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ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES OF WAGHOLI LAKE WATER, NALLASOPARA, PALGHAR FOR FISH FARMING.

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ABSTRACT

In recent years, India has witnessed the rapid transformation of fisheries sector from being food- based industries predominantly to evolving into a global commercial enterprise. Since, the shift of freshwater aquaculture from capture to culture practices, advance technology, better policy and geo-climatic suitability of Indian lake allows them to be a forerunner in the process of fish propagation in natural conditions. Assessment of water quality becomes an indispensable criterion as it directly affects the fish health and yield. Current study involves the physicochemical analysis of Wagholi lake water, for fish culture which is located about 70 Km away from Mumbai, Nallasopara town, Palghar district, Maharashtra. Palghar mainly a tribal dominated district of Maharashtra barely 100 Km from the metropolitan region, Mumbai reportedly has high rate of child death rate due to malnutrition. The prevalence of underweight, stunted children among the tribal population were significant chiefly because of poor dietary pattern and food practices. Fish can be utilized as the cheapest & important source of proteins, vitamins, minerals etc. which can help in improving the overall nutritional status of tribal masses residing in Palghar. No study has been conducted for evaluating the water quality of Wagholi Lake for fish farming. Thus, the hydrological parameter of lake water was assessed by grouping into mainly three categories -Physical, chemical & biological. Results of the analysis were compared with the water quality standard recommended by BIS 13891 (1994) & BIS 10500 (2012). Physicochemical analysis was done on eighteen parameters out of which nine elements were present in undesirable high amount which was responsible for the deterioration of Wagholi lake water quality. Some of the deviating factor are as follows - The mean investigated value for Turbidity, Total dissolved solids (TDS) & Electrical conductance were recorded to be 12 NTU, 719 mg/L, 1107 m Siemens/cm respectively, all fluctuated significantly high from the Indian standard value for fish farming. In chemical parameter-Total hardness, chloride & nitrate exist with the estimated average value of 380mg/L, 347 mg/L, 55 mg/L in high concentration in Wagholi lake water. Biological parameter comprising of Biochemical oxygen demand (BOD), Chemical oxygen demand (COD) and Dissolved oxygen (DO) were found to be remarkably high with the recorded mean value of 325 mg/L, 640 mg/L, and 54 mg/L respectively as compared to the Indian standard value acceptable for fish culture. This implies that the lake water is fairly polluted with varied contaminants due to direct discharge of domestic, agricultural wastes thus proper conventional & advance technological treatment is required for maintaining suitable water quality for efficient pisciculture. The present study will support the fish farmer in adopting and implementing varied strategies appropriate for aquaculture practices for increasing the fish production.

Key Words: *Aquaculture, Water quality, Hydrological parameters, Pisciculture, Malnutrition.*

1. INTRODUCTION

Fisheries sector in India has shown remarkable growth since mid-1980, due to its ability to provide livelihood to a large portion of socio-economic underprivileged population of the country (Balasubramanian & Ganesh Kumar, 2010). India accounts for being the second largest farmed fish producer in the world since the recent research advancement in carp polyculture technology, availability of infrastructure, supporting policy and shift of inland fisheries from capture to culture fisheries. Freshwater aquaculture has seen a rapid transformation from being a food production sector to global commercial enterprise by generating revenue, from export and small-scale industries (Ayyappan & Krishnan, 2004). In, India total fish production is about 22.31 million metric tons (Mmt) out of which inland fisheries contributes about 74% with production of 17Mmt and remaining 5.31 Mmt is harvested from marine resources. Inland water bodies of the country consist of rivers, lakes, estuaries, ponds, canals, reservoirs tanks etc. is used mainly for culture and capture fisheries whereas marine water masses are dominated with catching fishing activities (Srinivas *et al*., 2022).

