International Journal of Fauna and Biological Studies
Available online at www.faunajournal.com

E-ISSN 2347-2677
P-ISSN 2394-0522
https://www.faunajournal.com
IJFBS 2023; 10(5): 25-28
Received: 02-06-2023
Accepted: 04-07-2023

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Limnological studies on Dhudhaki Pond of Mangawan, Rewa (M.P.)

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Abstract
The present study was carried out to investigate the physico-chemical and biological properties of water of a perennial pond (Dhudhaki Pond) with a view to assess its suitability for fish culture. The seasonal variations (from July, 2020 to June 2022) of depth, transparency, temperature, pH, dissolved oxygen, free carbon dioxide, alkalinity, hardness, BOD, COD, phosphates, chloride, nitrate and plankton abundance have been studied in this pond. The result of investigation revealed that pond has distinctive features and more or less optimum physico-chemical and biological condition for fish culture. It may be concluded that the production capacity of a water body depends upon the quality of available nutrients which form the basic materials for structure, growth and development of living organisms which in turn form the food of fishes.

Keywords: Limnology, Perennial pond, Mangawan, Rewa

Introduction
The water resource is being used for various purposes such as domestic use, agriculture and fish culture etc. by local community. The quality of water resources is usually described according to its physical, chemical and biological characteristics. For confirming the good quality of water resources, large numbers of physico-chemical and biological parameters are to be studied in detail and must be found in normal range. Assessment of water resources quality from any region is an important aspect for the development activities of the region, because the rivers, lakes, ponds, wetland and manmade resources are used for water supply to domestic, industrial, agriculture and fish culture use (Kumar *et al*., 2016) [12]. Although, fish culture has been given great importance in the developed countries, its study in India in general and M.P. in particular has escaped the attention of scientists. There is large number of ponds, if these ponds maintained could be used for fish culture and are likely to show stimulating results in producing large quantities of food, augmenting income and creating employment in rural and urban areas. A number of researchers including Ashok (2019) [5], Verma (2020a) [22], Verma and Prakash (2020a) [24] did a lot on limnological studies. The present work is an endeavor to evaluate the magnitude of changes in physico-chemical and biological parameters in a perennial pond, Dhudhaki Pond of Mangawan tehsil of district Rewa (M.P.) with a view to assess its suitability for fish culture.

Materials and Methods
The Dhudhaki Pond is situated at 81.02' and 82.18' east and latitude 24.18' and 25.12' north in Mangawan tehsil of district Rewa (M.P.). The total catchment area of this pond is 3.901 ha (or 50220 Sq. M.). It is situated 17km away from sub-district headquarter Mangawan (tehsildar office) and 35km away from district headquarter Rewa. The study area was visited monthly and the surface water samples were collected by using samplers (Plastic containers of 5 liter size) from 3 sites of the pond. Some physico-chemical and biological parameters such as depth, transparency, temperature, pH, dissolved oxygen, free carbon dioxide, and alkalinity, hardness, BOD, COD, phosphates, chloride, nitrate and plankton density were analyzed in laboratory. The analysis of physico-chemical parameters were carried out by following standard method as described by APHA *et al*. (2012) [4].

Table: Physico-chemical and biological parameters of Dhudhaki Pond, Mangawan, Rewa

Characteristics of Water	July, 2020 to June 2021		July, 2021 to June 2022	
	Range	Mean ± SD	Range	Mean ± SD
Depth (m)	2.56 - 3.03	2.86 ±1.21	2.66 - 3.13	2.90 ±1.32
Temperature (ºC)	18.5 - 29.7	23.87 ± 0.97	18.9 - 29.9	24.01±102
Transparency (Cm)	14.0 - 24.0	19.36±0.79	12.33 -23.0	18.39±1.43
pH	7.43 -8.20	7.76±1.12	7.36 - 8.30	7.77±1.05
Free CO_2 (mg/L)	2.16 - 4.60	3.30±0.98	2.26 - 4.53	3.33±1.03
Dissolved Oxygen (mg/L)	6.36- 8.53	7.99±1.12	6.16- 8.66	7.49±1.03
BOD (mg/L)	2.06 - 3.76	2.95±0.82	2.10- 3.69	2.96±1.75
COD (mg/L)	20.63 - 41.19	29.97±2.12	21.46 - 42.10	30.63±1.54
Alkalinity (mg/L)	74.26 - 88.73	81.22±3.72	74.70 - 89.19	82.20±4.56
Hardness (mg/L)	66.70 - 97.46	82.36±4.32	66.29 - 98.33	81.50±3.78
Chloride (mg/L)	15.4 - 25.4	20.36±1.87	16.1 - 25.6	20.62±1.88
Phosphates (mg/L)	0.21 - 0.26	0.27±0.74	0.20 - 0.28	24.16±0.82
Nitrate (mg/L)	0.25 - 0.49	0.37±0.032	0.24 - 0.47	0.37±0.041
Phytoplankton (Unit/L)	514 - 1143	795±5.65	506 - 1128	764±5.23
Zooplankton (Unit/L)	528 - 914	664± 4.87	522 - 912	663±4.97

