

Seasonal Variations in Physico-Chemical Parameters of Fresh Water Reservoir, Talab Shahi, Dholpur (Rajasthan) and Their Impact on Fish Diversity and Fish Production

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Abstract

The present study investigates the seasonal variations in the physico-chemical parameters of the Talab Shahi Reservoir in the district Dholpur, Rajasthan, and their impact on fish diversity and fish production. The seasonal variations in the physico-chemical parameters play an important role to determine the quality and characteristics of water that useful to various purposes including fish diversity and fish production. The physico-chemical parameters analyzed during June 2022 to May 2023 include pH, Temperature, Color, Turbidity, Total Alkalinity, Total Acidity, Total Hardness, Chloride, Fluoride, Free CO₂, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), and nutrient concentrations, such as Sulphate, Nitrates and Phosphates. These parameters were monitored over different seasons (Monsoon, Post-monsoon, Winter and Pre-monsoon) to determine the impact of seasonal changes on water quality. The fish diversity and fish production (fish catches) have been evaluated for same duration.

The results indicate that the seasonal variations in the physico-chemical parameters correlate with fish diversity and fish production. The physico-chemical parameters during monsoon season suitable for fish breeding while the post-monsoon season suitable for fish growth and development. The main fishing is done from winter to pre-monsoon season and fish diversity and fish production also highest during same season. Overall, the water of reservoir is productive to fisheries.

Keywords: Talab Shahi Reservoir, Physico-Chemical Parameters, Seasonal Variation, Fisheries.

Introduction

India has multifarious ecology with a huge number of freshwater rivers, lakes, wetlands, and ponds in different parts of the country. Nowadays, freshwater has become a scarce commodity due to over exploitation, population growth, and also pollution. Industrial effluents, domestic sewage, and municipal wastes are being continuously added to the freshwater reservoirs affecting the water and changing its physicochemical quality and making it unfit for its uses and fish production (**Prasanjit Mukherjee, et. al., 2022**). Seasonal variation affects the quality of water in several ways. The poor water quality results into small earnings, low down product value, probable human health risks, declining manufacturing, reduced growth, reproduction and mortality to the cultured species. Indeed, the water quality is significant for intake, farming, aquaculture and manufacturing use (Dey, et. al., 2021). There is found a remarkable variation in physico-chemical parameters, such as temperature, dissolved oxygen (DO), pH, transparency, electric conductivity, total dissolved solids (TDS), alkalinity, total hardness, phosphate and sulphate levels (**TEAME, Tsegay and ZEBIB, Haftom, 2016**).

Water and aquatic life are complementary to each other and without one the other cannot be imagined. the quality of water largely depends on physicochemical parameters and biological characteristics as all physico chemical conditions are fully life supporting and helpful for the growth and nourishment of healthy fish (**Muhammad Arfan Hadyait, 2018**).The role of water in nature is unique not only from the point of human consideration; even the numerous organisms make aquatic medium their abode. The physical and chemical properties of fresh water bodies are characterized by the climatic, geochemical, geomorphological and pollution conditions. The quality of aquatic life depends on the water quality. Fresh water bodies can be successfully utilized for fish production keeping in view the physico-chemical factors (**Kavita Sahni and Sheela Yadav, 2012**).There are several hidden factors responsible for water quality variations during both wet and dry seasons. The water quality parameters vary on both temporal and spatial scales (**Kaniz Fatema, et. al., 2014**).The seasonal variations in physico-chemical parameters of fresh water reservoirs affect the aquatic life. Aquatic ecosystems consist of physico-chemical factors and biotic factors which are not alike in water bodies. They change either due to natural or artificial processes and directly related to diversity of flora and fauna of that water body. The productivity in terms of planktonic biomass in freshwater bodies is

regulated by various physico-chemical factors viz., temperature, transparency, pH, total hardness, nitrates, phosphates etc. The water quality of fresh water reservoirs is adversely affected and impaired by the discharge of domestic, agricultural and industrial wastes (**OK. Adeyemo, et. al., 2008**). In most of the European countries during February and July, a significant variation is found in the physical water quality parameters, such as salinity, EC and TDS of the fresh water reservoirs (**Ladipo, M.K., et. al., 2011**).

