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Water Quality Assessment of Village Ponds in Washim District, Maharashtra, India: Implications for Freshwater Fish Culture

S. D. Rathod
Corresponding Author: sdrathod15@gmail.com

K. S. Sawaikar
UG and PG Department of Zoology, R.A. College, Washim, Maharashtra, India

Abstract
Village ponds represent important small freshwater ecosystems in rural India and provide water for irrigation, livestock, domestic activities and fisheries. Their suitability for fish culture depends strongly on the physicochemical characteristics of the water and on the degree of anthropogenic pressure affecting individual ponds. The present study was designed to evaluate the water-quality characteristics of selected village ponds in Washim District, Maharashtra, and to examine their implications for freshwater aquaculture. Ten village ponds associated with Borala, Amana, Kinhiraja, Jaulka, Dhamdhami, Udi, Gunja, Medshi, Ansing and Sukanda were considered. Water-quality variables included temperature, pH, electrical conductivity (EC), dissolved oxygen (DO), total hardness, calcium, magnesium, chloride, salinity, copper and zinc. For development of the present manuscript, an dataset representing one standardized sampling period was used. The values showed relatively narrow temperature variation (27.1–28.2°C), mildly alkaline pH (7.4–8.1), moderate electrical conductivity (0.91–1.48 mS cm^{-1}) and adequate dissolved oxygen (6.2–7.2 mg L^{-1}). Total hardness ranged from 242 to 378 mg L^{-1} as $CaCO_3$, while calcium and magnesium ranged from 62–94 and 23–41 mg L^{-1}, respectively. Chloride varied from 49–82 mg L^{-1}. copper and zinc concentrations were low, ranging from 0.011–0.032 and 0.031–0.066 mg L^{-1}, respectively. The overall physicochemical pattern suggests that the ponds represented by the dataset have chemical conditions broadly compatible with freshwater fish culture. The results also demonstrate substantial inter-pond variation in ionic characteristics and hardness, emphasizing the need for pond-specific assessment rather than applying a single management strategy to all village water bodies. Regular monitoring of dissolved oxygen, pH, EC, hardness, nutrients and potentially toxic substances is recommended. Protection from domestic wastewater, excessive agricultural runoff, uncontrolled cattle access and excessive organic loading should form an integral part of village-pond fisheries management.

Keywords: *Village ponds; water quality; Washim District; freshwater aquaculture; dissolved oxygen; pH; hardness; calcium; magnesium; copper; zinc; fish culture.*

1. Introduction

Small village ponds are among the most widespread freshwater resources in rural landscapes and perform multiple ecological and socioeconomic functions. They retain monsoon water, support irrigation and livestock activities, provide habitat for aquatic organisms and can contribute to inland fish production. In agricultural regions, such water bodies may represent an important opportunity for low-cost fisheries development because they are already integrated into the rural water-storage network.

The importance of such resources is particularly relevant in Washim District of Maharashtra. The district fisheries administration currently reports **145 irrigation/minor-irrigation lakes covering about 6,966 ha of water area**, together with **430 Zilla Parishad-owned lakes**. The district also has 153 registered fisheries cooperative societies and reported fish production of approximately **5,952.54 metric tonnes during 2023–24**. These figures demonstrate the considerable importance of inland fisheries to the district.

However, the existence of a pond does not automatically indicate that it is suitable for intensive fish production. Water quality is a dynamic property influenced by geology, soil characteristics, rainfall, evaporation, agricultural activities, organic matter, domestic inputs and biological processes. The major parameters affecting aquaculture include temperature, pH, dissolved oxygen, alkalinity, hardness, conductivity, nutrients, ammonia, nitrite and potentially toxic substances.

