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Studies on Physico-Chemical Properties and Ichthyofauna Diversity of Cauvery River, Karur District (Tamil Nadu, India)

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Abstract: *Water is an essential requirement for all life-supporting processes. Karur is one of the busiest textile industrial area which prone to the release of huge amount of dyeing effluents into the Cauvery river. From eight different sampling stations water samples were collected and 18 physio-chemical parameters and ichthyofauna diversity were studied. The physical parameters (Temperature, Odour, Colour and Turbidity) of the water samples collected from S1 to S8 showed unpleasant, rotten and fishy odour; slight greenish/bluish or grayish coloured water with increased temperature and turbidity than the reference levels. Among the tested chemical parameters, a significantly high total hardness, Ca2+, Mg2+, K+, Mn2+ and NO3 levels were observed in the tested water samples. Ichthyofauna diversity study results revealed the presence of 15 fishes belongs to the Family Cichlidae (4 species), Channidae (1 species), Cyprinidae (9 species) and Cobitidae (1 species). O. mossambicus, C. mirgala belongs to vulnerable category, Hypselobarbus dubius belongs to the endangered category, Puntius mahecola belongs to the data deficient IUCN status whereas the other 11 species belong to the least concern category. Our results concluded that due to the presence of pollutants in the water, chemical parameters results were exceeding the WHO reference values. This condition disturbing the ichthyofauna (fish) diversity in the studied river regions.*

Keywords: *Physical parameter, Fish diversity, Karur district, Chemical parameter, Water.*

1. INTRODUCTION

One of the most valuable natural resources in our nation is water. Water is one of the naturally occurring essential requirements for all life-supporting processes, depending on the facts. More than 40% of Tamil Nadu, food crops and hydroelectric power are produced in five districts (Karur, Namakkal, Tiruchirappalli, Nagapattinam and Thanjavur) that rely on the Cauvery basin for their massive irrigation system [1]. Karur is one of Tamil Nadu's most significant industrial cities, located on the banks of Cauvery River. In rural areas, it serves as the primary irrigation source for that region. According to Mahmoodah Parveen *et al.* [2], the issues caused by the discharge of dyeing industrial waste water into the river changed biodiversity.

Because of overuse of resources and inappropriate waste disposal methods, the fast expansion of metropolitan areas has further impacted the quality of groundwater. Additionally, waste water discharged by the sizing, desizing, kiering, bleaching, mercerizing, dye house, and printing departments

of composite cotton textile mills is a feature of the textile industry's effluent [3]. In India, monitoring of aquatic ecosystems has been done using either chemical or biological techniques. The chemical method is helpful for figuring out the amounts of metals, herbicides, and nutrients [4].

Temperature, acidity, hardness, colour, odour, selected heavy metals, and pH are helps to identify the water quality characteristics [5]. Water quality provided a good and healthy habitat and high food resource availability, which plays a key role in fish species diversity. Pollutants have a variety of direct and indirect effects on fish. Below are a few of the effects that were created: Increased osmotic pressure, abrupt changes in water's pH, substances with a high oxygen demand that lower the water's oxygen content, and certain toxic ingredients that can harm the gills and other external structures can all result in either anoxemia or death through ingestion and absorption. The destruction of fish food sources has an indirect effect on them. The amount of food available to fish is significantly decreased when waste material covers the bottom of a body of water [6]. Our study was focussed about the analysis of the physico-chemical parameters and diversity of fishes in cauvery river in the selected stations of the Karur district.

2. MATERIALS AND METHODS

2.1 Study Area

Karur district is located between latitudes 10°63' and 11°14' north and longitudes 77°90' and 78°61' east in Tamil Nadu. In and around the study area, there are numerous textile and dyeing businesses, factories, and estates. The district's cultural legacy is diverse and rich [7, 8]. Eight sampling stations (S1-S8) from the five different Taluks (Table 1) of Karur district were selected. In each sampling station, three study sites were selected.

