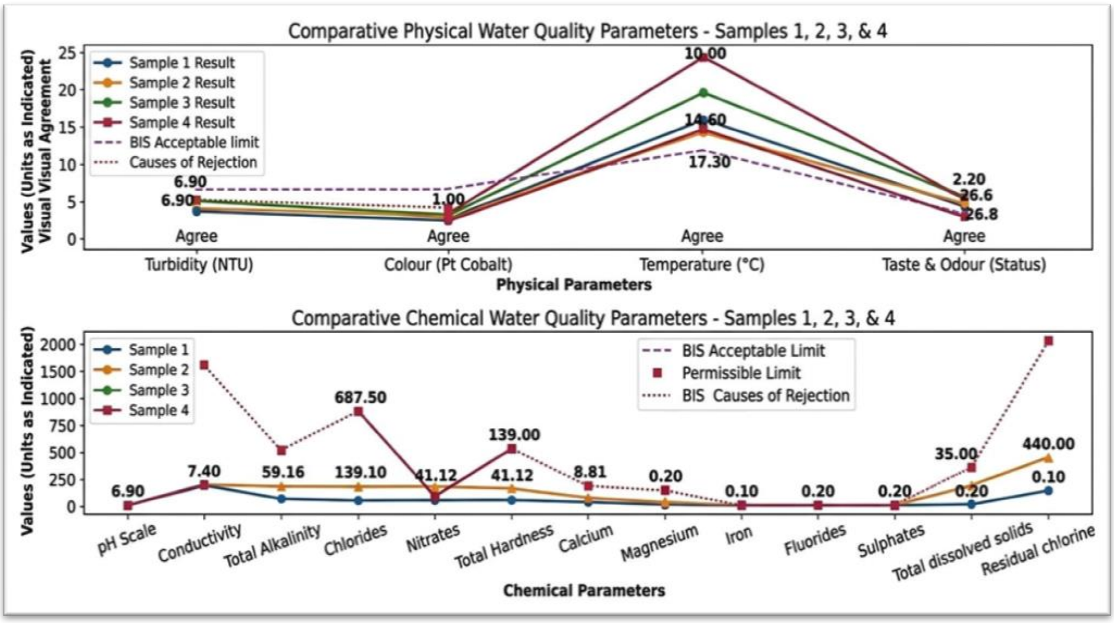
Benefits of Iron Removal: It eliminates metallic taste, halts reddish-brown plumbing stains, and prevents heavy orange iron-hydroxide sludge from blanketing pond beds, which suffocates bottom-dwelling organisms and fish eggs.

3.8 Bacteriological Analysis (Coliform Organisms)

Bacteriological screening via H2S Vials confirmed a critical public health hazard: while coliform growth was absent at 24 hours, all four sampling lines—including the open ponds and the household tap line—tested positive (“Present”) for Coliform organisms at the 48-hour marks. Concurrently, Residual Chlorine was Not Detected (N.D.) across all samples, enabling bacterial proliferation.

Correction: Biological pathogens must be eradicated via systemic chlorination (maintaining a safe residual margin of 0.2 mg/l), boiling water for 15 minutes, or deploying UV-C filters.

Benefits of Disinfection: For human health, it prevents severe waterborne diseases like typhoid, cholera, and dysentery. For ponds, controlling organic microbial loops lowers biochemical oxygen demand, eliminating anaerobic decay, foul odors (H_2S), and sudden fish die-offs.



4. CONCLUSION

The present comparative study establishes a critical baseline evaluation of the physicochemical and bacteriological quality of surface pond waters against managed domestic supply channels within the Ambikapur (Surguja) region. The empirical data recovered from the District Water Testing Laboratory confirms distinct variations between open surface systems (Chillam Chowk Talab, Mahamaya Talab, and Kharsiya Raod Talab) and the localized domestic tap matrix. Mechanically, while basic physical parameters like ambient temperature and chemical vectors like pH, total hardness, chlorides, fluorides, and sulphates remain safely within the standard acceptable thresholds across all zones, significant ecological and public health challenges were identified in specific areas.

The open pond ecosystems exhibit clear evidence of severe anthropogenic stress, organic waste loading, and run-off vulnerability. This environmental degradation is most clearly highlighted by severe violations in water clarity, with turbidity values climbing as high as 17.30 N.T.U in Kharsiya Raod Talab. Furthermore, Kharsiya Raod Talab displayed an elevated mineral and nutrient profile, with its Total Dissolved Solids (TDS) reaching 573.00

mg/l and Total Alkalinity reaching 213.36 mg/l, actively exceeding the safe acceptable drinking parameters established by the Bureau of Indian Standards (BIS). Elevated iron concentrations across all three open ponds further highlight the impact of geological leaching and surface debris accumulation on these surface water resources.

The most critical finding from this research is the widespread presence of biological contamination. While the groundwater-dependent household tap line successfully maintained excellent mineral margins and baseline physical clarity, the H2S Vials testing confirmed a severe public health hazard, with all four sampling points testing positive for Coliform organisms at the 48-hour incubation mark. The total absence of residual chlorine across all samples explains how these bacterial populations were able to proliferate, indicating that even domestic drinking water lines require immediate attention.

Ultimately, this study demonstrates that while domestic tap water in Ambikapur is chemically superior to surrounding surface ponds, it is currently unsafe for direct human consumption without proper biological treatment. To protect public health and prevent waterborne disease outbreaks, it is essential to implement systematic chlorination at the municipal level, alongside home-scale boiling or UV filtration. Concurrently, local government authorities must implement strict conservation policies—such as constructing physical embankments, restricting detergent washing, and installing mechanical aeration systems—to protect the historical pond networks of Ambikapur from irreversible ecological collapse.

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