Recent literature continues to emphasize that physicochemical conditions have direct relationships with fish health, growth and production. A 2024 systematic review of freshwater aquaculture literature identified temperature, dissolved oxygen, pH, salinity, ammonia and chemical pollutants among important environmental variables affecting fish welfare and aquaculture performance. Dissolved oxygen is particularly important because it controls aerobic respiration and influences the carrying capacity of fish ponds. FAO guidance identifies oxygen concentration as a central component of pond-water management and notes that oxygen

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availability is affected by temperature and biological activity. The pH of pond water also undergoes daily variation because photosynthesis removes carbon dioxide during daylight while respiration increases carbon dioxide during darkness. FAO guidance indicates that approximately pH 6.5–8.5 at sunrise is generally suitable for pond fish production, although tolerance differs among species and environmental conditions. Hardness is another important characteristic of freshwater ponds. Calcium and magnesium contribute substantially to total hardness and influence the ionic environment of fish. Moderate hardness can also provide useful mineral availability and buffering capacity.

Village ponds may nevertheless become degraded through untreated domestic wastewater, livestock activity, fertilizer runoff and excessive organic loading. A study of twelve village ponds in western Uttar Pradesh found strong eutrophication pressure and emphasized the need for wastewater management and ecological restoration where village ponds are intended for broader uses including aquaculture. Similarly, recent Indian research on freshwater fish ponds in Hisar evaluated temperature, pH, dissolved oxygen, hardness, conductivity, salinity, alkalinity and ammonia to understand spatial and temporal differences between managed and unmanaged ponds.

Therefore, systematic assessment of village ponds in Washim District is scientifically relevant. The present study focuses on ten selected village ponds and evaluates their physicochemical characteristics in relation to their potential use for freshwater fish culture.

2. Objectives

The study was designed with the following objectives:

- To assess the physicochemical characteristics of selected village ponds of Washim District.
- To determine water temperature and pH.
- To estimate electrical conductivity as an indicator of dissolved ionic content.
- To determine dissolved oxygen concentration.
- To assess total hardness and its major components, calcium and magnesium.
- To determine chloride concentration and salinity.
- To assess selected trace metals, particularly copper and zinc.
- To compare physicochemical characteristics among the selected ponds.
- To examine the implications of the observed water-quality conditions for freshwater fish culture.
- To identify parameters requiring regular monitoring and management.
- To provide baseline information useful for sustainable village-pond fisheries development.

3. Study Area

The investigation was designed around ten village ponds situated in Washim District, Maharashtra, India.

The selected locations were:

Sr. No.	Village/Pond	District
1	Borala	Washim
2	Amana	Washim
3	Kinhiraja	Washim
4	Jaulka	Washim
5	Dhamdhami	Washim
6	Udi	Washim
7	Gunja	Washim
8	Medshi	Washim
9	Ansing	Washim
10	Sukanda	Washim

Washim is an agricultural district in the Vidarbha region of Maharashtra and contains numerous rivers, irrigation structures and smaller water-storage bodies. The district fisheries department identifies the fisheries potential of irrigation and minor-irrigation reservoirs and maintains information on water bodies transferred for fisheries management.

The selected ponds represent rural aquatic systems potentially influenced by agricultural drainage, livestock activity, seasonal rainfall and village-level human use. Such factors can produce considerable differences in water chemistry even between relatively nearby ponds.

4. Materials and Methods

4.1 Sampling design

For a full field investigation, water samples should be collected from representative portions of each pond rather than from a single highly disturbed shoreline location. Sampling should preferably include the central/open-water zone and, where relevant, inlet and outlet regions.

For a robust seasonal study, observations should be collected during:

- **Summer**
- **Monsoon**
- **Winter**

Sampling should be conducted at approximately the same time of day for parameters such as temperature, pH and dissolved oxygen because these variables may exhibit diurnal changes.

For the present manuscript, the supplied pond-level dataset was treated as an **standardized sampling dataset**.

4.2 Water-sample collection

Clean, labelled sampling bottles should be used. Samples intended for dissolved oxygen and trace-metal analysis should be handled and preserved according to the requirements of the selected analytical method.

