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Assessment Of Physico-Chemical Parameters Of Water Quality From Pechiparai, Perunchani And Chittar Dams Of Kanyakumari District, Tamil Nadu, India

Anitha Grace, A[1], Nija, C[2], and Palavesam, A[3]

[1,2]*Department of Zoology, Women's Christian College, Nagercoil. Tamil Nadu - 629 003.*
[3]*Department of Animal Science, Manonmaniam Sundaranar University, Tirunelveli. Tamil Nadu-627012*

Abstract: Dams are the main source for water storage which can be used for water table maintenance, survival of human beings during drought conditions, irrigations, industrial purpose etc. Discharge of harmful chemicals, domestic wastes, sewage disposal, plastic wastes leads to exceed the limits of water quality. Physical and chemical analysis of the water can have a clear idea about the quality of water in the stored dams. Our study focused on Pechiparai, Perunchani, Chittar- I and Chittar-II dams at three different season namely Pre Monsoon, Monsoon and post Monsoon showed variations in their mineral concentrations. The analyzed results revealed the minerals such as calcium, magnesium, sodium, potassium, iron, manganese, ammonia, nitrite, nitrate, chloride, fluoride, sulphate and phosphate are within their permissible limits. The physical parameters such as pH, alkalinity, hardness, turbidity, TDS and conductivity of dams at three different months showed better results. From the observed data's the water from the dams are good and pollution free environment, thus it has no harmful effects against aquatic animals for their survival. Thus Pechiparai, Perunchani and Chittar dams are non-polluted but their physical and chemical parameters are slightly varied between the three Seasons.

Keywords: Dams, Water quality, physiochemical parameters, minerals, Pre Monsoon, Monsoon, post Monsoon

1. INTRODUCTION

Earth is the planet which accommodates 70% of water resources in its total area. Water is the major source for survival and growth of all aquatic organisms in ecosystem. The availability of pure water is an indispensable for precluding disease and improving quality of life (Hamaidi-Chergui *et al*., 2013**)**. Dams are the most important water resources they are polluted by indiscriminate disposal of sewage, industrial wastes and human activities. Fresh water resources are vital for agriculture, industries and almost all human activities. Water quality of the world have to face incoming decades of external pollution (Maya *et al*.,2013). Reservoirs are constructed across the rivers in the form of dams, lakes, ponds etc. The reserved water can be reused for industrial practice, irrigation, navigation, domestic water supply, fish culture, recreation, hydroelectricity generation and during water crises (Loucks

and Beek, 2017).Water used for agricultural, drinking, and recreational purposes was impaired by the degradation of water quality by natural processes and anthropogenic activities (Carpenter *et al*., 1998). The pollution of surface water sources has serious health and environmental implications. Enormous usage of resources by human population, industrialization, sewage addition, fertilizers in agriculture and other man made activities has polluted the natural resource by waste disposal, pesticide or fertilizer accumulation and this becoming contaminated and harmful to the environment (Subba *et al*., 2012). Fresh water need to have special attention to free from contamination and sustainable for the present and future generations. Water quality regulates biotic diversity and biomass, energy and material cycles, tropical levels and rate of succession. This, in turn, helps in planning exploitation, antipollution or conservation strategies. The environmental monitoring through water quality assessment is a process undertaken for testing suitability of water for agricultural, industrial, aquaculture, and domestic purposes (Pulugandi, 2014).