Fisheries play a critical role in global food security, economic development, and cultural practices. However, they also face challenges such as overfishing, habitat destruction, and climate change, which threaten fish populations and the livelihoods of those who depend on them. Sustainable management practices are essential to ensure the health of fish populations and the ecosystems they inhabit. An incredible fish diversity prevails in the various reservoirs of India. There is a diverse fish community consisting of tens and hundreds of species across different orders, families and genera. However, Cypriniformes and Siluriformes remain in the dominant orders. The importance of sustainable fisheries management to preserve biodiversity and support local livelihoods cannot be ignored because it is just because of this management that the fisheries are kept in order and the fish are successful in surviving getting adequately the required quantity of food and water (**Konakondla et al., 2022**). All the fisheries in the world require their proper management because the lack of management system can put the fish in difficulty and make their production and survival difficult. The primary requisite for fish production in ponds and tanks is sufficient and good quality of water essential for healthy growth of fishes. Water should offer most favourable hydro chemical conditions for the existence along with various varieties of fishes but also of other aquatic organisms which is also a form food for fishes. Water and fisheries have a close relationship with each other. There are several fisheries in the world including India, but none of them maintain the water quality required for the fish rearing.

The fresh water reservoirs in India reveal significant seasonal variations in water quality, with some parameters exceeding the recommended limits during certain times of the year. Hence, it is essential to test and measure the water quality parameters keeping in view the approved standards (**Solanki and Ahirwar, 2015**). Fish physiology is impacted by the changes in dissolved oxygen levels in the water. DO levels have a deep impact on freshwater fish

swimming, feeding, disease management, survival, respiration, metabolism, growth, reproduction, health indices, immunity, and stress of freshwater fishes **Ali, Bulbul & Anushka & Mishra, Abha (2022)**. Indeed, it is shocking to note that in the fisheries in India do not meet the standard norms for fishery propagation due to differences in water quality parameters, such as dissolved oxygen, biochemical oxygen demand, and chemical oxygen demand. It is essential to ensure the sustainability of such ecosystems (**Tyagi et al., 2021**). The trade-offs between reservoir fisheries development and the conservation of natural fish genetic resources in India reveal that there is an urgent need to balance the enhancement of fish production through capture fisheries and culture-based fisheries with the conservation of natural genetic resources, particularly in the context of reservoir ecosystems. (**Sugunan and Suresh, 2022**).

Objectives of the Study

1. Studying the seasonal variations in physico-chemical parameters of fresh water reservoirs in general.
2. To study and evaluate the various requirements needed to maintain fisheries.
3. To expose the contemporary scenario of fisheries in terms of the maintenance of the water quality parameters and standards.
4. Studying and experimenting the seasonal variations in physico-chemical parameters of fresh water reservoir Talab Shahi, Dholpur (Rajasthan)
5. Investing trimonthly seasonable variation from June to August (monsoon), September to November (post-monsoon), December to February (winter) and March to May (pre-monsoon) in physico-chemical parameters of water.
6. Finding out the impact of seasonal variations in physico-chemical parameters of fresh water reservoir Talab Shahi, Dholpur (Rajasthan) on fish diversity and fish production.

Methodology

The Talab Shahi Reservoir (also called Talab-e-Shahi), constructed in 1617 AD as a medium irrigation project, is located at 26-degree 37 north latitude and 77-degree 39 east longitude in the Parbati river basin near the town Bari and is about 27 k.m. away from the district headquarter Dholpur (Rajasthan). The methodology for this research is designed to analysis of physico-chemical water over a specified period from June 2022 to May 2023. The aims of present