Wagholi Lake is situated at 19° 24' 51" N and 72° 46' 46" E Nallasopara, Palghar district Maharashtra. Palghar is situated at a distance of 108 Km from the financial capital of India-Mumbai houses numerous tribal dominated regions, small-scale businesses & industries like engineering, pharmaceutical, plastics, textiles etc. However, the percentage of undernourished children suffering from stunting, underweight & wasting of body is remarkably high in tribal population of Palghar. Recent nutritional assessment has estimated that about 59% of children were found to be stunted, 53% underweight and 20% children under the age of four – six years showed wasting of body respectively. The key factors associated with prevalence of malnourishment among tribal children are-larger household, ethnicity, children's age, their health status, minimum level of diet diversity & unemployment (Ghosh *et al*., 2019). So, to tackle malnutrition fish can be utilize as a cheap, value-added product & alternative source of proteins, omega -3 fatty acids, vitamin D, essential micronutrients such as- iodine, calcium, zinc etc. Indian lakes are ideal for culture-based fisheries owing to its diverse nature and varied geo-climatic conditions. Lakes are relatively large water bodies occupying inland basin of various sizes, permanent or temporary, deep or shallow, freshwater or saline water (arid regions) and perform a crucial role in natural phenomenon such as biogeochemical cycle, hydrological cycle etc. They accumulate four times more water than the worldwide river sources and account for about 50.01% of all the water present on the surface of Earth making them an essential natural resource. Lake water ecosystem serve the purpose of housing diverse aquatic flora & fauna and provide major supply of water for drinking, irrigation, fisheries, industrial usage groundwater recharge and eco-tourism (Kumar *et al*., 2018).

Water plays a pivotal role in determining the efficiency of Pisciculture as complex interaction frequently occur among physical, biological and chemical component of lake which are discrete from land or air. It functions as a culture medium for aquatic life forms by supporting the major physiological activities as respiration, osmoregulation, excretion, reproduction etc. So, regular monitoring and maintaining a balance of water quality parameters become a paramount factor for the health, production and quality of farmed aquatic species (Bhateria & Jain, 2016).Urbanization, civilization and increased anthropogenetic activities has greatly affected the water quality of freshwater resources by increasing nutrient load, contamination, overuse of fertilizers, acid rain and exotic species invasion. These all factor trigger eutrophication of various surface water, if not been conserved immediately will cause water pollution & scarcity in near future.

Thus, the current study aims to investigate the physicochemical parameters of Wagholi lake water for determining its sustainability for fish culture by comparing the analyzed value with the recommended standard value for Pisciculture.

2. MATERIALS & METHODS

2.1 STUDY AREA

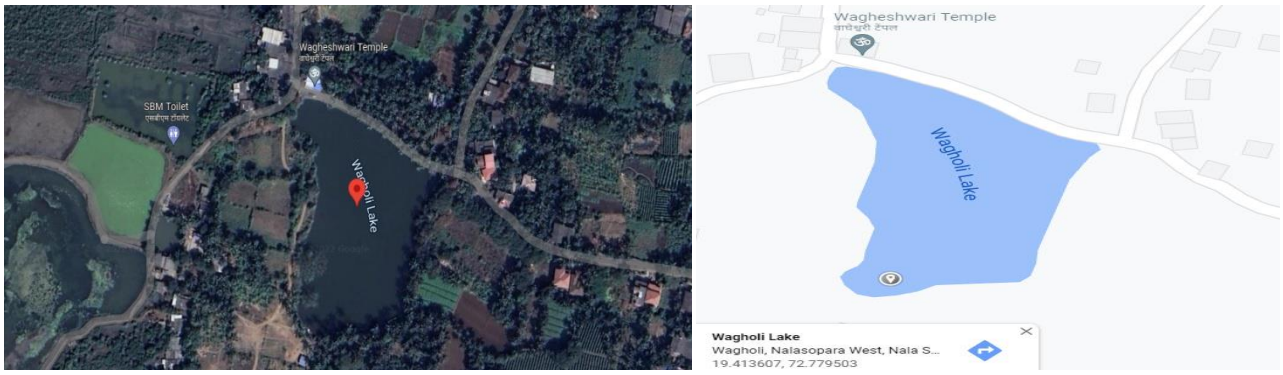

Figure 1: Location of the study area

Figure 2: Picture of the Wagholi Lake

Wagholi Lake is located in Wagholi village which is 3 km away from Nallasopara town, Palghar district, Maharashtra at 19° 24' 51" N and 72° 46' 46" E. It is a natural perennial, eutrophic, shallow water body spread over an area of 19 acres found near Wagheshwari temple. The lake water is extensively utilized for domestic, agricultural, religious practices as well as for fish farming. Indian major carps such as -*Labeo rohita* (Rohu), *Labeo catla* (Catla), *Cirrhinus cirrhosus* (Mrigal) some cichlids like *Oreochromis mossambicus* (Tilapia) and *Lates calcarifer* (Barramundi) is primarily cultured for marketing purpose.