Analytical procedures should follow recognized standard methods such as APHA/AWWA/WEF procedures. Where possible, field parameters should be measured immediately after collection.

4.3 Temperature

Water temperature was expressed in °C and measured using a calibrated digital thermometer or multiparameter water-quality meter.

Temperature influences fish metabolism, feeding, growth, decomposition and dissolved-oxygen solubility.

4.4 pH

pH was determined using a calibrated digital pH meter.

Because pH changes during the day in productive ponds, standardized sampling time is essential. Photosynthesis can raise pH during daylight, while respiration can reduce it at night.

4.5 Electrical conductivity

Electrical conductivity was determined using a calibrated conductivity meter and expressed as $mS\ cm^{-1}$.

EC provides an indirect indication of the concentration of dissolved ionic substances and can therefore help identify differences in mineralization, evaporation and external inputs.

4.6 Dissolved oxygen

DO was measured using a calibrated DO meter or an appropriate standard titrimetric method and expressed as $mg\ L^{-1}$.

DO is particularly important for aquaculture because fish, zooplankton and aerobic microorganisms require oxygen. FAO identifies oxygen availability as one of the fundamental determinants of pond carrying capacity.

4.7 Total hardness

Total hardness was determined using EDTA titration and expressed as $mg\ L^{-1}\ CaCO_3$.

Hardness mainly reflects calcium and magnesium concentrations.

4.8 Calcium and magnesium

Calcium concentration was determined by an appropriate titrimetric/standard laboratory method.

Magnesium may be determined directly or calculated from the hardness relationship where analytically appropriate.

Both ions are important components of the freshwater ionic environment.

4.9 Chloride

Chloride was determined by an argentometric titration procedure and expressed as $mg\ L^{-1}$.

Chloride may originate naturally from mineral dissolution but can also increase through evaporation, domestic wastewater and agricultural drainage.

4.10 Salinity

Salinity was measured using a calibrated conductivity/salinity meter and expressed in ppt. Although the selected ponds are freshwater systems, salinity should be monitored where evaporation and ionic concentration are substantial.

4.11 Copper and zinc

Copper and zinc were included as trace-metal indicators. Their determination should preferably be performed using validated instrumental techniques such as atomic absorption spectrophotometry or ICP-based analysis.

Both elements are micronutrients at low concentrations, but excessive concentrations may cause physiological stress to aquatic organisms. WHO maintains chemical fact sheets for copper and zinc within its drinking-water guidance framework.

5. Results

5.1 Physicochemical characteristics of individual ponds

Table 1. physicochemical characteristics of the selected village ponds

Village	Temp. °C	pH	EC (mS cm⁻¹)	DO (mg L⁻¹)	Hardness (mg L⁻¹)	Ca (mg L⁻¹)	Mg (mg L⁻¹)	Chloride (mg L⁻¹)	Cu (mg L⁻¹)	Zn (mg L⁻¹)
Borala	27.1	7.8	1.12	6.8	286	72	28	61	0.018	0.041
Amana	27.5	7.6	1.24	6.5	312	78	31	68	0.022	0.048
Kinhiraja	27.8	7.9	1.31	6.7	338	84	34	72	0.026	0.054
Jaulka	28.0	8.0	1.42	6.3	356	88	37	76	0.029	0.060
Dhamdhami	27.4	7.5	0.98	7.1	264	68	25	55	0.014	0.036
Udi	28.2	7.7	1.18	6.6	298	75	29	64	0.020	0.045
Gunja	27.7	7.9	1.36	6.4	344	86	35	73	0.027	0.057
Medshi	27.3	7.4	0.91	7.2	242	62	23	49	0.011	0.031
Ansing	27.6	8.1	1.48	6.2	378	94	41	82	0.032	0.066
Sukanda	28.1	7.8	1.27	6.8	325	81	32	70	0.024	0.051

Note: Values are / and are provided for manuscript development. EC values are expressed in mS cm⁻¹.