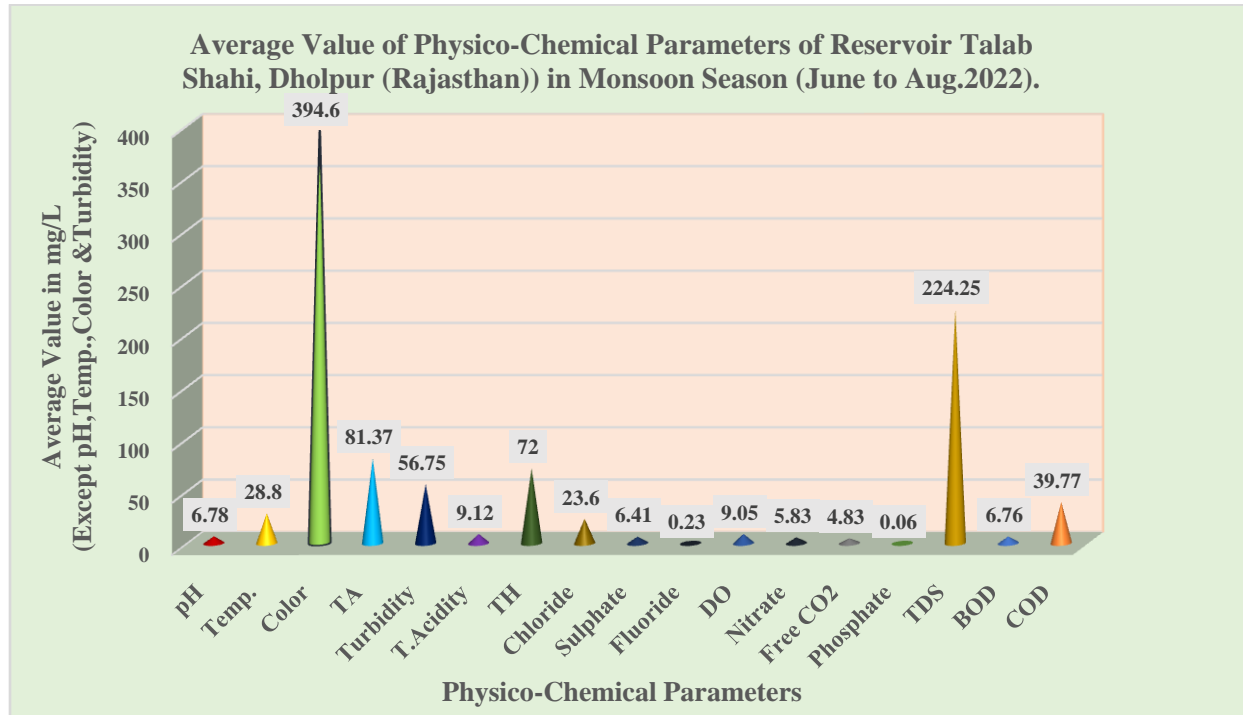
study to investigate trimonthly variation like season-wise June to August (monsoon), September to November (post-monsoon), December to February (winter) and March to May (pre-monsoon) if any, in physico-chemical parameters of water. The water samples were collected and analyzed twice a month with definite time interval and samples were collected in clean, airtight non-reacting and specific plastic bottles with capacity of one litre volume. Sampling was conducted in accordance with established protocols to ensure accuracy and reliability of data.

Water samples were collected from four different sites (S_1 , S_2 , S_3 and S_4) within the Talab Shahi Reservoir. These sites were strategically selected to represent different parts of the reservoir, ensuring a comprehensive assessment of the water quality across the entire water body. The sampling site S_1 : located Near Chandani chowk towards Bharat Nirman Rajiv Seva Kendra, S_2 : located towards the guest house, S_3 : located towards the village Nizampur, and S_4 : located towards the village Jore ka Pura. The collected water samples were analyzed and find out physicochemical parameters by various method as given by APHA (2005) like-pH (Electrometric Method), Temperature (On the spot by portable water analysis kit), Color (Spectrophotometer Method), Total Alkalinity (Titration Method), Turbidity (By Nephelometric Method), Total Acidity (Titration Method), Total Hardness (EDTA Titration Method), Chloride (By Silver nitrate titrimetric Method), Sulphate (Turbidimetric Method by Spectrophotometer), Fluoride (By SPADNS Method), Dissolved Oxygen (Winkler-azide Method), Nitrate (By Rubbing Method by Spectrophotometer), Free CO_2 (Standard alkali titrimetric Method), Phosphate (By stannous chloride Method by Spectrophotometer), Total Dissolved Solids (By electronic Method), Biochemical Oxygen Demand (By five-day incubation at $20^{\circ}C$ with serial dilute method), Chemical Oxygen Demand (By Potassium Dichromate Titration Method). The fish diversity was assessed by recording the number and abundance of species present. Metrics such as species richness, evenness, and diversity indices were calculated to quantify the diversity and distribution of fish species. The data of fish production estimated on the basis of fish catch. Day fauna surveys were conducted in collaboration with the fishing parties and Department of Fisheries, Government of Rajasthan, to assess fish production.

