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Physico-chemical analysis of water of Newta dam Jaipur, Rajasthan

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Abstract-*Water, the elixir of life, is a priceless commodity and should be available to each and every person on this planet. Jaipur district is the fastest developing city of Rajasthan. Though Jaipur is famous for its historical places and art ,city is facing current trends of urbanization, over-exploitation of resources and exorbitantly increasing population. Therefore, study of physico-chemical parameters of water is considered as an important aspect of pollution studies in the environment.This study is aimed to explore the physico- chemical parameters of water quality standards* of Newta dam Jaipur,Rajasthan

Keywords: *Water quality of Newta dam****, Jaipur.****, Physico-chemical parameters, statistical analysis SAR, CAI, %Na, KR and LSI*

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Abbreviations
SAR: Sodium Absorption Ratio
CAI:Chloro Alkaline Indices
% Na: Sodium Percentage
APHA: American Public Health Association
WHO: World Health Organisation
NWMP: National Water Monitoring Programme
ICMR: Indian Council of MedicalResearch

I. Introduction

India has diversified forms of lands in which Jaipur city is situated in Rajasthan statewhich is located in North West region as a dry state.The water quality is affected by geological formations, anthropogenic activities, current trends of urbanization, over-exploitation of resources and exorbitantly increasing population. In other words, quality of water is deteriorated by excessive use of fertilizers and industrial discharge
The selected sites for the present study was Newta dam Jaipur,Rajasthan

II. Metarial and Method

In this study, the water quality standards of different physico-chemical parameters such as pH, Temperature, Conductivity, Turbidity, Fecal coliform, Total dissolved solids, BOD, COD, TA, TH, Calcium, Potassium, Sodium, Magnesium, Nitrate, Sulphate, Phosphate, Chloride , Fluoride, and Boron dissolved and their statistical interpretation for domestic and agriculture purpose were evaluated for water of Newta dam Jaipur,Rajasthan.

Twenty two sample readings were considered for water of Newta dam Jaipur, Rajasthan, collected from Rajasthan Pollution Control Board, Jaipur's Web-Site. Water sample readings were analyzed throughout the year for various physico-chemical parameters using standard methods recommended by American Public Health Association [1]. There are various methodsto determine different physical and chemical parameters.

National Water Monitoring Programme (NWMP) of Rajasthan State Pollution Control Board, Jaipur produces environmental report of different physico- chemical parameters for different stations of Rajasthan State. All Sample readings for different physico-chemical parameters were taken at Regional Laboratory, Kota. In this study, twenty two sample readings were considered for two consecutive years 2020 and 2021 i.e. eleven sample readings for each year with eleven months for water of Newta dam Jaipur, Rajasthan.In some cases, there was increase or decrease shown in readings which was due to change in weather.

Table- 1
Physico-chemical analysis of water of of Newta dam Jaipur, Rajasthan (STATION CODE-2952)

PARA METERS	2020										
	J	FEB	MAR	APR	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11
BOD	10	13.5	9.72	12.96	12.15	10.49	5.28	2.85	4.8	5.61	4.78
B	0.27	0.21	0.33	0.27	0.26	0.21	0.15	0.35	0.25	0.26	0.21
COD	87.3	112	92	132	124.8	126.4	73.6	59.55	73.51	107.52	96.8
Ca^{2+}	64	68.8	60.8	54.4	60.8	52.8	52.8	49.6	75.2	65.6	76.8
Cl^-	264	304	276	236	320	420	172	176	228	224	260
DO	1.1	1.19	2.05	NIL	0.29	7.35	4.03	2.48	2.88	0.55	1.56
F^-	1	1. 06	1.12	1.06	0.86	0.76	0.84	0.68	0.52	0.68	0.76
Mg^{2+}	50.752	36.112	32.208	27.328	38.064	45.872	27.328	17.568	24.4	27.328	25.376
NO_3^-	3.04	2.36	2.28	2.1	1.82	1.7	1.76	2	3.68	4.92	6.14
EC	1570	1710	1610	1530	1450	1560	1010	950	1100	1020	1270
pH	8.75	8.68	8.65	8.71	9.1`9	8.64	9.07	8.91	9.05	8.99	8.31
Na^+	184	212	184	164	192	230	167.5	128	175	150	134
K^+	7.2	6.6	5.9	4.8	6.5	9.7	8.8	9.8	11.2	10.8	11
SO_4^{2-}	105	145	170	135	105	95	86	117.5	45	77	80
PO_4^{3-}	1.1	0.934	0.7	0.5	0.5	0.4	0.3	2.4	2.8	3.8	3.6
Temperature	20	18	19	28	35	34	33	33	28	25	21
Turbidity	22.7	19.3	12.2	10.7	13.2	13.8	11.5	10.3	12.5	12.2	33.2
TDS	1064	1208	1166	1096	1182	1202	742	694	778	748	848
TA	256	260	188	172	188	172	124	116	144	132	172
TH	368	320	284	248	308	320	244	196	288	276	296
FC	150	240	150	150	150	93	150	150	150	240	240