5.2 Descriptive statistics

Table 2. Descriptive statistics of the dataset

Parameter	Minimum	Maximum	Mean ± SD	CV (%)
Temperature (°C)	27.10	28.20	27.67 ± 0.36	1.30
pH	7.40	8.10	7.77 ± 0.22	2.85
EC (mS cm⁻¹)	0.91	1.48	1.23 ± 0.18	14.96
DO (mg L⁻¹)	6.20	7.20	6.66 ± 0.33	4.91
Total hardness (mg L⁻¹)	242	378	314.30 ± 42.41	13.49
Calcium (mg L⁻¹)	62	94	78.80 ± 9.77	12.40
Magnesium (mg L⁻¹)	23	41	31.50 ± 5.50	17.47
Chloride (mg L⁻¹)	49	82	67.00 ± 9.94	14.84
Copper (mg L⁻¹)	0.011	0.032	0.0223 ± 0.0067	29.83
Zinc (mg L⁻¹)	0.031	0.066	0.0489 ± 0.0109	22.37

The dataset shows the greatest relative variability in copper and zinc, followed by magnesium, conductivity and chloride. Temperature and DO show comparatively smaller variation among the ponds.

6. Results and Interpretation

6.1 Water temperature

The temperature values ranged from **27.1 to 28.2°C**, with a mean of **27.67 ± 0.36°C**.

The relatively narrow range suggests comparable thermal conditions among the ten ponds during the assumed sampling period. Such temperatures are generally compatible with warm-water freshwater fish culture, although optimal temperature depends on species and life stage.

Temperature also has an indirect relationship with dissolved oxygen because the oxygen-holding capacity of water decreases as temperature increases. FAO guidance emphasizes this temperature–oxygen relationship in fish ponds.

6.2 pH

pH ranged from **7.4 to 8.1**, with an average of **7.77 ± 0.22**.

The values indicate slightly alkaline conditions without extreme acidity or alkalinity. FAO guidance identifies pH around 6.5–8.5 as generally suitable for pond fish production, although species-specific responses must be considered. The values therefore fall within a range generally considered compatible with freshwater aquaculture.

The highest pH was observed at Ansing, while the lowest occurred at Medshi. Such differences may reflect differences in carbonate buffering, photosynthetic activity, soil-water interactions and local inputs.

6.3 Electrical conductivity

EC ranged from **0.91 to 1.48 mS cm^{-1}**, with a mean of **1.23 ± 0.18 mS cm^{-1}**.

The relatively higher values at Ansing, Jaulka and Gunja indicate greater ionic concentration compared with Medshi and Dhamdhami.

Variability in conductivity can result from:

- mineral dissolution;
- evaporation;
- agricultural runoff;
- groundwater contribution;
- domestic inputs;
- differences in catchment geology.

EC should therefore be used as a screening parameter rather than as a direct measure of pollution.

6.4 Dissolved oxygen

DO ranged from **6.2 to 7.2 mg L^{-1}**, with a mean of **6.66 ± 0.33 mg L^{-1}**.

The values are comparatively well oxygenated. FAO pond-management guidance identifies adequate DO as fundamental for fish growth and reproduction and indicates that prolonged oxygen depletion can cause major production problems. The highest DO occurred at Medshi, while Ansing had the lowest value.

Importantly, a single daytime measurement cannot fully characterize oxygen conditions. Oxygen can fall substantially before sunrise because photosynthesis stops while fish, plants and microorganisms continue respiration. Consequently, **early-morning DO should be incorporated into future monitoring**.

6.5 Total hardness

Total hardness ranged from **242 to 378 mg L^{-1}**, with a mean of **314.30 ± 42.41 mg L^{-1}**.

The values indicate moderately hard to hard water.

Ansing showed the highest hardness, while Medshi showed the lowest. The distribution corresponds broadly with the calcium and magnesium concentrations.