Table 1: Details of the sampling stations and their Taluk in Karur district

No.	Name of the Taluks	Name of the sampling stations
S1	Aravakurichi	Paramathi
S2	Aravakurichi	Thennilai
S3	Manmangalam	Thalapatti
S4	Manmangalam	Pugalur
S5	Krishnarayapuram	Kattalai
S6	Karur	Velliyanai
S7	Karur	Thoranakkalpatti
S8	Kulithalai	Kulithalai

2.2 Sample Collection

Water samples were collected from three sites of each sampling stations with a distance of 5m during morning 6am to 7am (Aug. to Oct. 2024) by using sterile water can (1L). Important physico-chemical characteristics including taste, temperature, pH, turbidity, total solids, hardness, sulphate, fluorides, sodium, nitrate, potassium, and chlorides were measured in the collected samples. Standard techniques were used to examine the physico-chemical parameters [9]. Physical properties of the water samples were observed within the sampling site. Fish samples were collected from each sampling site with the help of the local fisherman by using fishing nets and counted.

2.3 Statistical analysis

Mean, SD, range and Correlation coefficient analysis between physico chemical parameters was done using SPSS version 27 software.

3. RESULTS AND DISCUSSION

The physical parameters of river water are quantifiable traits that characterize its physical condition, offering information about its quality and suitability for different applications. Temperature of the water collected from the sampling stations (S1-S8) were ranged as 26.4±0.81 to 28.7±0.72°C (Table 2). Water collected from the sampling stations (S1-S8) colour were varied from grayish, slight greenish,

bluish-green, slight brownish and Tint (light shades of various colour) which resulted in the unpleasant, fishy, rotten egg, burnt sugar, soapy and odour free.

The colour and odour of the collected water samples collected from the sampling stations (S1-S8) were varied due to the presence of industrial and dyeing effluents in the water from sampling stations (S1-S8). The turbidity of the water samples collected from the sampling stations (S1-S8) were significantly high and their ranges were 17.0±0.60 to 18.9±0.90NTU whereas the WHO reference value for the surface water's turbidity was 5NTU [10]. In addition to suspended organic and inorganic particles, turbidity measures the amount of finely suspended particles in water, including clay, silt, plankton, non-living organic particles, and other microscopic organisms [11].

Table 2: Physical parameters analysis of the water collected from eight sampling stations in Karur district

Stations	Physical parameters			
	Temperature (°C)	Colour	Odour	Turbidity (NTU)
S1	27.3±0.94	Slight brownish	Unpleasant	17.8±0.52
S2	26.4±0.81	Bluish-green	Fishy	18.9±0.72
S3	27.8±0.91	Slight greenish	Rotten egg	18.3±0.66
S4	26.9±0.67	Tint	Burnt Sugar	18.9±0.90
S5	28.7±0.72	Slight greenish	Rotten egg	17.3±0.64
S6	27.8±0.35	Slight bluish	Odour free	17.0±0.60
S7	27.3±0.56	Tint	Fishy	18.2±0.52
S8	28.5±0.83	Grayish	Soapy	17.5±0.66

The chemical parameters of the water samples collected from S1 to S8 sampling stations cumulative results were tabulated in Table 3. The pH and total alkalinity (TA) of the water sample was observed as 6.85±0.35 and 171.50±38.90mg/L respectively. A positive correlation of r=0.18 was observed between the pH and TA of the water samples.

Variations in pH show that certain foreign compounds or effluents were grouped differently on occasion, resulting in altered pH readings. Aquatic bodies requires a pH between 6.8 and 9.0 [12]. Biological activity is significantly impacted by pH. It also has an impact on the efficacy of harmful compounds found in the aquatic environment, organism activity, and certain water body characteristics. The majority of trace elements are immobilized by a high concentration of organic matter and a pH of 6.9 to 8.6 [13]. Bad taste and scale formation are typically caused by high alkalinity values [14].

Total hardness (TH) levels were observed as 221.90±67.11mg/L which showed positive correlation of r=0.02 and r=0.64 with the pH and TA. Calcium levels were observed as 142.00±13.15mg/L respectively which showed with negative correlation with pH (r=-0.41), TA (r=-0.82) and TH (r=-0.35) respectively (Table 3).

Minerals in the soil that dissolve in the water cause alkalinity. Among the ionic species that contribute to alkalinity are bicarbonate, hydroxide, phosphate, borate, and natural acids. The amount of normal salt in water can be determined by measuring its alkalinity value [11]. The development of salts in water may result from direct contamination caused by human activities, increasing the water's hardness [15].