Physico-Chemical parameters are the important component in aquatic system to indicate water quality of aquatic ecosystem (Singh and Singh, 2008). Regular assessment of water quality is now become a critical factor for the conservation of aquatic resource and ecosystem. It should be a continuous process with periodic assessment for sustainability for agriculture, industries, aquaculture etc. Pollution in water is measured primarily by assessing the physico-Chemical parameters of water (Latha and Mohan, 2010). High concentration of chloride is considered to be the indicator of pollution due to organic wastes of animal origin, regarded harmful to aquatic life and troublesome in irrigation water (Rajkumar *et al*., 2004).Total hardness is a parameter of water quality used to describe the effect of dissolved mineral (Ca2+ and Mg2+), determining solubility of water for domestic, industrial and drinking purpose attributed to presence of bicarbonates, sulphate, chloride and nitrates of calcium and magnesium (Arya and Gupta, 2013).Higher concentration of Mg makes the water unpalatable and act as laxative to human beings (Preeti *et al*., *2009*).The natural elements which cause water pollution is gases, soil, minerals, humus materials, waste created by animals and other living organisms present in water. In addition, other water quality characteristics that may influence water management options for fracturing operations include concentrations of organic compounds, usually hydrocarbon derivatives, which are detected by analysis (using standard test methods) for suspended solids, soluble organics, iron, calcium and magnesium, The natural source of pollution and their impact on ecobiological environment can be assessed and remedies for polluted water bodies can be governed with physico-Chemical analysis. The present investigation is focused on Pechiparai, Perunchani, Chittar- I and Chittar-II dams at three different seasons namely Pre Monsoon (February to may), Monsoon (June to Septemper) and Post Monsoon(October- January) . Pechiparai dam in the Kanyakumari District of Tamil Nadu is one among four dams in Kodayar irrigation project and was constructed during the period from 1896 to 1906. Perunchani dam was built during the period 1948-1953 by the erstwhile Travancore- Cochin State. This was built across River Paralayar . Chittar dam I and II are constructed across River Chittar which has its source in the mountains in klamala Reserve Forest .To solve the problems in water resources, quality assessment, planning to maintain good ecofriendly environment nearby areas can help it. Therefore, the present study is carried out to evaluate seasonal variations in water quality parameters of Pechiparai, Perunchani and Chittar reservoir.

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2. MATERIALS AND METHODS

Study area

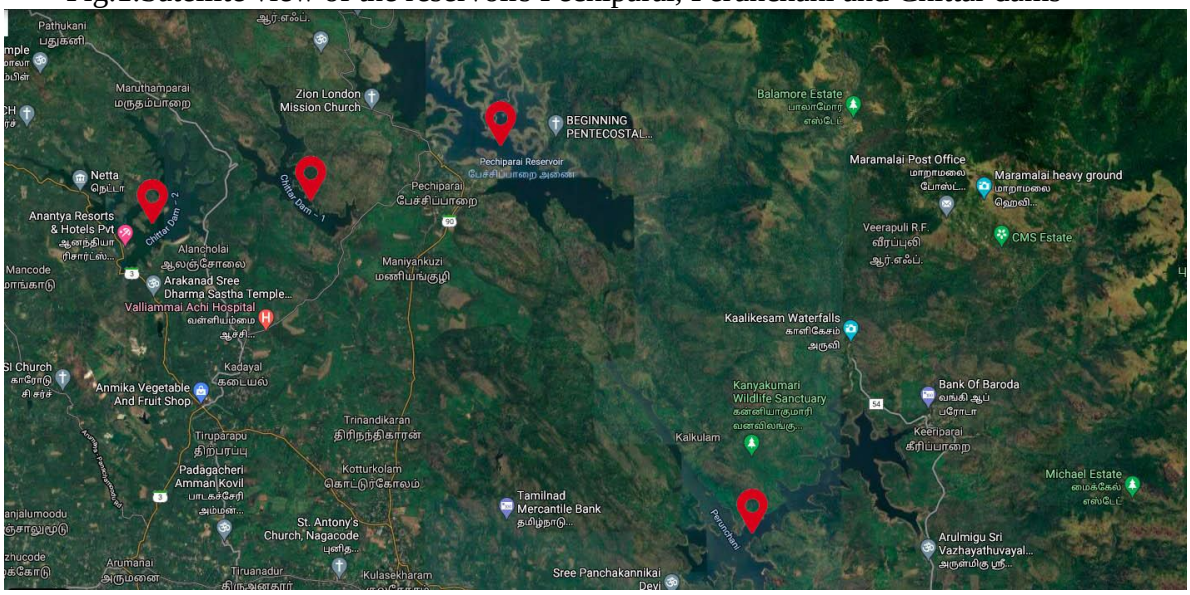
Water samples were collected from Pechiparai, Perunchani , Chittar 1 and Chittar 2 dam, located at Kanyakumari district, Tamil Nadu, India. (Fig.1 and 2).