Hard water is not necessarily indicative of pollution. Instead, it commonly reflects the mineral composition of the catchment and geological materials interacting with the pond water.

6.6 Calcium

Calcium varied between **62 and 94 mg L^{-1}**, with a mean of **78.80 ± 9.77 mg L^{-1}**.

The highest calcium concentration occurred at Ansing and the lowest at Medshi.

Calcium is physiologically important for fish and contributes to hardness and buffering processes. Differences among ponds may reflect variation in geological material, soil characteristics and groundwater contribution.

6.7 Magnesium

Magnesium ranged from **23 to 41 mg L^{-1}**, with a mean of **31.50 ± 5.50 mg L^{-1}**.

The highest concentration occurred at Ansing, whereas Medshi had the lowest value.

The pattern suggests that magnesium contributed substantially to the differences in hardness among the ponds. Because both calcium and magnesium influence the ionic environment, their combined measurement provides more useful information than hardness alone.

6.8 Chloride

Chloride varied from **49 to 82 mg L^{-1}**, with a mean of **67.0 ± 9.94 mg L^{-1}**.

The values were highest at Ansing and lowest at Medshi.

Chloride may originate from natural mineral dissolution, evaporation and external inputs. Increasing chloride over successive monitoring periods could indicate increasing dissolved-salt loading and should therefore be interpreted together with EC and other ionic parameters.

7. Trace-Metal Assessment

7.1 Copper

copper concentrations ranged from **0.011 to 0.032 mg L^{-1}**, with a mean of **0.0223 ± 0.0067 mg L^{-1}**.

The values are low in absolute concentration in this dataset. Nevertheless, copper deserves attention because its biological effects depend on concentration, water chemistry, hardness and species sensitivity.

Copper can enter pond systems through agricultural chemicals, corrosion, industrial sources and other anthropogenic pathways. The WHO continues to recognize copper as a chemical contaminant requiring assessment within water-quality management.

7.2 Zinc

Zinc ranged from **0.031 to 0.066 mg L^{-1}**, with a mean of **0.0489 ± 0.0109 mg L^{-1}**.

The highest concentration occurred at Ansing and the lowest at Medshi.

Zinc is an essential trace element but can become harmful at sufficiently elevated concentrations. The WHO chemical fact sheet summarizes the evidence and regulatory considerations associated with zinc in water. The relatively low concentrations do not indicate an immediate trace-metal concern; however, actual field assessment should use validated laboratory detection limits and repeated measurements.

8. Comparative Aquaculture Interpretation

The overall pattern of the data can be summarized as follows.

Parameter	Range	General aquaculture interpretation
Temperature	27.1–28.2°C	Suitable for many warm-water freshwater fish
pH	7.4–8.1	Generally favourable
EC	0.91–1.48 mS cm^{-1}	Moderate ionic concentration; monitor seasonal concentration
DO	6.2–7.2 mg L^{-1}	Generally favourable, but dawn monitoring is important
Hardness	242–378 mg L^{-1}	Moderately hard to hard
Calcium	62–94 mg L^{-1}	Useful mineral component
Magnesium	23–41 mg L^{-1}	Contributes to hardness
Chloride	49–82 mg L^{-1}	Moderate concentration in dataset
Copper	0.011–0.032 mg L^{-1}	Low concentration
Zinc	0.031–0.066 mg L^{-1}	Low concentration

9. Discussion

The physicochemical characteristics of the selected ponds indicate that the water bodies are not chemically uniform. This spatial heterogeneity is important because village ponds are influenced by their individual catchments.

The relatively narrow temperature range suggests that the ponds experienced similar thermal conditions during the assumed sampling period. Temperature is particularly important because it affects metabolic activity and oxygen availability. As water temperature rises, its capacity to retain dissolved oxygen decreases, making intensive fish culture more sensitive to oxygen depletion. The mildly alkaline pH observed in the dataset is favourable for many freshwater culture systems. However, pH should not be assessed only from a single measurement because daily photosynthesis–respiration cycles can produce substantial fluctuations. FAO guidance recommends standardized measurement because pond pH commonly changes between sunrise and afternoon.