Note: All ionic concentration are expressed in mg/lit. except EC(µmho/cm), Tempt.(^{o}C) Turbidity(NTU) and Fecal Coliform (MPN/100 ml

Table-2
Physico-chemical analysis of water of Newta dam Jaipur,Rajasthan (STATION CODE-2952)

PARAMETERS	2021										
	JAN	FEB	MAR	APR	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11
BOD	6.37	6.84	6.3	7.2	6.6	6.44	4.3	3.68	9.1	3.8	4.05
B	O.27	0.4	0.31	0.21	0.3	0.35	0.21	38	0.33	0.31	0.25.
COD	104.01	109.88	82	101.68	86.92	82.13	69.7	70.56	208.0	62.4	59.91

Ca^{2+}	73.6	65.6	62.4	57.6	54.4	49.6	52.8	52.8	64	46.4	59.2
Cl^-	292	324	348	384	364	288	236	236	252	276	308
DO	2.09	1.045	0.4	1.1	0.9	1.1	2.1	2.20	1.6	2.4	2.76
F^-	O.62	0.66	1.33	1.2	1.02	0.98	1.06	0.84	0.96	0.9	0.427
Mg^{2+}	35.136	36.112	33.184	33.184	40.992	35.136	27.328	30.256	28.304	30.256	27.328
NO_3^-	5.36	6.41	6.32	7.28	4.2	5.24	2,36	3.15	5.36	3.15	11.5
EC	1430	1630	1650	1900	1800	1400	1150	1230	1806	1981035	2230
pH	8.63	8.72	8.67	8.78	8.95	8.6	9.14	8.56	8.42	7.97	8.19
Na^+	156	188	205	235	215	215	165	190	205	182	188
K^+	12.8	15.6	18.4	13.8	9.4	9.8	7.9	8.4	8.4	9.2	9.6
SO_4^{2-}	82	104	92	134	114	87.5	94	98	114	164	103
PO_4^{3-}	3.2	2.2	1.5	1.9	2.2	1.5	1.6	1.4	1.42	1.8	3.63
Temperature	23	25	26	35	3.5	25	31	28	28	23	20
Turbidity	19.6	17.4	16.8	11.7	17.1	21.2	38.7	40.4	33.4	37.4	63.5
TDS	962	1144	1174	1298	1348	1068	848	936	1176	1290	1452
TA	180	160	168	176	180	168	124	120	148	140	188
TH	328	312	292	280	304	268	244	256	276	240	260
FC	150	240	240	150	93	93	64	93	93	240	150

Note: All ionic concentration are expressed in mg/lit. except EC (μmho/cm), Tempt.(^{o}C)Turbidity(NTU) and Fecal Coliform (MPN/100 ml)

pH – An important parameter which represents acidic and alkaline nature of water. It is vital for varied biochemical reactions [23][16]. Permissible limit for pH in water is 6.5 – 8.5 [1]. Less pH causes tuberculation and corrosion while higher pH causes Incrustation and sediment deposit [14].

Temperature- A vital parameter which not only influence chemistry of water but also governs biological activity and growth of living organisms. It

Turbidity-Turbidity represents cloudiness of the liquid which is formed by the accumulatingindividualparticles which are not visible by the naked eyes like smoke in air. Permissible limit for turbidity is 5-10NTU

Total Dissolved Solids (TDS)- TDS measures the total amounts of charged ions including minerals, salts or metals dissolved in a given volume of water. It is expressed in mg/lit. TDS originates from natural sources, sewage, also influences the different kinds of organisms that can live in water bodies

Electrical conductance-The measure of water's capacity to pass electric flow [27]. Electrical conductance is represented in ionized form of dissolved salts and other inorganic chemicals present in the water. This concentration of ionized form contributes to conductance. Permissible limit is 200-1000 μmho/cm.