Geographically, the dams were located within the latitudes and longitudes (Pechipparai : lat 8.448901, long 77.317309. Perunjani: lat 8.366767, long 77.360891, Chittar 1: lat 8.440383, long 77.238372 and Chittar 2: lat 8.447974, long 77.252105)

Sampling was carried out during 2020 October, June and February in 2 liter polyethylene bottles for further analysis.

Physical parameters such as pH, temperature, conductivity were measured in the field condition. Electrometric, Chemical analysis of nitrate, nitrite, chloride, were analyzed by standard procedure described by American Public Health Association (APHA,1998; APHA,2005). Minerals such as Calcium and magnesium were analyzed by atomic absorption spectrophotometer and sodium by flame photometry (Varian AA240). Nitrate is identified using colorimetric procedure (APHA 1998). Total hardness by titration with EDTA. The organic matter was determined by permanganate oxidation method (Wilson, 1959).

Fig.1.Satellite view of the reservoirs Pechiparai, Perunchani and Chittar dams



A

B

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C **D**

Figure. 2. Water quality sampling area A. Pechiparai B. Perunchani, C. Chittar-I D.Chittar –II

3. RESULT AND DISCUSSION

The water samples collected from four different resources such as Pechiparai, Perunchani, Chittar I and II dams on three different Seasons exhibited similarity in their appearance, colour and odour.

Turbidity is the quantity of suspended material which interferes in light penetration in the water column. Turbidity of samples from Pechiparai showed similar results in all the seasons. Perunchani dam showed no significant variation in their results at three different seasons ($P>0.05$). Chittar dam showed more or less similar in Monsoon and pre Monsoon season, but at post Monsoon the results show variation. Total dissolved solids (TDS) in Pechiparai dam was significantly similar at three different seasons and Perunchani, Chittar I, Chittar II dams showed significantly difference in their results in monsoon and pre monsoon($P<0.05$).

Conductivity mainly depends on concentrations of total dissolved solids and major ions (Bhatt *et al*., 1999). The results from samples showed lowest range of 30 Micro mho/cm and highest range of 61 Micro mho/cm. The range above 1000 Micro mho/cm is considered to be polluted water (APHA, 1995). Conductivity of the samples at different months at different dams showed significant difference in their observation ($P<0.05$).

Table .1 Physico-Chemical examination of water samples collected from different resources during pre monsoon season

Parameter	Acceptable Limit	Permissible Limit	Pechiparai	Perunchani	Chittar-1	Chittar-2
Appearance	-	-	Clear	Clear	Clear	Clear
Color	-	-	Clear	Clear	Clear	Clear
Odour	-	-	None	None	None	None
Turbidity	-	-	3	5	4	4