2.2 SAMPLE COLLECTION AND ANALYSIS

The current study was carried out for three months from 1st April 2022 to 30th June 2022. Two liters of water samples were collected randomly from different sites of Wagholi Lake. Sampling was done in sealed sterilized plastics bottles during the morning hours of investigation period. The water was filled up to the fullness by removing the seal, immersing the bottle completely into the lake, collecting the water sample and was sealed back again. At most care was taken while transporting the water sample from the site to the laboratory for physicochemical analysis to avoid unusual changes in the water quality.

Hydrological parameter was mainly grouped into three categories-Physical, chemical and biological. The physical parameter comprises of- Color, Odor, Temperature, Turbidity, Total dissolved solids (TDS) & Electrical conductance. Chemical parameters include- pH value, Alkalinity, Total hardness (CaCO3), Chlorides, Sulphates, Iron, Fluoride, Nitrate, Phosphorus and Silica. Biological parameters consist of- Biochemical oxygen demand (BOD), Chemical oxygen demand (COD) and Dissolved oxygen (DO). All physicochemical parameter were analyzed as per the IS 10500-2012.

3. RESULTS AND DISCUSSION

Table 1. It depicts the mean value result of physicochemical analysis of Wagholi lake water, Nallasopara and its comparison with Indian Standards for Drinking Water, Bureau of Indian Standards (BIS), 2012.

Sr. No.	Test Parameters	Units	Results	Limits (IS 10500 - 2012)	Method Of Analysis
A.	**PHYSICAL PARMETERS**				
1.	Color Odor	Hazen units ----	7.0 Not-Agreeable	5 --------	Colorimeter Physically Observed
2.	Temperature	Degree Celsius	25.5	25 – 30	Thermometer
3.	Turbidity	NTU	12.0	10	Turbid meter
4.	Total Dissolved Solids (TDS)	mg/Liter	719	500	Oven Method
5.	Electrical Conductivity	mSiemens /cm	1107	500	----
B.	**CHEMICAL PARAMETERS**				
6.	pH Value	----	8.64	6.50 – 8.50	Electrometric Method
7.	Alkalinity	mg/Liter	250.0	200	Titrimetric Method
8.	Total Hardness ($CaCO_3$)	mg/Liter	380.0	300	Titrimetric Method
9.	Chlorides (as Cl)	mg/Liter	347.0	250	Titrimetric Method
10.	Sulphates (as SO_4)	mg/Liter	84.0	200	Gravimetric Method
11.	Iron (as Fe)	mg/Liter	3.0	2.0	Spectrophotometer Method
12.	Fluoride (as F)	mg/Liter	1.0	1	Spectrophotometer Method
13.	Nitrate (as NO_3)	mg/Liter	55.0	45	Spectrophotometer Method
14.	Phosphorus (P)	mg/Liter	0.1	0.5	Spectrophotometer Method
15.	Silica (as SiO_2)	mg/Liter	10.0	---	Spectrophotometer Method
C.	**BIOLOGICAL PARAMETERS**				
16.	Biochemical Oxygen Demand (BOD) (at 27^oC for 3 Days)	mg/Liter	325.0	30	Titrimetric Method
17.	Chemical Oxygen Demand (COD)	mg/Liter	640.0	250	Titrimetric Method
18.	Dissolved Oxygen (DO)	mg/Liter	54.0	40	Titrimetric Method

3.1 Determination of physical properties

Color and odor

The investigated lake color varies from light green to dark green when observed visually. Green, bluish -green/ brown-greenish color develops due to the high growth rate of phytoplankton in the lake, which represent good plankton population hence, beneficial for fish health (Das, 1997). An average value of 7 Hazen units was measured using the colorimeter which falls within the permissible limit value of 15 Hazen units as recommended by BIS 2012. Odor of the studied lake was determined by smelling through nose. Foul odor was detected as a result of domestic waste disposal. According to Das (1997) a well sustainable and ideal lake is odorless.

