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ABSTRACT

The river ljubljanica is situated in the southern part of the ljubljana basin in the country Slovenia. The old name of ljubljanica was "Leybach". The river is 41 km long having a basin of 1860 km2. Ljubljanica flows in to sava river, the longest tributary of danube river. Inorganic nutrient ions and physicochemical parameters are important factors for developing river ecosystem. Algae are one important source of food for fishes, snails, crabs etc. It was observed that this river is a good habitat for algal colonization. Coliform count is important parameter of river water drinking permeability and result showed that river ljubljanica is not contaminated with faecal material. In this study we tried to find physico-chemical parameters, biologically significant ions, trace ions, micro algae present and coliform bacteria status of the river water.

Keywords: *Ljubljanica, physioco-chemical parameters, ions, microalgae and coliform etc.*

INTRODUCTION

Rivers are vital for maintaining of sustainable development life of any nation as it one of the prime sources of economy. River is an important source to maintain ecosystem (Bunn *etal*, 2002). The Ljubljanica riverbed has been considered since 2003 as one of the vital archaeological sites along Europe. The ljubljanica is the continuation of several karsat rivers that flow from the prezid karast field to Vrhnika on the surface and underground in caves and so the river is poetically said to have seven names (six name changes): trbuhovica, obrh, Strzen, Rak, Pivka, unica and ljubljanica. This river can be considered as lifeline of ljubljanica town. It is reported that this river is a natural habitat of more than 2000 species of fishes, macrophytes, algae etc. Physicochemical parameters are important factors for aquatic ecosystem in any region (Ray et.al, 2023). Inorganic nutrient ions play vital role in the growth of aquatic diversity (Debnath et.al, 2023). Algae are vital group for aquatic ecosystems and for evaluating water quality (Zahara *et al* 2018). Phytoplanktons mainly algae are one of the important sources of food for aquatic fauna such as fishes, snails, crabs etc. They are also valuable biological indicators of aquatic ecosystem conditions due to their variable growth pattern in different environmentally variants reported by Ray and Sk (2023). Seasonal algal composition and variation in their growth pattern in aquatic habitat greatly depend on environment variants and in inorganic nutrients (Meshram *et al* 2000). Reports say that some Physico-chemical parameters like TDS, Salinity, Conductance, Turbidity, Alkalinity pH, etc. have vital impact in living organism aquatic ecosystem (Ray, 2015; Ray et.al, 2021, Ray, 2021; Negi et.al, 2022).

The present study is to assess the algal composition in River Ljubljanica in relation to some physico-chemical parameters and biologically significant inorganic ions which are important for the development of aquatic life.

SAMPLING AND METHODS

Ljubljanica water samples were collected by boat from three sampling sites of town Ljubljana; which are namely trnovski pristan, sustaraski most (cobblers' bridge) and zmajski most (Dragon bridge). All the sampling sites are located within the Ljubljana town, the capital of Slovenia.

We had represented the sampling sites as follows:

SITE 1	trnovski pristan, and
SITE 2	sustaraski most (cobblers' bridge)
SITE 3	zmajski most (Dragon bridge)

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The water samples were collected during June 2025 randomly from 3-4 ft depths of sampling sites. All the water samples were analysed through Titremetry, Spectrophotometry etc. predominantly at BRS College, EVS laboatory. Onsite measurements of some physicochemical parameters like pH, Conductance, TDS, Salinity were done using EUTECH made multi-parameter PCSTester 35. On site dissolve oxygen was measured using Dissolved Oxygen Meter, Lutron DO-5509. The water samples were collected using sterile plastic bottles of 125 ml capacity. Microalgae were analysed at department of botany and coliforms count were made at department of microbiology of Barrackpore Rastraguru Surendranath College. Trace metals were analyses using Parkin Elmer instument at Central Inland Fisheries Research Institute, Barrackpore, WB, India.

Microbiological assessment was performed by sampling 100 ml of water from river ljubljanica. Microbial samples were collected in sterilized container and preserved aseptically until the study and assessed according to the guideline of APHA (2005). 5 tube most probable number (MPN) test was executed for the assessment of total coliform present in the sample. Briefly the method is as follows; 10 ml, 1 ml and 0.1 ml of water sample was added to different test tube containing 10 ml of sterile Lauryl tryptose broth (LSB; Hi-media, India) with an inverted durham's tube in each tube. The sets of tube were incubated for 24 hr at 37°C. Formation of acidic environment or gas accumulation in any tube is indicative for the positive result.

RESULTS

Table 1. Physicochemical parameters of ljubljanica river water of different sampling sites

PARAMETER	SITE 1	SITE 2	SITE 3
TEMPERATURE (°C)	20.5	20.6	20.5
pH	8.16	8.15	8.15
CONDUCTANCE (µS)	433	434	433
SALINITY (ppm)	209	210	209
TDS (ppm)	307	307	308
DO (ppm)	7.8	7.8	7.7
BOD (ppm)	1.7	1.9	1.7
HARDNESS (ppm)	132.392	132.392	132.392
TOTAL ALKALINITY (ppm)	120	120	120
CARBONATE ALKALINITY (ppm)	6	6	6
BICARBONATE ALKALINITY (ppm)	114	114	114
TURBIDITY (ppm)	0.6	0.6	0.8

Table 2. Biological significant ions of ljubljanica river water taken from different sampling sites