Total dissolved Solids mg/L	-	-	20	21	38	34
Electrical conductivity Micro mho/cm	-	-	30	32	60	62
pH	6.5-8.5	6.5-8.5	7.17* ± 0.02	7.42* ± 0.03	7.62 * ± 0.02	7.8* ± 0.02
Total Alkalinity as $CaCo_3$ mg/l	200	600	13.43 * ± 0.4	15.26 * ± 0.30	16.3 3* ± 0.3	17.2 * ± 0.20
Total Hardness as $CaCo_3$ mg/l	200	600	26.46 *±0.45	27.43 * ± 0.25	28.4 0* ± 0.45	29.2 6* ± 0.20
Calcium as Ca mg/l	75	200	3.2* ± 0.25	4.3* ± 0.25	5.3* ± 0.35	6.3* ± 0.25
Magnesium as Mg mg/l	30	100	0.66 ± 1.15	0.7 ±1.2	1.16 ± 1.15	1.6 ± 1.5
Sodium as Na mg/l	-	-	3.2* ± 0.25	4.46* ± 0.25	5.4* ± 0.30	6.2± 0.30
Potassium as K mg/l	-	-	1.33 ± 0.15	2.60 ± 0.20	3.5 ± 0.35	4.3 ± 0.26
Iron as Fe mg/l	0.3	1	0.24* ± 0.03	0.35* ± 0.035	0.44 * ± 0.025	0.53 * ± 0.03
Manganese as Mn mg/l	0.1	0.3	0	0	0	0
Free Ammonia as NH_3 mg/l	0.5	0.5	0.35* ± 0.03	0.44* ± 0.025	0.52 * ± 0.020	0.66 * ± 0.03
Nitrite as NO_2 mg/l	-	-	0.013 * ±0.03	0.025 *± 0.02	0.03 5* ± 0.03	0.04 * ± 0.003
Nitrate as NO_3 mg/l	45	45	2.6* ± 0.17	3.42* ± 0.30	4.41 * ± 0.24	5.47 * ±0.35
Chloride as CL mg/l	250	1000	50.45 *± 0.33	51.49 * ± 0.27	52.5 8* ± 0.23	53.2 3* ± 0.23
Fluoride as F mg/l	1	1.5	0.35* ± 0.03	0.44* ± 0.035	0.54 * ± 0.03	0.65 * ± 0.03
Sulphate as SO_4	200	400	9.5* ± 2.6	10.48 * ± 3.6	11.5 4* ± 0.30	12.5 5* ± 0.26

mg/l						
Phosphate as PO_4 mg/l	-	-	0.67* ± 0.01	0.77* ± 0.023	0.84 * ± 0.02	0.95 * ± 0.03
Tidys Test 4 hrs as O_2 mg/l	-	-	0.27* ± 0.02	0.34* ± 0.04	0.45 * ± 0.03	0.56 * ± 0.03

*p < 0.05; Statistical analysis of the data was performed by one-way analysis of variance (ANOVA) followed by Tukey's multiple range tests for *post-hoc* analysis by using Sigmastat Version-12 software.

Chemical parameters of the water showed variability in their observation based on different climatic conditions, environmental changes, pollutions, ecological imbalance etc. The water from four dams like Pechiparai, Perunchani, Chittar-1 and Chittar-2 were taken for the chemical analysis and analyzed for various parameters during the pre-monsoon period. pH of all the four water sample are in permissible level. The changes in pH if any noticed could be due to the presence or addition of effluents from external environment. (Tessena *et al*., 2014). Total alkalinity varied from 13.43 ± 0.4 to 17.2 ± 0.20 mg/l. Total hardness ranges from 26.46 ± 0.45mg/l to 29.26 ± 0.20mg/l in pre monsoon season. The calcium content showed about 3.2 to 6.3mg/l. The magnesium content was the minimum and there is no magnesium in Perunchani dam water and Chittar-2 has the high content of about 1.6 ± 1.5mg/l. The sodium content was high in Chittar-2 dam water (6.2 ± 0.30mg/l), the least with 3.2 ± 0.25mg/l in Pechiparai dam water. The potassium amount was around 1.33 to 4.3 mg/l and iron about 0.24 to 0.53 mg/l. There is no manganese content in all four dam water. Free ammonia was around 0.3-0.6mg/l. Chittar-2 has high amount of 5.47 ± 0.35mg/l of nitrate and 53.23 ± 0.23mg/l of chloride. According to WHO maximum permissible limit for Chloride is 500 mg/l. The value observed in present study are well below the permissible limit. Chloride is an inorganic anion found in water bodies which are considered to be toxic against aquatic lives (Rajkumar *et al*., 2004). Higher concentration of fluroide in water is mainly due to pollution from organic waste or industrial origin. Fluoride content varied from 0.35 to 0.65 mg/l. The sulphate content was high in Chittar-2 dam with 12.5 ± 0.26mg/l and is low in Pechiparai dam water (9.5 ± 2.6mg/l). This increase in concentration may due to presence of carbonates and bicarbonates in the water. Bhalerao, (2012) also reported the same in Kasar Sai Dam, Hinjewadi, Pune. During summer the organic matters decay due to water level reduction, which results in the release of $Co_2$with addition of carbonate and bicarbonates. The same statement was noted in Chandola Lake, Gujarat which was reported by Pradeep *et al*., (2012). The Tidys Test 4 hrs. has around 0.27 - 0.56mg/l in four dams. Analysis of basic parameter showed the values obtained are within the acceptable and permissible values (**Table 1**).