Temperature

Temperature is the measure of hotness or coldness of a body. Thermal fluctuation affects the productivity in aquaculture as fishes are ectothermic organisms, they don't produce heat and their body temperature varies according to that of environment. Elevated temperature increases the metabolic activity of aquatic life forms, thus increasing the oxygen demand which will ultimately reduce the dissolved oxygen content of water and will raise the ammonia level. The average temperature of the Wagholi Lake was found to be about 25.5 degree Celsius. This value is within the standard value of 24 to 30 degree Celsius required for carp culture as recommended by Santhosh & Singh (2007).

Turbidity

Turbidity is the cloudiness or haziness of water caused by particles dissolved or suspended, organic particulate matter, chemicals and dispersion of plankton. High turbidity has a negative impact on aquatic life as it blocks the light penetration which will limits photosynthesis, oxygen production & also harm fish gills (Carballo *et al*., 2008). The studied lake has an average value 12 NTU which exceeds the permissible limit of 10 NTU of BIS 1994 & BIS 2012 respectively. The effective ways to lower the turbidity of lake is by constructing silt catchment basin or by the addition of agricultural gypsum about 1gram per 100 liters of lake water.

Total dissolved solids (TDS)

Total dissolved solids represent the total concentration of dissolved substances made up of inorganic salts such as calcium, potassium, carbonates, nitrates, sulfates etc. & small amount of organic matter. These minerals are mainly added into water bodies through human activities such as agricultural practices, urban and industrial waste water discharge. The average value of Total dissolved solids (TDS) is 719 mg/L which is far greater than 0.13mg/L mentioned by Davis (1993). This indicates that Wagholi lake water should be treated first with chemicals to lower the quantity of dissolved solids to make it suitable for fish culture.

Electrical conductance

Electrical conductance refers to the total ionic content of water, which depends on the relative concentration of $Ca^{2+,}$ $Mg^{2+,}$ $HCO^{3-,}$ $CO^{3-,}$ $NO^{3-,}$ PO^{4-} etc. and serve a major indicator for fish production by determining the chemical richness (primary productivity) of lake. The estimated mean value for electrical conductance was recorded to be 1107mSiemens/cm which is far above the standard value of 500mSiemens/cm for fish farming as per James (2000). Stone and Thomforde (2004) have reported that100-2,000 mSiemens/cm is a suitable range for lake & pond fish culture.

3.2 Determination of chemical properties

pH value

pH is a measure of acidity or alkalinity of a solution. Generally, most of the water bodies has a slight alkaline pH due to the existence of carbonates, bicarbonates and is greatly influenced by carbon dioxide, alkalinity, hardness etc. of water. The average value of the pH is found to be 8.64 for Wagholi Lake. This value is within the standard range of value of 6.0-9.0 as recommended by Davis (1993). Santhosh & Singh (2007) has defined that pH range of 6.7-9.5 is desirable for fish culture, 7.5 and 8.5 is an acceptable pH range thus above and below this level is stressful for the fish which would result into mortality or low yield.

Alkalinity

Alkalinity is defined as the buffering capacity of a water body and its ability to resist changes in pH by neutralizing acid. Total concentration of different bases in lake water such as- carbonates, bicarbonates, hydroxides, phosphates, borates and other compounds determine the alkalinity. The average estimated value of alkalinity for the analyzed lake was about 250 mg/L. James (2000) has recommended 50 to 300 mg/L value of alkalinity acceptable for fish farming. According to the result of our investigation the estimated value is within the permissible limit of BIS 1994.