Result and Discussion

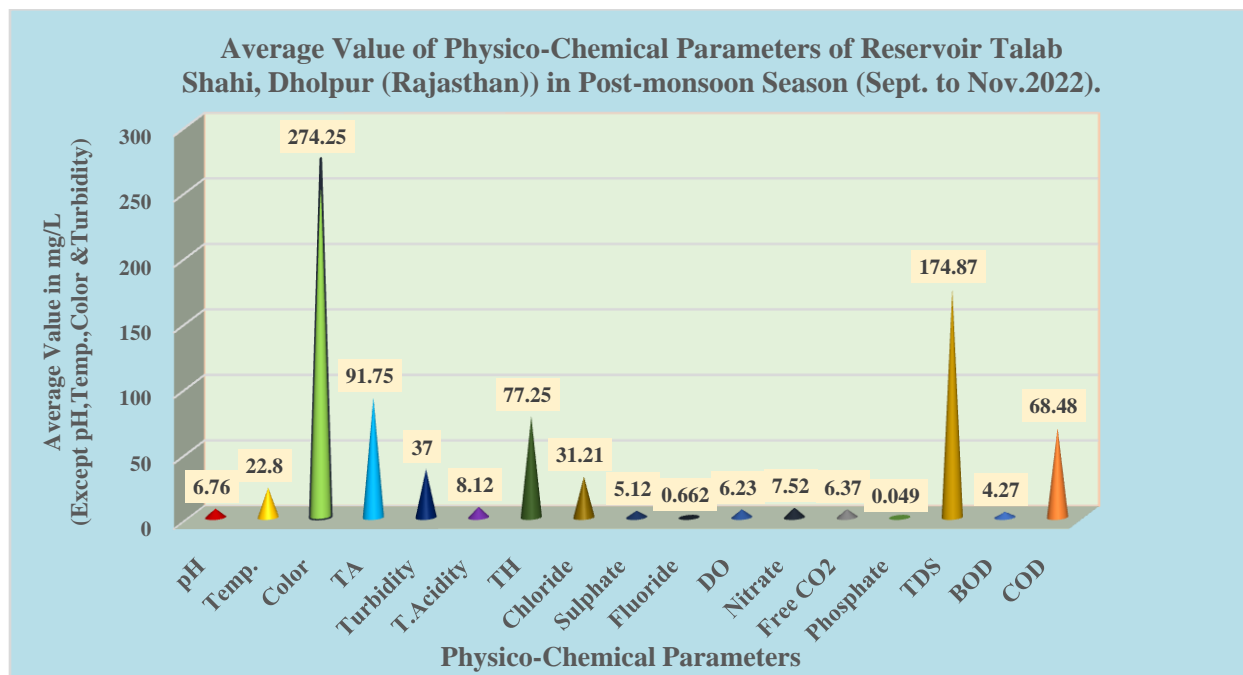
Table-01 Seasonal Average Value of Physico-Chemical Parameters of Reservoir Talab Shahi, Dholpur (Rajasthan) during June 2022 to May 2023.

Parameters	Unit	Seasons			
		Monsoon (June to Aug.2022)	Post-monsoon (Sept. to Nov.2022)	Winter (Dec.2022 to Feb.2023)	Pre-monsoon (March to May2023)
pH	-	6.78	6.76	6.66	7.02
Temperature	(°C)	28.8	22.8	15.9	26.4
Color	Hazen Unit	394.6	274.25	196.0	368.0
Total Alkalinity	mg/L	81.37	91.75	116.0	128.37
Turbidity	NTU	56.75	37.0	26.5	52.25
Total Acidity	mg/L	9.12	8.12	8.25	11.00
Total Hardness	mg/L	72.00	77.25	84.25	92.87
Chloride	mg/L	23.60	31.21	27.98	40.05
Sulphate	mg/L	6.41	5.12	4.45	3.58
Fluoride	mg/L	0.230	0.662	0.966	0.878
Dissolved Oxygen	mg/L	9.05	6.23	7.10	5.57
Nitrate	mg/L	5.83	7.52	8.02	11.92
Free CO ₂	mg/L	4.83	6.37	5.35	8.97
Phosphate	mg/L	0.060	0.049	0.019	0.035
Total Dissolved Solids	mg/L	224.25	174.87	161.87	186.75
Biological Oxygen Demand	mg/L	6.76	4.27	2.52	5.35
Chemical Oxygen Demand	mg/L	39.77	68.48	62.86	84.82