Table 2. Physico-Chemical examination of water samples collected from different resources on monsoon season

Parameter	Acceptable Limit	Permissible Limit	Pechiparai	Perunchani	Chittar-1	Chittar-2

Appearance	-	-	Clear	Clear	Clear	Clear
Color	-	-	Clear	Clear	Clear	Clear
Odour	-	-	None	None	None	None
Turbidity	-	-	3	5	4	3
Total dissolved Solids mg/L	-	-	20	22	37	39
Electrical conductivity Micro mho/cm	-	-	31	33	61	63
pH	6.5-8.5	6.5-8.5	7.1* ± 0.05	7.3* ± 0.07	7.0* ± 0.04	7.4* ± 0.01
Total Alkalinity as $CaCo_3$ mg/l	200	600	10.6* ±0.5	14.0* ± 1	19.3* ± 0.5	16* ± 1
Total Hardness as $CaCo_3$ mg/l	200	600	21.0* ± 1.0	29.0* ± 1.0	25.0* ± 1.2	30.3* ± 0.5
Calcium as Ca mg/l	75	200	4.13* ± .032	5.3* ± 0.4	2.3* ± 0.2	3.1* ± 0.28
Magnesium as Mg mg/l	30	100	0.66 ± 1.15	1 ± 1	2.6 ± 2.08	1.3 ± 1.5
Sodium as Na mg/l	-	-	4.5* ± 0.4	2.9* ± 0.4	5.5* ± 05	4.3* ± 0.4
Potassium as K mg/l	-	-	2.5* ± 0.5	5.4* ± 0.4	3.8* ± 0.2	6.5* ± 0.2
Iron as Fe mg/l	0.3	1	0.2* ± 0.01	0.31* ± 0.03	0.33* ± 0.01	0.28* ± 0.01
Manganese as Mn mg/l	0.1	0.3	0	0	0	0
Free Ammonia as NH_3 mg/l	0.5	0.5	0.33* ± 0.01	0.24* ± 0.02	0.39* ± 0.01	0.29* ± 0.01
Nitrite as NO_2 mg/l	-	-	0.02* ± 0.01	0.01* ± 0.00	0.04* ± 0.00	0.01* ± 0.00

Nitrate as NO_3 mg/l	45	45	3.7* ± 0.2	1.9* ± 0.1	4.0* ± 0.15	1.22* ± 0.2
Chloride as CL mg/l	250	1000	51.5* ± 0.5	56.3* ± 1.5	54.1* ± 0.3	49.5* ± 0.5
Fluoride as F mg/l	1	1.5	0.38* ± 0.02	0.46* ± 0.01	0.27* ± 0.03	0.38* ± 0.02
Sulphate as SO_4 mg/l	200	400	8.9* ± 0.3	10.9* ± 0.3	9.7* ± 0.6	7.7* ± 0.2
Phosphate as PO_4 mg/l	-	-	0.75* ± 0.05	0.91* ± 0.01	0.65* ± 0.03	0.53* ± 0.02
Tidys Test 4 hrs as O_2 mg/l	-	-	0.28* ± 0.00	0.22* ± 0.01	0.31* ± 0.01	0.26* ± 0..01

*p < 0.05; Statistical analysis of the data was performed by one-way analysis of variance (ANOVA) followed by Tukey's multiple range tests for post-hoc analysis by using Sigmastat Version-12 software.