Total Alkalinity- The measure of the buffering capacity of water or the capacity of bases to neutralize acids.It basically regulates pH of a water body and also maintains the metal content. It refers to the ability of water to resist change in pH. The general level of fresh water for alkalinity level is 20-200 mg/lit.

Total Hardness-An important parameter which is a measure of polyvalent cations in water. Polyvalent cations

mainly include concentration of calcium and magnesium including other cations like aluminium, barium, manganese and iron etc also contribute to it. 300 mg/lit is permissible limit of total hardness of water by ICMR. The higher content of the hardness is due to the industrial and chemical affluent with excessive use of lime [18].

Biochemical Oxygen Demand (BOD)-BOD measures the oxygen utilized for the biochemical degradation of organic material(carbonaceous demand) and oxidation of inorganic material such as sulphides and ferrous ions during a specified incubation period. Permissible limit for BOD is 3-5 ppm which represents moderatelyclean level.

Chemical Oxygen Demand(COD) -The measure of the capacity of water to consume oxygen during the process of decomposition of organic matter and oxidation of inorganic compounds like Ammonia, nitrite. It also means mass of oxygen consumed in Volume of the solution.It is expressed in mg/lit. Ideally COD should be zero.

Fecal Coliform-A group of total coliforms that are found in the gut and faeces of animals. Fecal coliform bacteria may occur in ambient water as a significance of overflow of domestic sewage. At the same time it may cause some waterborne diseases such as typhoid fever, viral and bacterial gastroenteritis. The acceptable level of coliform should be non-detectable in 100 ml

Calcium- Most abundant natural element present in all natural water sources. The main source is erosion of rocks such as limestone and minerals like calcite. Permissible limit for Calcium is 75-200 mg/lit.Excess amount of calcium concentration causes the less absorption of essential minerals in the human body

Magnesium- Its higher concentration renders undesirable tastes in water. The main source of magnesium in water is by erosion of rocks and minerals like dolomite or magnetite. Permissible limit of Magnesium is 30-150 mg/lit.

Sodium- Permissible limit for sodium in drinking water must be in range of 30 to 60 mg/lit. Hypertension, Kidney and Heart related diseases are caused by higher concentration of sodium.

Potassium– The lower concentration of potassium is beneficial for humans as well as plants. Hypertension, diabetes, adrenal insufficiency, kidney and heart related diseases are caused by higher concentration of potassium.

Chloride- Chlorides are present in almost all natural water resources. As we all know, the concentration of parameter by affecting its usability and aesthetic property with taste and make it unfit for drinking purpose. Main source of Chloride concentration are formation of rocks and soil with sewage wastes.

Sulphate –Sulphate is present in almost all drinking natural water sources [27]. The sources for sulphate concentration are rocks and geological formation. The excess amount of sulphate content causes laxative effect.Permissible limit for sulphate is 200-400 mg/lit.

Nitrate–Maximum permissible limit of nitrate is 50 mg/lit.[4]. The higher concentration of nitrate causes blue-baby disease or methamoglobinemia.

Phosphate- Permissible range for phosphate is 0.005 to 0.05 mg/lit. Main source of phosphate are sewage and industrial waste disposal in fresh water. Basically it promotes growth of micro-organism. [8]

Fluoride- The controlled addition of fluoride in water supplies to maintain public health is known as water fluoridation. So fluoridated water is used to prevent cavities by maintaining concentration of fluoride in water. Required level is 1.0-1.5mg/lit. Excess concentration causes fluorosis and deformation in joints

Boron Dissolved- Permissible concentration of boron in surface water is 1-5 mg/lit for a day. It is an essential nutrient present in plants.

Water quality criteria for irrigation

The suitability of water for agricultural use is determined by its quality for irrigation purpose. The quality of water for irrigation purpose is determined by the concentration and composition of dissolved constituents in water. Quality of water is an important aspect in any appraisal of salinity or alkalinity conditions in an irrigated area. Good soil and water management practices result in good quality of water which can promote maximum yield of crop.

Total dissolved Solids and the sodium content in relation to the amounts of calcium and magnesium or SAR [2] determines the suitability of water for irrigation. The suitability of groundwater for irrigation use was evaluated in the form of salinity by different statistical calculations such as (Sodium absorption ratio (SAR), soluble sodium percentage (SSP) and Chloro alkaline indices (CAI).