Total hardness

Total hardness is a measurement of the mineral content in a water sample mainly comprising of alkaline earth elements such as Calcium, Magnesium and also some other ions such as Aluminium, Iron, Manganese etc. In fishes, Calcium and Magnesium plays vital role during bone and scale formation. An average value of 380 mg/L was found to be the measure of total hardness for the studied lake which is far greater than the standard value of 50-100 mg/L recommended by WHO 2003. Estimated total hardness value of our investigation is within the permissible limit of 600 mg/L in accordance to the BIS 2012.Still, the water is too hard for fish farming and proper treatment is needed for lowering its level. Addition of zeolite and avoiding the runoff water during heavy rainfall as it carries lot of slits will be an efficient long-term method for reducing the hardness of lake (Bhatnagar *et al*., 2013).

Chlorides

Chloride is the most common inorganic anion found in water, which helps the fish in maintaining the osmotic balance and its abundance in Lake Ecosystem indicate pollution. High level of chloride, in inland freshwater basin is due to the accumulation of animal origin organic waste, which makes the water salty and damages fish's gills (Sangapal *et al*., 2011). Chloride average value in the studied lake was about 347 mg/L which is far above than the standard recommended value of 250 mg/L by BIS 2012. Ambatipati (2013) has suggested a natural & economical way to reduce chloride level in water by using dried biomass of *Parthenium* spp. leaves along some mechanical agitation.

Sulphates

Dissolved sulphate occurs naturally in freshwater by mineral weathering, decomposition, combustion of organic matter. Other factors such as drainage of wetlands, lowering of groundwater levels, leaching of fertilizer from agricultural fields and industrial wastewater are primarily responsible for raising the amount of sulphate in water (Hile *et al*., 2012). The studied lake depicts an average value of 84.0 mg/L for sulphate which is within the standard limit value of 200 mg/L as per BIS 2012.

Iron

Fish uses iron for facilitating oxygen transport and storage through hemoglobin and myoglobin. In aquatic ecosystem iron act as a limiting factor in determining phytoplankton growth (Beard *et al*., 1996). Average iron content in the Wagholi Lake was estimated about 3 mg/L which is slightly above the standard value of 2 mg/L recommended by BIS 1994 & BIS 2012.

Fluoride

Fluoride occurs naturally on earth crust and is released in the environment from the weathering of rocks into the soil, water & air. All water bodies on Earth contain an appreciable amount of fluoride. Naturally, some groundwater & natural springs contain high levels of fluoride (Singh *et al*., 2018). Wagholi Lake shows an estimated average value of 1 mg/L for fluoride, which is significant with the standard value of 1 mg/L as stated by BIS 2012.

Nitrate

Nitrate is harmless and highest oxidized form of inorganic nitrogen which is produced by the autotrophic bacteria in aquatic ecosystem. Due to domestic sewage & agricultural runoff nitrate level increases, which deteriorate the water

quality of lake. Although, nitrate is a major nutrient required for the facilitating the rapid growth of algae in lake (Murhekar, 2011). An average value of 55 mg/L was recorded for the nitrate content of Wagholi Lake which exceeded the permissible limit of 45 mg/L as suggested by BIS 2012. Thus, before the culturing of fish nitrate level has to be reduced, which can be done by utilizing denitrifying biological filtration, ion exchange materials and by diluting lake water with the water having lower nitrate level.

Phosphorus

In water phosphorous exist in both the form-organic and inorganic but, only inorganic phosphorous exhibits an active role in aquatic environment. When phosphorous is present in huge amount eutrophication of water bodies occurs due to the rapid growth of algae which reduces the dissolved oxygen content. Phosphorus content in the lake was found to be 0.1 mg/L which fall within the range of 0.5 mg/L recommended by BIS 2012. As per Stone and Thomforde (2004) the phosphate level of 0.06 mg/L is most beneficial for fish culture.

Silica

Silica is the oxide form of silicon and is a major structural component of diatoms and sponges (Jadhav *et al*., 2013). Naturally silica exists as suspended particles, silicate ions or in a colloidal state in water. An average value of 10 mg/L was measured for the silica in the studied lake which is in accordance with the value recorded by Sinha & Jha (1997) from Ox bow lakes of North Bihar.