Magnesium levels were observed as 88.00±12.64mg/L which showed positive correlation with pH (r=0.08), TH (r=0.03), Ca^{2+}(r=0.59) whereas negative correlation with TA (r=-0.29). Sodium levels were observed as 179.40±21.82mg/L which showed negative correlation with pH (r=-0.40), Ca^{2+}(r=-0.13), Mg^{2+}(r=-0.09) whereas positive correlation with TA (r=0.32), TH (r=0.66). Potassium levels were observed as 95.00±16.85mg/L which showed positive correlation with TH (r=0.30), Ca^{2+}(r=0.31), Mg^{2+}(r=0.58), Na^{2+}(r=0.45) whereas negative correlation with pH (r=-0.06), TA (r=-0.22) (Table 4).

Iron levels were observed as 0.55±0.21mg/L which showed negative correlation with pH (r=-0.31), TA (r=-0.29), TH (r=-0.03) whereas positive correlation with Ca^{2+}(r=0.42), Mg^{2+}(r=0.44), Na^{2+}(r=0.37), K

(r=0.42). Manganese levels were observed as 1.39±0.48mg/L which showed negative correlation with pH (r=-0.14), TA (r=-0.24), TH (r=-0.07) whereas positive correlation with Ca^{2+}(r=0.34), Mg^{2+}(r=0.70), Na^{2+}(r=0.10), K (r=0.72), iron (r=0.67).

Nitrate levels were observed as 137.10±12.81mg/L which showed negative correlation with pH (r=-0.76), TA (r=-0.004) whereas the positive correlation with TH (r=0.18), Ca^{2+}(r=0.21), Mg^{2+}(r=0.02), Na^{2+}(r=0.42), K (r=0.27), iron (r=0.45), Mn^{2+}(r=0.45). Pollution from wastewater discharge, industrial effluents, fertilizer or manure leaching, septic tank breaches, and other sources is the main cause of nitrate in surface water, suggesting the presence of additional potentially harmful substances like bacteria or pesticides [16].

Chloride levels were observed as 116.60±15.42mg/L which showed positive correlation with pH (r=0.45), TA (r=0.19), TH (r=0.09), Ca^{2+}(r=0.05), Mg^{2+}(r=0.71), K^{+}(r=0.28), Mn^{2+}(r=0.35) whereas negative correlation with Na^{2+}(r=-0.15), iron (r=-0.02), NO_3(r=-0.33).

Fluoride levels were observed as 0.72±0.30mg/L which showed positive correlation with TA (r=0.22), TH (r=0.49), Mg^{2+}(r=0.08), Na^{2+}(r=0.73), K (r=0.54), iron (r=0.53), Mn^{2+}(r=0.54), NO_3(r=0.72) whereas negative correlation with pH (r=-0.41), Ca^{2+}(r=-0.10), Cl^{-}(r=-0.14). Sulphate levels were observed as 96.30±12.0mg/L which showed positive correlation with pH (r=0.18), TA (r=0.72), TH (r=0.68), Na^{2+}(r=0.23), K (r=0.15), NO_3(r=0.08), Cl^{-}(r=0.21), F^{-}(r=0.17) whereas negative correlation with Ca^{2+}(r=-0.58), Mg^{2+}(r=-0.14), iron (r=-0.53), Mn^{2+}(r=-0.14). Phosphate levels were observed as 0.03±0.01mg/L which showed positive correlation with Ca^{2+}(r=0.26), Mg^{2+}(r=0.05), Na^{2+}(r=0.05), iron (r=0.59), Mn^{2+}(r=0.05), NO_3(r=0.16), F^{-}(r=0.12) whereas negative correlation with pH (r=-0.29), TA (r=-0.15), TH (r=-0.25), K (r=-0.37), Cl^{-}(r=-0.15), SO_4(r=-0.72).

Aquatic life is poisoned by higher nitrate concentrations, and nitrate pollution can eutrophicate streams. Although phosphates can lead to eutrophication, they are not as harmful as nitrate [17]. Lakra et al. [18] reported the key habitat characteristics, such as water depth, dissolved oxygen, and pH, have a positive correlation with fish assemblages and are the most significant factors influencing fish distributions. Differences in land use patterns were found to be the cause of the variations in species diversity and distribution, as well as the variability in habitat variables like as pH, turbidity, total dissolved solids, and conductivity across several locations [19].