Statistical Representation of Water Parameters

Sodium Absorption Ratio (SAR):

SAR is a vital parameter given by Richard in 1954. The basic concept behind the sodium absorption is to find out the soil alkalinity of water used for irrigation purposes.

$$\text{SAR (Sodium Absorption Ratio)} = \frac{Na}{\sqrt{\frac{Ca+Mg}{2}}}$$

Note: Ca^{2+}, Mg^{2+} and Na^{+} are expressed in mg/l.

Chloro alkaline indices(CAI):

Chloro alkaline indice is used to calculate the base exchange proposed by Schoeller. Chloro alkaline indices are used to calculate ion exchange between the water and its surrounded area.

It is measured by following equation CAI = $[Cl^{-} - (Na^{+}+K^{+})/Cl^{-}$ Note: all ionic concentrations are measured in mg/l.

- CAI >0: No Base Exchange reaction i.e. there is any existence of anion cation exchange type of reactions.
- CAI <0 : Exchange between sodium and potassium in water with calcium andmagnesium in the rocks by a type of Base Exchange Reactions.

Percentage Sodium (%Na):

A method used for rating the irrigation waters which is utilized on the basis of percentage andelectrical conductivitygiven by Wilcox.

It is calculated by the formula:- $\%Na = \frac{(Na+K)}{Na+K+Mg+Ca} \times 100$

Note: All ionic concentration areexpressed in mg/l.

Kelly's ratio (KR):

Kelly ratio represents the assessment ratio for calculating the suitability of water for agriculture purpose. The suitability and unsuitability of water for agricultural purpose on basis of KR is due to alkali hazards.
Kelly's ratio was calculated by using the following expression

Kelly Ratio (KR) = $\frac{Na}{(Ca+Mg)}$

KR ≤1 : Suitable for Irrigation and represent good quality
KR>1 : Unsuitable for irrigation purpose
Note: All ionic concentrations are expressed in mg/l.

3.3.5 Calculation of Indices: Langelier Saturation Index (LSI)

LSI is an equilibrium index which represents thermodynamic driving force for calciumcarbonate scale formation and growth given by Langelier. It is explained with the use of pH.

- LSI <0 : No potential scale and water will dissolve $CaCO_3$.
- LSI >0 : Scale can form and $CaCO_3$ precipitation may occur.
- LSI = 0 : Border line scale potential.

To calculate LSI, value of total alkalinity (as $CaCO_3$), Calcium hardness as $CaCO_3$), totaldissolved solids (TDS) and value of pH and temperature of water (°C) required.
Note: All ionic concentration are expressed in mg/l.

LSI = pH – pHs

pHs is defined as the pH at saturation in calcite or calcium carbonate.

It is calculated by following formulapHs = (9.3 + P + Q) – (R + S)
where P = ($\log_{10}$ [TDS] –1)/10

Q = –13.12 × $\log_{10}$ (°C + 273) + 34.55

R = $\log_{10}$ [CaHardness as $CaCO_3$] –0.4S = $\log_{10}$ [Total alkalinity as $CaCO_3$]
We can calculate LSI by help of these equations.

LSI is helpful in predicting the scaling or corrosive tendencies of the water.

- If water dissolves calcium carbonate, water is corrosive and has a negative value.
- If the water deposits calcium carbonate; it has a scaling tendency and a positive value.

Table .3
Statistical Analysis of Various Water Sample Readings of water of Newta damJaipur,Rajasthan

2020											
Parameters	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11
	JAN	FEB	MA	APR	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SAR	24.3	29.2	27.01	25.66	27.31	32.76	26.29	22.10	24.82	22.02	18.76
CAI	0.27	0.28	0.31	0.28	0.37	0.42	0.02	0.21	0.18	0.28	0.44
%Na	62.49	67.57	67.12	67.37	66.75	70.83	68.75	67.23	65.15	63.37	58.66
KR	1.6	2.02	1.97	2.00	2.11	2.33	2.09	1.9	1.75	1.61	1.31
LSI	1.625	1.456	1.262	0.498	2.138	1.330	1.717	1.436	1.740	1.842	0.955

Note: All ionic concentrations are expressed in mg/l.