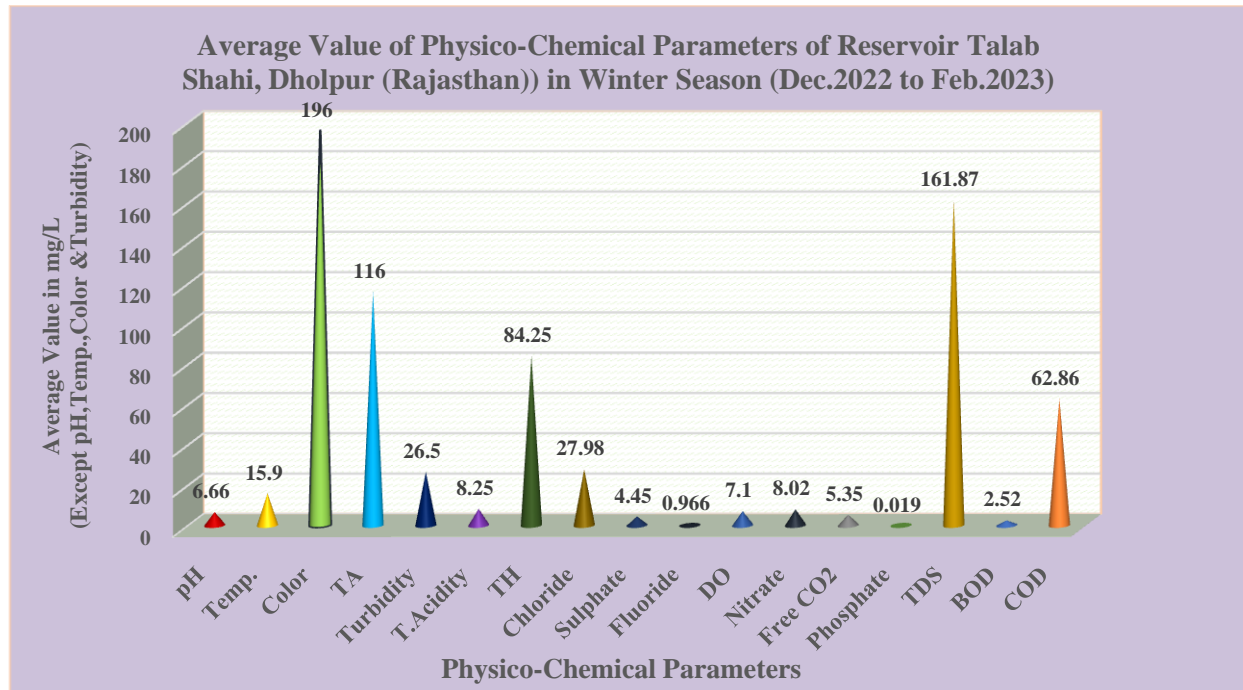
TA- Total Alkalinity T.Acidity- Total Acidity TH- Total Hardness DO- Dissolved Oxygen TDS- Total Dissolved Solids BOD- Biochemical Oxygen Demand COD- Chemical Oxygen Demand

Fig.01 Average Value of Physico-Chemical Parameters of Reservoir Talab Shahi, Dholpur (Rajasthan) in Monsoon Season(June to Aug.2022).



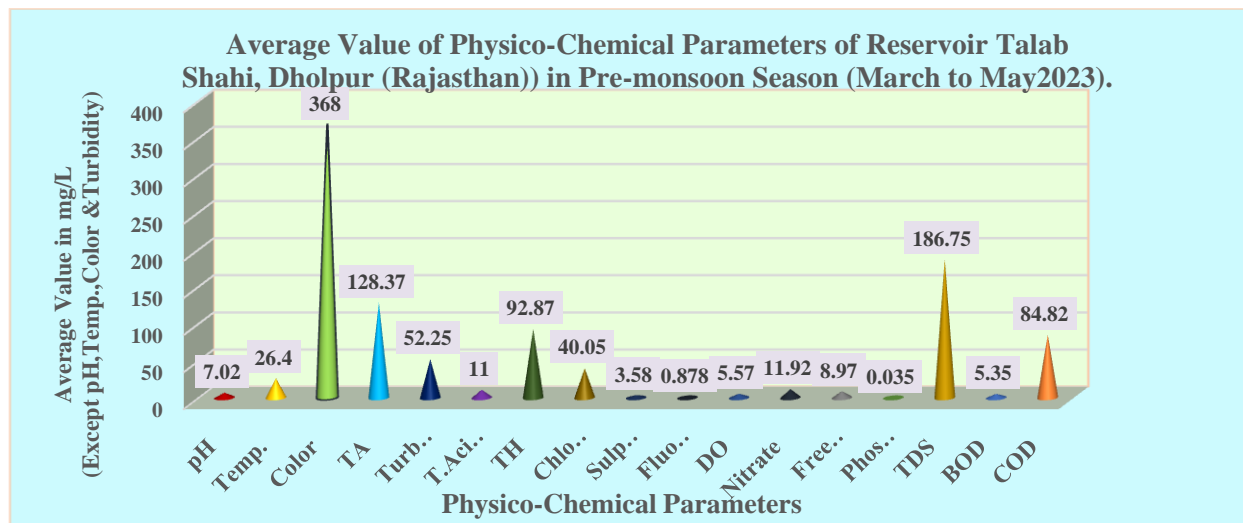
TA- Total Alkalinity T.Acidity- Total Acidity TH- Total Hardness DO- Dissolved Oxygen TDS- Total Dissolved Solids BOD- Biochemical Oxygen Demand COD- Chemical Oxygen Demand