Several parameters of water from four different dams namely Pechiparai, Perunchani, Chittar-1 and Chittar-2 dams have been analyzed during monsoon season. Total alkalinity of the dam water varies 10±6 to 19.3 ± 0.5mg/l. The hardness of the water was analyzed and found that chittar-2 and Perunchani has about 30.3 and 29.0mg/l as maximum level. According to WHO permissible amount is 500 mg/l in drinking water and based of the hardness water was classified as 75 mg/l as soft, 76 to 150 mg/l as moderate, 151-300 mg/l as hard and300 mg/l as very hard. Calcium content was around 2.3 (Chittar-1) to 5.3 mg/l(Perunchani). Magnesium content of the water was limited to 0.66 to 2.6mg/l. Minimal concentration of calcium was noticed may due to absorption of calcium by aquatic organism. In aquatic environment calcium is considered to be a micronutrient for most organisms. The desirable limit of calcium in the water is 75 mg/l and maximum limit of permissible was 200 mg/l. Report by Nisbet and Verneau, (1970) states the calcium ranges 60 - 120 mg/l^{-1} are good for fishing water. The Pechiparai dam water has the least amount of magnesium (0.66mg/ml) whereas the Sodium content was high with 5.5 ± 0.5mg/l in Chittar-1. Potassium content was low in Pechiparai dam with 2.5±0.5mg/l. The minerals such as iron, Ammonia, Nitrite, Fluoride and Phosphate were around 0.1 to 0.65 mg/l for all the four dams. Fluoride is essential for human at lower concentrations, at higher level it is toxic, permissible level is 0.6 to 1 mg/l. In drinking water higher level of fluoride leads to degeneration of bones and dental mottling especially in pregnant women and children. The manganese was absent in all the water. Magnesium is considered to be essential for chlorophyll and for the growth of planktons in waters. Perunchani have about 10.9 mg/l of Sulphate content as the highest. According to central ground water board the limit of sulphate as SO4 ranges between 200-400 mg/l. Sulphate and chloride concentration in water is the main reason for hardness. Chloride is ranging from 49.5 to56.3 mg/l with minimum level and it confirms the minimum hardness of water in all four dams at 3 seasons (**Table 2**).

Table 3. Physico-Chemical examination of water samples collected from different resources on post monsoon season

Parameter	Acceptable Limit	Permissible Limit	Pechiparai	Perunchani	Chittar-1	Chittar-2
Appearance	-	-	Clear	Clear	Clear	Clear
Color	-	-	Clear	Clear	Clear	Clear
Odour	-	-	None	None	None	None
Turbidity	-	-	4	5	3	5
Total dissolved Solids mg/L	-	-	20	20	39	39
Electrical conductivity Micro mho/cm	-	-	30	30	59	59
pH	6.5-8.5	6.5-8.5	7.43* ± 0.02	7.56* ± 0.03	7.65* ± 0.03	7.75* ± 0.03
Total Alkalinity as $CaCo_3$ mg/l	200	600	7.57* ±0.36	9.5* ± 0.26	10.5* ± 0.3	11.74* ± 0.2
Total Hardness as $CaCo_3$ mg/l	200	600	9.56* ± 0.3	11.4* ± 0.2	13.5* ± 0.3	15.61*± 0.4
Calcium as Ca mg/l	75	200	3.58* ± 0.3	4.4* ± 0.36	5.6* ± 0.3	6.5* ± 0.26
Magnesium as Mg mg/l	30	100	0.7 ± 1.2	0.76 ± 1.3	1.0 ± 1	1.7 ± 1.6
Sodium as Na mg/l	-	-	2.53* ± 0.3	3.3* ± 0.1	4.5* ± 0.2	5.2*± 0.2
Potassium as K mg/l	-	-	1.46* ± 0.2	3.6* ± 0.3	4.4* ± 0.38	5.5* ± 0.2
Iron as Fe mg/l	0.3	1	0.24* ± 0.03	0.34* ± 0.02	0.45* ± 0.03	0.55* ± 0.02
Manganese as Mn mg/l	0.1	0.3	0	0	0	0
Free Ammonia as	0.5	0.5	0.25* ± 0.1	0.36* ± 0.03	0.44*± 0.03	0.47* ± 0.03