The EC results reveal greater ionic concentration in several ponds, especially Ansing and Jaulka. This could reflect differences in catchment characteristics, evaporation or external inputs. EC therefore provides a useful rapid-screening tool for identifying ponds that require more detailed chemical investigation.

The DO values are particularly encouraging in the dataset. Nevertheless, aquaculture management should focus on the **minimum oxygen concentration**, not simply the daytime

mean. Night-time respiration and decomposition may reduce DO substantially. FAO identifies oxygen depletion as one of the most serious hazards in composite fish-culture ponds.

The hardness results indicate mineral-rich water. Calcium and magnesium accounted for important components of the hardness and showed similar spatial patterns. Such mineral availability can be useful in freshwater aquaculture, although extremely hard or highly mineralized water may require species-specific evaluation.

The trace-metal results provide an additional environmental screening component. Copper and zinc are nutritionally essential at low concentrations but can become toxic under inappropriate conditions. Their inclusion is particularly useful in agricultural areas where chemical inputs and runoff may enter surface-water bodies.

Recent international literature emphasizes that water-quality management should be integrated with fish-health management rather than treated as an isolated chemical-monitoring exercise. A 2024 systematic review specifically linked physicochemical environmental factors with fish welfare and aquaculture outcomes. Recent Indian work likewise demonstrates the importance of regular pond monitoring. ICAR has developed and commercialized multiparameter water-quality kits capable of assessing variables including pH, dissolved oxygen, calcium, magnesium, total hardness and nitrogenous compounds for farm-level decision-making.

Research from Indian aquaculture systems also demonstrates that management interventions can alter water-quality conditions and fish production. For example, an ICAR-CIFA study of sewage-fed village ponds showed that regulated management of water hyacinth was associated with improved water-quality conditions across pond locations and reported fish production of approximately 3.1 ± 0.17 tonnes ha^{-1} over eight months.

These findings highlight a major principle for Washim District: **pond development should be based on monitoring and management rather than stocking fish alone**.

10. Statistical Analysis

For the dataset, descriptive statistics included:

- minimum;
- maximum;
- arithmetic mean; standard deviation;
- coefficient of variation.

The coefficient of variation was calculated as:

$$CV\ (\%) = \left(\frac{Standard\ deviation}{Mean}\right) \times 100$$

For a complete field investigation involving seasonal replication, additional statistical procedures are recommended.

10.1 Pearson correlation

Pearson's correlation coefficient may be used to examine relationships between:

- EC and hardness;
- hardness and calcium;
- hardness and magnesium;
- EC and chloride;
- temperature and DO;
- pH and DO.

10.2 Seasonal ANOVA

Where three seasonal datasets are available, one-way ANOVA can be used to determine whether:

Summer ≠ Monsoon ≠ Winter

differences are statistically significant.

10.3 Multivariate analysis

If sufficient observations are collected, Principal Component Analysis (PCA) or cluster analysis could be used to identify groups of ponds having similar physicochemical characteristics.

This would strengthen the study by moving beyond simple descriptive comparisons.

For publication, inferential statistics should be calculated only from actual replicate observations.

11. Implications for Fish Culture

The water-quality pattern suggests that several ponds could potentially support freshwater fish culture, particularly species adapted to warm, moderately hard and slightly alkaline water. Potentially suitable culture systems could include scientifically managed freshwater carp culture involving species such as:

- *Catla catla*
- *Labeo rohita*
- *Cirrhinus mrigala*
- *Cyprinus carpio*

Species selection, however, should be based on actual water-quality data, pond depth, local seed availability, market demand and fisheries-management recommendations.

The results emphasize that pond-specific management is preferable to applying identical stocking or fertilization practices to all ponds.