Fig.02 Average Value of Physico-Chemical Parameters of Reservoir Talab Shahi, Dholpur (Rajasthan)) in Post-monsoon Season (Sept. to Nov.2022).



TA- Total Alkalinity T.Acidity- Total Acidity TH- Total Hardness DO- Dissolved Oxygen TDS- Total Dissolved Solids BOD- Biochemical Oxygen Demand COD- Chemical Oxygen Demand

Fig.03 Average Value of Physico-Chemical Parameters of Reservoir Talab Shahi, Dholpur (Rajasthan) in Winter Season (Dec.2022 to Feb.2023).



TA- Total Alkalinity T.Acidity- Total Acidity TH- Total Hardness DO- Dissolved Oxygen TDS- Total Dissolved Solids BOD- Biochemical Oxygen Demand COD- Chemical Oxygen Demand

Fig.04 Average Value of Physico-Chemical Parameters of Reservoir Talab Shahi, Dholpur (Rajasthan) in Pre-monsoon Season (March to May 2023).

Table-02 Fish Diversity of Talab Shahi Reservoir, Dholpur (Rajasthan)

Talab Shahi reservoir rich with a variety of fish fauna like-

Major Carps - *Labeorohita*, *Cattlacattla*, *Cirrhinusmrigala*, *Labeocalbasu*

Minor Carps -*Labeo bata*, *Puntius puntius*

Cat Fishes -*Wallago attu*,*Mystusseenghala*, *Mystus oar*, *Ompokbimaculatus*, *Channa merulius*, *Channa nama*, *Clarias magur*, *Heteropneustesfossilis*.

Other Fishes - *Ctenopharyngodonidella*,*Notopterusnotopterus**Cyprinus carpio* etc.

Table-03 Fish Production ((Kg. /Hac.) of Talab Shahi Reservoir, Dholpur (Rajasthan) during June 2022 to May 2023.

Month, Season and Year→ Fishes ↓	Monsoon (June to Aug.2022)	Post-monsoon (Sept. to Nov.2022)	Winter (Dec.2022 to Feb.2023)	Pre-monsoon (March to May2023)	Total Production
Major Carps	-	98	271	139	508
Minor Carps	-	32	109	44	185
Cat Fishes	-	22	77	30	129
Others	-	51	242	65	358
Total	-	203	699	278	1180