3.3 Determination of biological properties

Biochemical oxygen demand (BOD)

Biochemical oxygen demand represents organic pollution & is refers to the amount of oxygen consumed by aerobic microorganism during the oxidative breakdown of organic matter in aquatic communities. Excess entry of dead & decaying organic matter, domestic waste, animal manure, industrial effluents & urban storm water runoff are some of principal sources for elevating BOD level in lentic ecosystem (Bhatnagar *et al*., 2013). BOD average value comes out to be 325 mg/L for Wagholi Lake which is remarkably high as compared to the standard value of 30 mg/L as per BIS 2012. This display that the lake is heavily contaminated with organic matter & appropriate measures is required for lowering the BOD level before the farming of fish. Discarding of floating / non biodegradable organic matter or debris from the lake surface by repeated netting, mechanical aeration using bamboo and avoiding overstocking of fish are some convenient strategies for reducing the BOD in lake.

Chemical oxygen demand (COD)

Chemical oxygen demand quantifies the amount of oxidizable organics pollutant present in surface water. It is defined as the total amount of oxygen required for a chemical reaction in breaking down of organic material using strong oxidizing agents like potassium dichromate, potassium permanganate and is also indicative about the level of reducing substances present in the water such as organic, nitrite, sulfide, ferrous salts, etc. (Mehta *et al*., 2016). The mean recorded value for COD was found out to be 640 mg/L which is far above the permissible limit of 250 mg/L recommended by BIS 2012 for aqua farming. Proper aeration, regular monitoring of organic load and lowering it by adding more water & avoiding domestic waste disposal would help in controlling the COD level in lake.

Dissolved oxygen (DO)

Dissolved oxygen is a vital parameter in determining the overall health status of a water body. Higher the concentration of dissolved oxygen more suitable the water body become in supporting the aquatic life. In water, oxygen is directly absorbed from atmosphere or is produced by hydrophytes through photosynthesis. Oxygen depletion occurs with deposition of organic matter, high temperature, salinity, humidity, algal blooms etc. which leads to fish starvation and mortality (Mehta *et al*., 2016). 54 mg/L was the investigated mean value for the dissolved oxygen content of Wagholi Lake which exceeded the permissible standard value of 40 mg/L for fish culture according to BIS 2012. Strategies which

are appropriate for bringing the DO to an acceptable range for fish farming are such as- avoid overuse of fertilizer, limiting the overheating of lake water by constructing artificial shades during summer season, avoiding overstocking of fish, controlling phytoplankton and aquatic biomass.

4. CONCLUSION

Water depletion & contamination has greatly affected many countries in recent years thus evaluating the physicochemical analysis of water bodies becomes a predominant criterion for the sustainability of life on Earth. The present study was done to evaluate the hydrological parameter comprising of physical, chemical & biological determinants of Wagholi lake water, Nallasopara, Palghar district of Maharashtra for fish culture. Except for color, temperature all determinants of physical parameters such as- Turbidity, Total dissolved solids (TDS), Electrical conductance all were significantly higher than the acceptable range for fish farming. Majority of chemical parameters were within the permissible limit for Pisciculture except for pH, Iron which were slightly above the standard value but chloride, nitrates and total hardness of lake water were observed remarkably high while the analysis period. BOD, COD, DO all were found in elevated concentration during the physicochemical analysis of Wagholi Lake. This implies that the Wagholi Lake is fairly contaminated for fish farming & might undergo eutrophication due to continuous agricultural, domestic waste discharge. So, there is an immediate need for lake rejuvenation and proper steps should be taken for improving the water quality of the lake by adopting conventional treatment like biological, chemical & mechanical etc. As well as modern scientific technologies for the successful propagation of fish. This research will further aid in restoration of nutritional status among the tribal children of Palghar.

5. REMEDIATION AND RECOMMENDATION

Some recommendation for controlling the level of pollutants in the lake is as following:

1. Campaign & programs should be organized for the general awareness of masses regarding the existing laws and guidelines related to fish farming in India.
2. Regular monitoring of water quality and stoppage of domestic effluents discharge for reducing the organic content of lake.
3. Proper aeration by beating the water surface regularly by bamboo sticks for increasing the dissolved oxygen content in the lake water.
4. Avoid overstocking of fish and over application of fertilizers in lake.
5. Bioremediation by introduction of freshwater bivalves, mussel such as *Lamellidens consobrinus*, controlling plankton biomass and soil filtration.

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