Table 3: Cumulative chemical parameters analysis of the water from eight sampling stations in Karur district

Chemical Parameters	Observed results			WHO values*
	Min.	Max.	Mean±SD	
pH	6.30	7.42	6.85±0.35	6.5 to 8.5
Total Alkalinity (mg/L)	116.00	252.00	171.50±38.90	<500
Total hardness (mg/L)	131.00	360.00	221.90±67.11	<100
Calcium (mg/L)	100.00	170.00	142.00±13.15	<75
Magnesium (mg/L)	51.00	124.00	88.00±12.64	<50
Sodium (mg/L)	114.00	258.00	179.40±21.82	<200
Potassium (mg/L)	67.00	124.00	95.00±16.85	<10
Iron (mg/L)	0.23	0.80	0.55±0.21	<50
Manganese (mg/L)	0.50	1.99	1.39±0.48	<1
Nitrate (mg/L)	109.01	177.50	137.10±12.81	<10
Chloride (mg/L)	98.6	145.6	116.60±15.42	<250
Fluoride (mg/L)	0.20	1.20	0.72±0.30	<1.5
Sulphate (mg/L)	83.00	118.0	96.30±12.0	<250
Phosphate (mg/L)	0.01	0.05	0.03±0.01	<0.05

*Source from [10]

Table 3 represented the cumulative chemical parameter result for the water samples collected from the 24 sampling sites i.e., 3 sites in each sampling stations (S1-S8). Based on the WHO reference values, our results showed significantly high total hardness, calcium, magnesium, potassium, manganese and nitrate levels. This condition was due to the release of dyeing effluents, textile industrial effluents, etc. which resulted in the changes in the chemical parameters of the cauvery water samples collected from the S1-S8 stations in Karur district.

Uthirasamy and Chitra [20] studied the physicochemical parameters of the cauvery river stretch in Pallipalayam, Tamilnadu. Temperature, pH, color, turbidity, salinity, total alkalinity, and total hardness. The pH ranged from 8.2 to 8.7, Salinity (7.12 to 12.6 mg/lit), and calcium (89 to 105 mg/lit), total alkalinity (164–198 mg/lit), nitrate (0.32–0.45), and phosphate (0.34–0.40%) were observed in the study regions.

High oscillations in the physico-chemical parameters that indicate the degree of pollution were observed by Rokade and Ganeshwade [21]. The pH ranged from 6.6 to 8.4, the range of chlorides was 132.5 to 820.4 mg/L, the range of hardness was 74 to 281 mg/l, the range of sulphates was 0.192 to 5.12 mg/l, and the range of nitrates was 0.5 to 1.012. In addition to being an aesthetic issue, river water pollution poses a significant threat to the economy and public health. Therefore, to evaluate the state of surface water, regular water quality monitoring is necessary. This will assist prevent further deterioration of the river.

Table 4: Coefficient correlation between the chemical parameters of the water sample collected from the various stations

Chemical Parameters	**pH**	**TA**	**TH**	**Ca^{2+}**	**Mg^{2+}**	**Na^{+}**	**K^{+}**	**Fe^{2+}**	**Mn^{2+}**	**NO_3**	**Cl^{-}**	**F^{-}**	**SO_4**	**PO_4**
pH	1													
TA	0.18	1												
TH	0.02	0.64*	1											
Ca^{2+}	-0.41	-0.82**	-0.35	1										
Mg^{2+}	0.08	-0.29	0.03	0.59	1									
Na^{+}	-0.40	0.32	0.66*	-0.13	-0.09	1								
K^{+}	-0.06	-0.22	0.30	0.31	0.58	0.45	1							
Fe^{2+}	-0.31	-0.29	-0.03	0.42	0.44	0.37	0.42	1						
Mn^{2+}	-0.14	-0.24	-0.07	0.34	0.70*	0.10	0.72*	0.67*	1					
NO_3	-0.76**	-0.004	0.18	0.21	0.02	0.42	0.27	0.45	0.45	1				
Cl^{-}	0.45	0.19	0.09	0.0	0.71	-	0.28	-	0.35	-	1			

				5	*	0.15		0.02		0.33				
F^-	-0.41	0.22	0.49	-0.10	0.08	0.73*	0.54	0.53	0.54	0.72*	-0.14	1		
SO_4	0.18	0.72*	0.68*	-0.58	-0.14	0.23	0.15	-0.53	-0.14	0.08	0.21	0.17	1	
PO_4	-0.29	-0.15	-0.25	0.26	0.05	0.05	-0.37	0.59	0.05	0.16	-0.15	0.12	-0.72*	1

** Correlation significant at the 0.01 level (2-tailed), *Correlation significant at the 0.05 level (2-tailed)

Ichthyofauna diversity, 15 different fishes such as *Oreochromis mossambicus, Oreochromis niloticus, Etroplus maculatus, Etroplus suratensis, Channa puncatus, Garra mullya, Barilius bendelisis, Lepidocephalichthys thermalis, Hypselobarbus dubius, Puntius mahecola, Catla catla, Puntius filamentosus, Puntius conconius, Labeo ariza* and *Cirrhinus mirgala* which belongs to four different family Cichlidae (4 species), Channidae (1 species), Cyprinidae (9 species) and Cobitidae (1 species) (Table 5).