Results and Discussion

Depth: The depth of a water body has an important correlation with the physico-chemical conditions of water. If the water is too deep, the bottom layers will be cold and less productive. The average depth of pond varied between 2.56 to 3.03 (2.86±1.21) meters and 2.60 to 3.13(2.66-3.13) meters during the first and second year of study period, respectively. Ghosh *et al.* (2019) [9] reported that depth of water in fish-culture pond should be between 1.5 to 2.0 meters is good for fish culture.

Water Temperature: Water temperature is an important physical factor in controlling most of the chemical and biological characteristics of fresh water bodies. It affects all the metabolic, physiological activities and life processes of different trophic levels of aquatic ecosystem. The average water temperature of pond varied between 18.5 to 29.7 ºC (23.87±0.97) and 18.9 to 29.9 ºC (24.01±102) during the first and second year of study period, respectively and is suitable for fish culture for Indian major carp and slightly higher for exotic carps (Ansari and Prakash, 1999 & 2000) [2, 3]. The fluctuation in temperature of this pond followed the seasonal variations in atmospheric temperature (Imam and Khan, 2014) [10].

Transparency: Transparency is an important limiting factor for growth and distribution of aquatic organisms inhabiting in the water body. The transparency of water body is affected by several factors like planktonic growth, rainfall, sun's position in the sky, angle of incidence of rays, cloudiness, visibility and turbidity due to suspended inert particulate matter (Prakash *et al.*, 2015) [17]. In the present study the average water transparency of pond varied between 14.0 cm to 24.0 cm (19.36±0.79 cm) and 12.33 cm to 23.00 cm (18.39±1.43 cm) during the first and second year of study period, respectively. Chattopadhyay (1998) [8] and Ghosh *et al.* (2019) [9] stated that a transparency of 20-40 cm is beneficial for fish culture.

Hydrogen ion Concentration (pH): pH is one of the most important parameters in water chemistry and as intensity of acidity or alkalinity on a scale ranging from 0-14. During the present study pH ranges from 7.43 -8.20 (7.76±1.12) and 7.36 - 8.30 (7.77±1.05) during the first and second year of study period, respectively. Banerjea (1967) [6] reported that pH between 6.5 to 8.5 was suitable to achieve good fish production whereas according to Ghosh *et al.* (2019) [9] the range of pH 7.5 to 8.5 is ideal for fish culture.

Free Carbon dioxide: The free carbon dioxide play an important role in the photosynthesis of primary fish food organisms. The average free carbon dioxide of the pond water varied between 2.16 to 4.60 mg/L (3.30±0.98) and 2.26 to 4.53 mg/L (3.33±1.03) during the first and second year of study period, respectively. The high concentration of free carbon dioxide could probably be associated with active decomposition of organic matter in the ponds. The present finding is similar to that of Mishra *et al.* (1997) [16] and Kumar *et al*. (2015) [13].

Dissolved Oxygen: Dissolved oxygen is very important parameters in water quality assessment as it serves as an indicator of the physical, chemical and biological activities of the water body (Kumar *et al*., 2015) [13]. In the present study the average dissolved oxygen of the pond water varied between 6.36 to 8.53 mg/L (7.99±1.12 mg/L) and 6.16 to 8.66 mg/L (7.49±1.03 mg/L) during the first and second year of study period, respectively. The dissolved oxygen above 5.0 mg/L (or ppm) is suitable for fish culture (Banerjea, 1967; Chattopadhyay, 1998; Ansari and Prakash, 2000) [6, 8, 3]. Thus, regarding concentration of dissolved oxygen in the pond is productive.

Biochemical Oxygen Demand (BOD): BOD is an important indicator of a water body's pollution status and water quality. It refers to the dissolved oxygen required by microorganisms for aerobic decomposition of organic substances present in water (Kumari and Jha, 2015) [14]. In the present study the average BOD of the pond water varied between 2.06 to 3.76 mg/L (2.95±0.82 mg/L) and 2.10 to3.69 mg/L (2.96±1.75 mg/L) during the first and second year of study period, respectively.

Chemical Oxygen Demand (COD): COD is generally used to measure the pollution status of domestic as well as industrial waste water. In the present study the average BOD of the pond water varied between 20.63 to 41.19 mg/L (30.63±1.54 mg/L) and 21.46 to 42.10 mg/L (29.97±2.12 mg/L) during the first and second year of study period, respectively. APHA (2012) [4] reported that the suitable levels

of COD < 2 mg/L for drinking water. The upper permissible limit of COD for drinking water is 20 mg/L. Thus the pond water should not be used for drinking purpose.