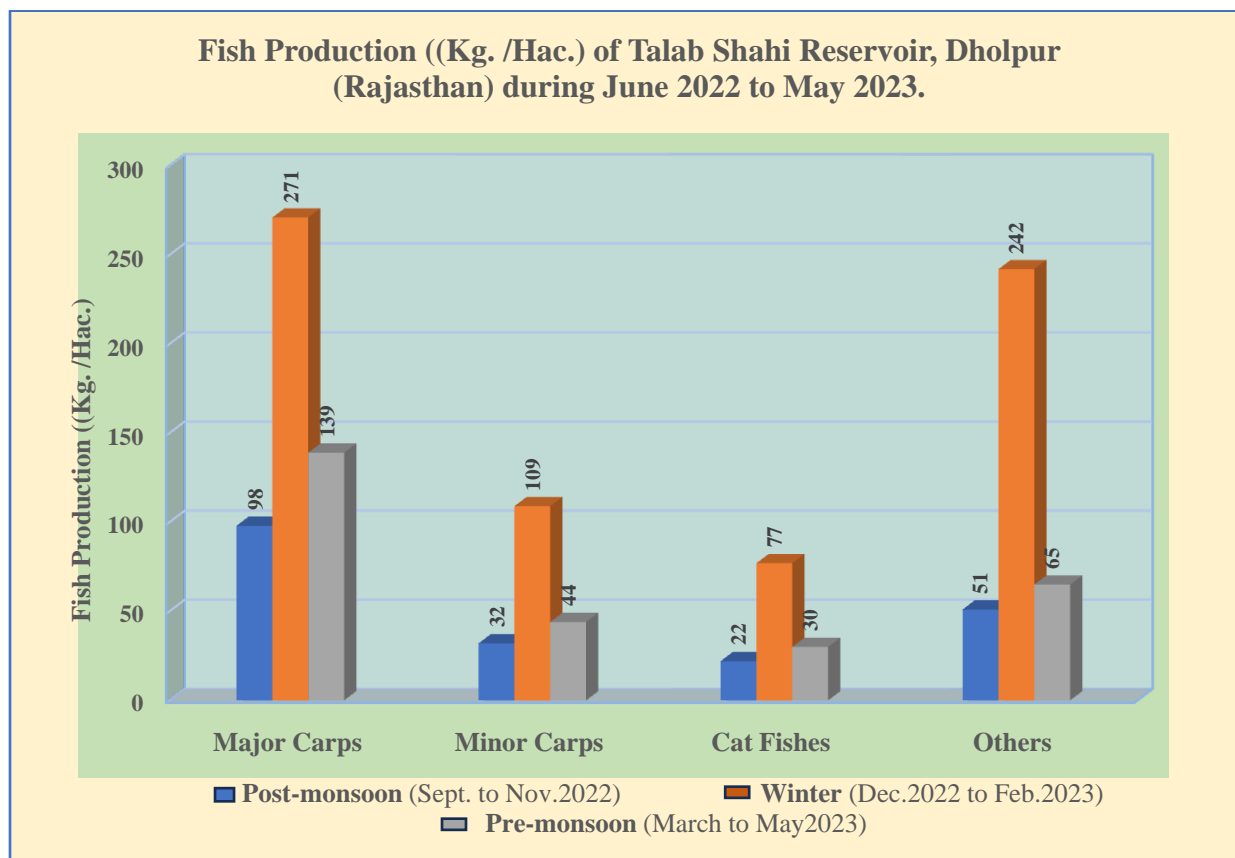


Fig.-05 Fish Production ((Kg. /Hac.) of Talab Shahi Reservoir, Dholpur (Rajasthan) during June 2022 to May 2023.

The given Table 01 and Fig. 01 to 04 reflecting the average seasonal variations in the physico-chemical parameters in the Talab Shahi reservoir as pH highest recorded 7.02 in Pre-monsoon and lowest 6.66 in Winter. The value of pH slightly acidic to neutral suitable to fish production. The maximum average value temperature 28.8°C during June to August (Monsoon season) and minimum 15.9°C recorded during winter. The average value of color and turbidity showed peak values during monsoon due to higher suspended solids, likely due to runoff and inflow during the monsoon and lower in winter season.

Total alkalinity and hardness showed moderate values, with peaks in the pre-monsoon respectively 128.37 & 92.87 mg/L, indicating the water's capacity to buffer against pH changes and the presence of calcium and magnesium ions. The highest acidity 11.0 mg/L was recorded in

pre-monsoon, which could be due to increased organic matter decomposition or runoff during this period and lowest 8.12 mg/L in post-monsoon season. The highest concentration of chloride (40.05 mg/L) was recorded in pre-monsoon and lowest (23.60 mg/L) in monsoon. Nitrate levels were relatively higher during the pre-monsoon months, with a maximum average of 11.92 ppm, suggesting nutrient inflows from agricultural runoff. Phosphate levels were low across all seasons but slightly higher during the monsoon months, which could potentially lead to eutrophication if not managed properly. The highest value of sulphate was recorded 6.41 mg/L recorded during monsoon season.

The highest average level (8.97 ppm) of Free CO₂ was recorded in pre-monsoon, which could affect fish respiration if levels continue to rise and lowest 4.83 ppm in monsoon. The highest average value of TDS (224.25 ppm) was recorded in monsoon, which could influence the water's ionic balance while lowest (161.87 ppm) in winter season. Dissolved oxygen (DO) levels were highest in the monsoon season (9.05 ppm in June to August 2022), which is crucial for maintaining aquatic life, while lower values were observed in the pre-monsoon. Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) values were higher in the monsoon and pre-monsoon seasons respectively, indicating increased organic pollution during this period.