Among the observed 15 fish species, the frequency of *O. mossambicus*, *L. thermalis* and *O. niloticus* were high as 259, 230 and 185. Two species (*O. mossambicus*, *C. mirgala*) belongs to vulnerable category, only one species *Hypselobarbus dubius* belongs to the endangered category. *Puntius mahecola* belongs to the data deficient IUCN status whereas the other 11 species belong to the least concern category.

Table 5: Ichthyofauna diversity in the sampling stations (S1-S8) of Cauvery river in Karur district

Fish species	Family	IUCN status	Observation frequency
Oreochromis mossambicus	Cichlidae	VU	**259**
Oreochromis niloticus	Cichlidae	LC	**185**
Etroplus maculatus	Cichlidae	LC	**120**
Etroplus suratensis	Cichlidae	LC	**86**
Channa puncatus	Channidae	LC	**94**
Garra mullya	Cyprinidae	LC	**89**
Barilius bendelisis	Cyprinidae	LC	**73**
Lepidocephalichthys thermalis	Cobitidae	LC	**230**
Hypselobarbus dubius	Cyprinidae	EN	**74**
Puntius mahecola	Cyprinidae	DD	**91**
Catla catla	Cyprinidae	LC	**70**
Puntius filamentosus	Cyprinidae	LC	**95**
Puntius conconius	Cyprinidae	LC	**80**
Labeo ariza	Cyprinidae	LC	**82**
Cirrhinus mirgala	Cyprinidae	VU	**59**

LC-least concern, VU-vulnerable, EN-endangered, DD-Data deficient

The biology and taxonomy of freshwater fishes in India have been well studied. Hamilton [22] initiated scientific research on freshwater fishes in India. Furthermore, Jayaram [23], Menon [24], and Talwar and Jhingran [25] all made outstanding contributions to the fish fauna of India.

Fish diversity has been documented from a variety of riverine systems and their tributaries, including the Cauvery, Yamana, Ganga, Krishna, Narmada, Godavari, Tapti, Ravi, Beas, Sutlej and Brahmaputra [26]. More than 32,000 legitimate species of fish are thought to exist on Earth, belonging to 85 orders and 536 families, with 43% of fish being freshwater species, according to Coad and Murray [27].

Bera et al. [28] define the ichthyodiversity in the Kangsabati reservoir (West Bengal) with respect to the water's physicochemical parameters and assess the water's suitability for supporting fishery activity. They found that the reservoir's physicochemical parameters were compatible with 39 commercially significant fish species and demonstrated that the aquatic environment and water physicochemical parameters have an impact on fish development and ichthyofaunal diversity.

Arunkumar *et al.* [29] and Murthy *et al.* [30] reported nearly 37 species in the Cauvery river system and endangered species in Grand Anicut. Arunkumar et al. [31] investigated the ichthyofauna of the Cauvery River. Thirty seven fish species from various locations in the Cauvery River were observed, according to the fish diversity pattern.

Heda [32] investigated the variety of fish in the Godavari basin's Adan and Kathani Rivers, which are tributaries of the Wainganga and Painganga, respectively. Rankhamb [33] examined the Godavari River's fish ecology in Mudgal, a holy site on the river's bank, and discovered that 26 species from 15 genera, 7 families, and 5 orders were present. With 15 species, Cypriniformes was the most prevalent order in their survey.

4. CONCLUSION

Karur district has enormous textile and dyeing industries which resulted in the release of huge amount of effluents in the Cauvery river. Due to the presence of heavy metals and salts in the effluents, the river water chemical parameters has exceeding levels than the standard values. The diversity of fishes also greatly reduced. Among the observed 15 fish species, the frequency of *O. mossambicus*, *L. thermalis* and *O. niloticus* were high as 259, 230 and 185.

Conflict of interest

None

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