Total Alkalinity: Alkalinity is directly related to the productivity of the water body because it regulates the pH and free carbon dioxide of the water body. Bicarbonate, carbonates and hydroxides are the basic components in natural water that determines the alkalinity of water. In the present study the average total alkalinity of the pond water varied between 76.30 to 89.00 mg/L (3.30±0.98 mg/L) and 76.53 to 88.86 mg/L (3.33±1.03 mg/L) during the first and second year of study period, respectively. Boyd (1985) [7] reported the optimum level of alkalinity between 50 to 300 mg/L for fish culture. Singh (1990) [19] stated that the 80.0-227.0 mg/L alkalinity is the indication of good productivity.

Total Hardness: Hardness of water is generally caused by the soluble contents of calcium and magnesium salts, including sulphates and chlorides of these elements in water. Total hardness is the index of fertility of the aquatic ecosystem (Kumar *et al*., 2015) [13]. In the present study the average total hardness of the pond water varied between 66.70 to 97.46 mg/L (82.36±4.32 mg/L) and 66.29 to 98.33 mg/L (81.50±3.78 mg/L) during the first and second year of study period, respectively. Pond water with a hardness up to 75 mg/L is treated as soft from 75-150 mg/L moderately hard and 150- 300mg/L as hard and above that very hard (Kiran, 2010) [11].

Chloride:Chloride is one of the most important inorganic anion in natural surface as well as waste water.In the present study the average chloride of the pond water varied between 15.4 to 25.4 mg/L (20.36±1.87 mg/L) and 16.10 to 25.60 mg/L (20.62±1.88 mg/L) during the first and second year of study period, respectively. Swaranlatha and Rao (1998) [21] reported that in general fresh water contain 8.3 mg/L chloride, but its concentration was observed in high range in the present ponds indicating somewhat polluted nature of habitat.

Phosphate: Phosphate is essential for the growth of organisms and a nutrient that limits the primary productivity of a water body (Kumar *et al*., 2015) [13]. In the present study the average phosphate content of the pond water varied between 0.21 to 0.24 mg/L (0.27±0.74mg/L) and 0.20 to 0.28 mg/L (24.16±0.82 mg/L) during the first and second year of study period, respectively.

Nitrate: Nitrogen is a primary nutrient and playing an important role in plant nutrition. It is found in the natural water in the form of nitrate, nitrite, ammonia and other organic material or insoluble organic material but most chemically stable available form of nitrogen is nitrate in natural water (Kumar *et al*., 2015) [13]. In the present study the average nitrate content of the pond water varied between 0.25 to 0.49 mg/L (0.37±0.032 mg/L) and 0.24 to 0.47mg/L (0.37±0.041mg/L) during the first and second year of study period, respectively.These nitrates in the ponds may be due to agriculture runoff from catchment area. Similar observations have been recorded by Singh and Patil (1991) [20] and Agarwal *et al.* (1997) [1].

Phytoplankton: Phytoplanktons are primary producers that play a crucial role in the food chain of all aquatic ecosystems. The density of phytoplankton in the pond fluctuated between 514 to 1143Units /L (795±5.65 units/L) and 506 to 1128 Units/L (764±5.23) during the first and second year of study period, respectively. During summer, the temperature increases causing higher evaporation and reduction in water at shallow ponds. This further leads to nutrient concentration creating favorable conditions for growth of phytoplankton (Vidhate and Somani, 2019) [27].

Zooplankton: Zooplankton are the chief trophic link in food chain and being heterotrophic organisms it plays an important role in the cycling of organic materials in a water body. Zooplanktons are very sensitive to environmental changes, so they are important indicators for assessing the pollution status of the water bodies (Magadza, 1994) [15]. The density of zooplankton in the pond fluctuated between 528 to 914Units /L (664±4.87) and 522to 912Units/L (663±4.97) during the first and second year of study period, respectively. In the present marked seasonal variation of planktons were found, sometimes their density is more and sometimes low depends upon the physico-chemical condition of pond water. This investigation concluded that Dhudhaki Pond has distinctive features and highly productivity

It may be concluded that the production capacity of a water body depends upon the quality of available nutrients which form the basic materials for structure, growth and development of living organisms which in turn form the food of fishes. However, anthropogenic activities, electronic wastes and microplastics badly influence the aquatic environment and biodiversity (Verma, 2020b; Prakash and Verma, 2022; Verma and Prakash, 2020b, 2022) [23, 17, 25, 26].

Acknowledgement: The authors are thankful to Principal, Govt. Model Science College, Rewa (M.P.) for providing laboratory facilities.

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