NH_3 mg/l						
Nitrite as NO_2 mg/l	-	-	0.01* ± 0.002	0.03* ± 0.003	0.04* ± 0.003	0.05 * ± 0.003
Nitrate as NO_3 mg/l	45	45	2.3* ± 0.2	3.7* ± 0.2	4.5* ± 0.3	5.4* ± 0.1
Chloride as CL mg/l	250	1000	50.4* ± 0.2	51.6* ± 0.2	52.5* ± 0.3	53.8 * ± 0.1
Fluoride as F mg/l	1	1.5	0.36* ± 0.02	0.45* ± 0.03	0.56* ± 0.03	0.65 * ± 0.03
Sulphate as SO_4 mg/l	200	400	7.61* ± 0.3	8.6* ± 0.3	9.5* ± 0.2	10.5 * ± 0.2
Phosphate as PO_4 mg/l	-	-	0.65* ± 0.03	0.77* ± 0.02	0.87* ± 0.02	0.95 * ± 0.02
Tidys Test 4 hrs as O_2 mg/l	-	-	0.26* ± 0.003	0.27* ± 0.003	0.29* ± 0.003	0.25 * ± 0.003

*$p < 0.05$; Statistical analysis of the data was performed by one-way analysis of variance (ANOVA) followed by Tukey's multiple range tests for *post-hoc* analysis by using Sigma stat Version-12 software.

Table: 3 shows the chemical examination of water samples collected during the post monsoon season. The alkalinity varies from 7.57 to 11.74mg/l. The total hardness are higher in chittar-2 and is 15.61 mg/l when compared to other three dams. Manganese was absent in all four dams. Studies reveals presence of manganese in drinking water showed lower intellectual quotient in school aged children (Bouchard *et al*., 2011). Higher concentration of manganese exposure leads to hyperactive behaviors (Bouchard *et al*., 2007). Calcium and Magnesium content are high in chittar-2 dam with value of 6.5 and 1.7 mg/l respectively. Total hardness of water is caused by the presence of Calcium and, Magnesium salts. Hardness has no known adverse effect on health. However, maximum permissible level has been prescribed for drinking water is 500mg/l (WHO, 2004). The minerals such as Iron, Sodium, Potassium and Nitrate of dam water confirmed that Chittar-2 dam water has maximum contents of all the above. Sodium present in the water has no significant effects on hardness, but beyond the permissible limits leads tasteless nature and unsuitable for irrigation. It also has a role in function of nervous system, membrane system, and excretory system. Free ammonia and fluoride present in all the four dams during post monsoon season are lesser when compare to other minerals. The ammonia level which exceeds the permissible level in the water leads to death among fishes and other aquatic organisms. Chloride shows the highest variations among other minerals. It is higher in chittar-2 about 53.8 mg/l. Sulphate content varies from 7.61 mg/l (Pechiparai)to 10.5 mg/l(Chittar-2). The obtained analysis values are between the acceptable and permissible value (**Table 3**). The observation of nitrate in water sample implies incomplete oxidation of ammonia in water or nitrate reduction reaction. The prescribed limit of NO3 - by WHO is 50 mg/l for domestic water. Nitrate and

nitrite present in the source mainly due to direct or indirect contact with water bodies in agricultural land such as chemical fertilizer or sewage water waste. This presence shows serious problems and toxic towards human beings and also environmental problems. The US environmental protection agency reveals 0.08 PPM of phosphate in eutrophicated in lakes and reservoirs are considered to be critical (U.S. Environmental Protection Agency, 1976). Based on the ANOVA most of the parameters are significant in different seasons except manganese and magnesium. Comparatively the water quality of four dams were better in the Monsoon season (June- September) than in Pre monsoon (January- May) and Post monsoon(October-December). Thus in the present study on water quality assessment all four reservoirs namely Pechiparai, Perunchani,Chittar-1 and Chittar-2 in three different seasons like pre Monsoon, Monsoon and Post monsoon revealed that most of the parameters are in permitted limit and the water quality seems good.

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