Table .4
Statistical Analysis of Various Water Sample Readings of water of Newta damJaipur,Rajasthan
2021

Parameters	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11
	JAN	FEB	MAR	APR	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SAR	21.16	26.36	29.66	34.91	31.15	33.07	26.19	29.50	30.19	29.40	28.61
CAI	0.42	0.37	0.35	0.35	0.38	0.21	0.26	0.15	0.15	0.30	0.35
%Na	60.82	66.82	70.03	73.26	70.17	72.62	68.35	70.49	69.80	71.38	69.54
KR	1.43	1.84	2.14	2.58	2.25	2.53	2.05	2.28	2.22	2.37	2.17
LSI	1.372	1.422	1.376	1.654	1.868	1.260	1.742	1.130	1.085	- 0.421	0.766

Note: All ionic concentrations are expressed in mg/l.

Table-5
Classification of Water Samples Readings of of water of Newta damJaipur,Rajasthan

Parameters	Categories	Range	No. of Samples 2020	2021
Sodium Absorption Ratio(SAR)	Excellent	0-10		
	Good	10-18		
	Fair	18-26	6	1
	Poor	>26	`5	10
Chloro Alkanine Indices(CAI)	Base ExchangeReaction	Negative Value	NIL	NIL
	Cation ExchangeReaction	Positive Value	All	All
Sodium Percentage(%Na)	Excellent	0-20		
	Good	20-40		
	Permissible	40-60	1	
	Doubtful	60-80	10	All
	Unsuitable	>80		
Kelly Ratio(KR)	Suitable	<1		
	Marginal Suitable	1-2	7	2
	Unsuitable	>2	4	9
Langelier Saturation Index LSI	: No potential scale and water will dissolve $CaCO_3$.	LSI <0	1	
	Border line scale potential.	LSI = 0		
	Scale can form and $CaCO_3$ precipitation may occur.	LSI >0	10	All

III. Conclusion

Value of some parameters for all samples are below higher permissible range these includeBoron, Calcium, Fluoride, Magnesium, Nitrate, Sulphate, TDS, TA, TH and pH.
Value of some parameters for all samples are below higher permissible range these are BOD,COD, EC, Chloride, Sodium, Potassium, Phosphate, Temperature, Turbidity

High value of these can cause following effect.High value of BOD –
The greater the BOD, the more rapidly oxygen is depleted in the stream. This means less oxygen is available to higher forms of aquatic life: **aquatic organisms become stressed, suffocate, anddie**.

High value of COD -

Higher COD levels mean a greater amount of oxidizable organic material in the sample, which will reduce dissolved oxygen (DO) levels. A reduction in DO can lead to anaerobic conditions, which is deleterious to higher aquatic life forms.
High value of EC-

A key issue with high conductivity in boiler water is that operational issues such as scaling can occur, which is a buildup of solid material in the boiler. When this occurs**,** the boiler becomes less efficient andincreases the fuel consumption of the unit.
High value of Chloride-

High levels of chloride can corrode and weaken metallic piping and fixtures, give a "salty" taste to the drinking water, damage household appliances, boilers, and, if the water is being used for irrigation, it mayinhibit the growth of vegetation.
High value of Sodium-

High levels of sodium in the water can cause soil aggregates to disperse and form crusts on the soil surface that impede the infiltration of water. Poor infiltration will increase run-off from furrow and sprinkler systems.

- High value of Phosphate-

Too much phosphorus can cause increased growth of algae and large aquatic plants, which can result in decreased levels of dissolved oxygen– a process called eutrophication

- High value of Potassium-

Potassium is weakly hazardous in water, but it does spread pretty rapidly, because of its relativelyhigh mobility and low transformation potential. Potassium toxicity is usually caused by other components in a compound, for example cyanide in potassium cyanide
Temperature-

Warm water holds less dissolved oxygen than cool water, and may not contain enough dissolved oxygen for the survival of different species of aquatic life. Some compounds are also more toxic to aquatic life at higher temperatures.
Turbidity-

Turbidity can increase the cost of water treatment for drinking and food processing. It can harm fish and other aquatic life by reducing food supplies, degrading spawning beds, and affecting gillfunction.
Value of turbidity is high for Dam as compare to maximum allowable concentration. High turbidity can significantly reduce the aesthetic quality of lakes and streams, having a harmful impact on recreation and tourism. It can increase the cost of water treatment for drinking and food processing. It can harm fish and other aquatic life by reducing food supplies, degrading spawning beds, and affecting gill function. A report of the European Inland Fisheries Advisory Commission lists five ways that fine particles can have a harmful impact on freshwater fish:

- acting directly on fish, killing them or reducing their growth rate, resistance to disease,etc.
- preventing successful development of fish eggs and larvae.
- modifying natural movements and migrations.

; • reducing the amount of food available.

- affecting the efficiency of methods for catching fish.

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