The Table-02 showing the fish diversity or fish fauna of reservoir is characterized by a wide range of species, classified into major carps, minor carps, catfishes, and other species. The presence of these species indicates a healthy aquatic ecosystem capable of supporting a diverse range of aquatic life. It is incredibly rich with a variety of fish fauna like Major Carps - *Labeo rohita*, *Catla catla*, *Cirrhinus mrigala*, *Labeo calbasu*; Minor Carps – *Labeo bata*, *Puntius puntius*; Cat Fishes - *Wallago attu*, *Mystus seenghala*, *Mystus oar*, *Ompok bimaculatus*, *Channa merulius*, *Channa nama*, *Clarias magur*, *Heteropneustes fossilis*; many other fishes - *Ctenopharyngodon idella*, *Notopterus notopterus*, *Cyprinus carpio* etc. Indeed, reservoir's water is suitable for the fishes and highest diversity of fishes found in winter to pre-monsoon seasons due to favourable physico-chemical and other characteristics of water.

The Table-03 and Fig.05 showing the seasonal variation in fish production (kg/hac.) in Talab Shahi reservoir. The total fish production in Talab Shahi during June-2022 to May-2023 was 1180 kg/hac and this season wise fish production from September to April i.e. the post-monsoon (203 kg/hac), winter (699 kg/hac) and pre-monsoon (278 kg/hac). The fish production estimated on

the basis of fish catch. Day fauna surveys were conducted in collaboration with the fishing parties and Department of Fisheries, Government of Rajasthan, to assess fish production. The use of gears and crafts varies in accordance with the depth of water, nature of fish to be caught. Generally used gears are gill nets, cast nets, drag nets and wooden made boats of size 03 mt. to 06 mt., Dinghi (small boats) were employed to capture fish from different habitats within the reservoir.

The fish production in Talab Shahi reservoir reveals notable seasonal variations influenced by various factors including physico-chemical parameters of water and others. The seasonal variations in physico-chemical characteristics of reservoir's water directly or indirectly influenced the fishery management and fish production. For instance, the winter season typically show higher fish production and diversity, as this season offer optimal physico-chemical and other conditions of water for fish growth and development. In contrast, monsoon season and summer months may present challenges such as reduced water levels, increased turbidity, and fluctuating temperatures. These conditions can stress fish populations, potentially leading to reduced diversity and changes in species composition. For example, some species may migrate to deeper waters or more favourable habitats, while others may experience increased mortality rates. Understanding these seasonal dynamics is crucial for effective fishery management and conservation efforts. It allows for the development of targeted strategies to protect critical habitats and ensure the sustainability of fish populations throughout the year.

Key Findings & Conclusion

Fisheries refer to practices or systems where fish and other aquatic organisms are harvested for commercial, recreational, or subsistence purposes. They encompass both the natural environments where fish live and the practices involved in catching them. The above description reflecting the fish diversity and fish production in Talab Shahi reservoir is evident to confirm that it is a significant fresh water reservoir regarding fish diversity and fish production point of view. However, it cannot be denied that the production and diversity fluctuates season to season by various reasons may be due to physico-chemical and other factors reflecting seasonal variations. Therefore, the seasonal variations in physico-chemical parameters of fresh water reservoir Talab Shahi show the impact on fish diversity and fish production. The physico-chemical parameters

during monsoon season suitable for fish breeding while the post-monsoon, winter and pre-monsoon seasons suitable for fish growth and development. The main fish catching or fish production is done from December to April i.e. the winter and pre-monsoon season. Fish catching restricted means no fishing is done from June to August (Monsoon Season) because in these months fishes engaged in breeding so considered as breeding season and observed as closed season. The highest diversity and production of fishes recorded in winter to pre-monsoon seasons due to favourable physico-chemical and other characteristics of water. Major carps contribute the most to the total fish production, followed by other species, minor carps and catfishes. Overall, the water of reservoir is productive to fisheries and all the physico-chemical parameters within the permissible limit of various standards in all seasons except color and turbidity. However, the sustainable management and fishing practices are essential to ensure the long-term viability of fish diversity and fish production.

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