IONS	SITE 1	SITE 2	SITE 3
SODIUM (ppm)	21.24	20.72	20.48
POTASSIUM (ppm)	4.36	4.64	4.39
CALCIUM (ppm)	36	35	35
NITRATE (ppm)	0.01	0.01	0.02
CARBONATE ION (ppm)	3.6	3.6	3.6
BICARBONATE ION (ppm)	139.08	139.08	139.08

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Table 3. Biological significant trace ions of ljubljanica river water taken from different sampling sites

IONS	**Amount present in river (µg/L)**	**Permissible limit of EPA USA (µg/L)**
Cr	0.147	Cr^{3+} Nil Cr^{6+} 50
Mn	4.720	-
Fe	146.822	-
Co	0.034	-
Ni	Below Detectable Limit	8.2
Cu	0.213	3.1
Zn	Below Detectable Limit	81
As	1.007	36
Cd	Below Detectable Limit	7.9
Pb	0.024	8

Table 4. List of Algae in Ljubljanica river found in all three sites

Sl. No.	Algae	Dominance
1	*Oedogonium* sp	++
2	*Chlorella vulgaris*	++
3	*Cladophora* sp	+
4	*Chlorococcum* sp	++
5	*Lyngbya* sp	+
6	*Nostoc* sp	+
7	*Coscinodiscus* sp	++
8	*Nitzschia* sp	+
9	*Diatoma* sp	+
10	*Fragilaria* sp	+
11	*Aulacosiera* sp	+
12	*Pinnularia viridis*	+++
13	*Navicula* sp	+
14	*Spirogyra* sp	++

+++ Dominant ++ Available + Rare

Table 5: Presence of Coli form group of bacteria in the collection site of the river ljubljanica. The MPN test was performed using 5 tube multiple tube fermentation.

Study sites	**Test result in Sample Concentration (10 ml, 1 ml and 0.1 ml)**	**MPN Index 100 mL^{-1}**	**95% Confidence Limits**		**WHO standard count 100 mL^{-1} (2022)**
			Lower	**Upper**	
SITE 1	0-0-0	< 2	0	2	3
SITE 2	0-0-0	< 2	0	2	3
SITE 3	0-0-0	< 2	0	2	3

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DISCUSSIONS

pH value 8.15-8,16 suggest river water is slightly alkaline, this may be due to dissolved carbonate and bicarbonate ions. Amount of dissolved oxygen is sufficient for aquatic ecosystem. Low turbidity allows sufficient penetration of sunlight, helpful for photosynthesis of aquatic flora. BOD value suggest that river water is not polluted. High conductance value can be attributed to the presence of adequate sodium, calcium etc. ions. Hence salinity also ranges 209-210 ppm, which is greater than the normal river waters. The water may be characterized as moderately hard. One interesting observation must be mentions that, relative high concentration of calcium and bicarbonate ions create a scope of biomineralization in winter when solubility of river water decreases due to very low temperature. It is very significant that the presence nitrate ion is negligible. Except iron other trace metals like chromium, manganese, iron, cobalt, copper and lead are very low, whereas Nickel zinc and cadmium are below detectable limit. Only two blue green algae (*Lyngbya sp* and *Nostoc sp*) and seven type of diatoms (*Coscinodiscus sp, Nitzschia sp, Diatoma sp, Fragilaria sp, Aulacosiera sp, Pinnularia viridis, Navicula sp*) have been observed in all three collection sites. Green algae dominate over blue-green algae; green algae present are *Oedogonium sp, Chlorella vulgaris, Cladophora sp, Chlorococcum sp*. & *Spirogyra sp*).

Total coliform counts from the sampling site of the river ljubljanica is presented in the Table no. 1. The absence of detectable coliform bacteria in the river water sample suggests that the microbial contamination level is extremely low, and there is no evidence of recent fecal pollution at the sampling site. The MPN result of < 2 coliforms/100 mL falls within the permissible limit recommended for drinking water after appropriate disinfection treatment (WHO, 2022). This finding is significant because coliforms, particularly *Escherichia coli*, are widely recognized as indicator organisms for fecal contamination (Edberg et al., 2000). Their absence indicates that the water has not been recently contaminated by domestic sewage, animal waste, or effluents from nearby settlements or agricultural activities (Ashbolt, 2015).

The river ecosystem in Russian freshwater systems varies widely depending on geographical region, population density, and industrial influence. In relatively less urbanized catchments, river water often exhibits lower microbial loads due to reduced anthropogenic discharge inputs (Kavimandan & Parfenova, 2020). The present result of all three sites aligns with such observations, implying that the specific sampling location is likely less impacted by human activities.

However, while the absence of coliforms suggests acceptable bacteriological quality at the time of sampling, it should be noted that surface water sources remain dynamic. Seasonal variations, rainfall-driven runoff, agricultural activity, and upstream waste discharge can change microbial quality rapidly (Craun & Calderon, 2006). Therefore, regular monitoring is essential for confirming long-term potability.

CONCLUTIONS

The nature of river water is slightly alkaline, slightly saline and have low turbidity as found in all three sites. There is no nitrate pollution. Due to presence of trace nitrate, only two blue-green algae (*Lyngbya sp* and *Nostoc sp*) are present but with rare dominancy. At least five green algae and seven type of diatoms present. These algae present provide food for river fishes etc. The sodium and calcium concentrations are relatively higher than expected in normal river water. Potassium concentration is average. Trace metal ions chromium, manganese, iron, cobalt, copper and lead are within permissible limit and not polluting the river. Arsenic is present but in negligible amount. Nickel zinc and cadmium can be considered as absent in the river water. Coliform bacteria is totally absent and this makes the river water “Holy” since coliform bacteria is a serious threat for ecosystem and human civilisation.

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