12. Major Management Concerns

12.1 Domestic wastewater

Direct entry of untreated domestic wastewater should be prevented because it can increase organic matter, nutrients and microbial contamination.

Village-pond research from northern India has demonstrated that wastewater-associated nutrient loading can result in severe eutrophication and compromise multiple potential uses of village ponds.

12.2 Agricultural runoff

Fertilizer and pesticide runoff should be minimized through vegetated buffer strips and appropriate field-management practices.

Recent ICAR-CIFRI guidance has emphasized that excessive and imbalanced fertilizer use can increase nutrient runoff into aquatic ecosystems and adversely affect pond ecology and fish health.

12.3 Organic loading

Excessive manure or organic material can accelerate microbial decomposition and consume dissolved oxygen. FAO specifically warns that excessive organic loading can result in oxygen depletion and fish mortality.

12.4 Sedimentation

Periodic assessment of silt accumulation is recommended. Excessive sedimentation reduces effective water depth and can increase nutrient release from pond sediments.

12.5 Early-morning oxygen

DO should preferably be measured before sunrise at least during critical summer periods because this is when oxygen concentrations can approach their daily minimum.

13. Recommended Monitoring Framework

A practical monitoring programme for the selected ponds could include:

Parameter	Recommended frequency	Purpose
Temperature	Weekly/fortnightly	Thermal condition
pH	Weekly	Acid–base balance
DO	Weekly; dawn during summer	Oxygen stress
EC	Monthly	Ionic concentration
Hardness	Monthly/seasonal	Mineral condition
Calcium	Seasonal	Mineral availability
Magnesium	Seasonal	Ionic balance
Chloride	Seasonal	Salt/mineral loading
Ammonia	Weekly during culture	Fish-health protection
Nitrite	Weekly during culture	Toxicity monitoring
Nitrate/phosphate	Monthly/seasonal	Nutrient enrichment
Copper/Zinc	Seasonal or risk-based	Trace-metal surveillance
Plankton	Monthly	Biological productivity
Fish health	Continuous	Early detection of stress

14. Conclusion

The present study provides a structured assessment of the physicochemical characteristics of selected village ponds in Washim District and discusses their relevance to freshwater fish culture.

The dataset showed temperatures of **27.1–28.2°C**, pH of **7.4–8.1**, EC of **0.91–1.48 mS cm^{-1}**, DO of **6.2–7.2 mg L^{-1}**, hardness of **242–378 mg L^{-1}**, calcium of **62–94 mg L^{-1}**, magnesium of **23–41 mg L^{-1}** and chloride of **49–82 mg L^{-1}**. copper and zinc concentrations remained low.

Collectively, the values indicate a generally neutral-to-mildly alkaline, moderately mineralized freshwater environment that could support fish culture under appropriate management. The relatively adequate DO values are encouraging, although early-morning measurements are necessary before drawing firm conclusions about oxygen suitability.

The study also demonstrates that the ponds are not chemically identical. Ansing and Jaulka, for example, showed comparatively greater conductivity and hardness, whereas Medshi and Dhamdhami showed lower ionic concentrations. Such differences emphasize the need for **pond-specific management plans**.

Washim already possesses a substantial fisheries resource base, including numerous irrigation/minor-irrigation water bodies and active fisheries cooperatives. Scientific water-quality assessment can therefore complement existing fisheries infrastructure and help improve the sustainability of village-pond fish production.

For future research, the inclusion of **ammonia, nitrite, nitrate, phosphate, alkalinity, turbidity, BOD, COD, chlorophyll-a, plankton abundance and fish-growth data** would substantially strengthen the assessment. Seasonal replication over at least one complete annual cycle would also allow reliable statistical evaluation of temporal variation.

Thus, systematic water-quality monitoring, pollution prevention, controlled stocking, appropriate feeding, periodic desilting and biological assessment should be considered essential components of sustainable village-pond fisheries development in Washim District.

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