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COMPARATIVE STUDY OF PHYSICO-CHEMICAL PARAMETER OF WATER OF SIRPUR LAKE AND ITS IMPACT ON MACROPHYTIC SPECIES WITH SPECIAL REFERENCE TO INVASIVE SPECIES WATER HYACINTH: A REVEIW

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Abstract: India is a rich biodiversity area. But our climate is changing continuously, therefore research and review of our precious ecosystem is necessary. Sirpur wetland is a freshwater ecosystem in Indore, M.P. It is important as 130 species of migratory and native bird's dependent on the site for their habitat. Recently it is declared Ramsar site. One more pride of Indore city. Therefore, its conservation is our duty. Sirpur wetland provides important ecological services like source of water, fisheries, cultivation of medicinal plants, buffering communities which protect from floods and storm and helps to recharge ground water. Anthropogenic pressure on wetland led to direct impact on species diversity, population and quality of water. Comparative study of physicochemical parameters of Sirpur wetland done to find that these parameters are under permissible limit or not. The water is becoming eutrophic over a period of time and affecting macrophytes communities. The study of fresh water Bivalves Lamellidens corrianus inhabiting in Sirpur Lake of Indore used to determine a local environmental monitoring network and act as a bio-indicator to determine bioaccumulation of heavy metals (Zn, Cu, Pd, Cd) in freshwater ecosystem. And reaches from primary producers to humans through food web. There is a change in species composition of Lake also, Growth of highly invasive species (Eichhornia crassipes and Pistia stratiote etc.) in lake is a matter of concern. Plants absorbs these heavy metals and nutrients above their permissible limit and shows massive growth. These invasive species with massive growth reduces the growth of other species and algae. But simultaneously, they act as a water purifier by absorbing toxic substances like metal ions, organic and inorganic substances. But they need to be harvest regularly before they start to destroy other aquatic organisms like fish and some invertebrates. When they died, their decomposition releases nutrients into the water and disturbs food web and nutrient cycling. They have some beneficial uses along with harmful effects. Some studies shows that these plants may use to prepare ethanol by fermenting them. Crude extract of E, crassipes shows anticancer activity over several tumour type. Preparation of biogas by bio methanation of mixture of E. crassipes, Garden waste, Food waste and Municipal solid waste in different proportion. Sludge obtained from digester used to form fuel pellets and vermicompost. Our conclusion by this review suggested need of regular monitoring of lake water and harvesting of invasive species (E. crassipes) followed by using it as a useful product.

Index Terms - **Invasive species, Heavy metals, Eutrophication, Macrophytes, Nutrients, Anticancer.**

I. Introduction

India has a diverse variety of flora and fauna due to different topographical regions and type of climates present over there. From The Himalayan range in north to Coastal regions of south, Western ghats etc. from cold climate in north to moderate, humid and hot climate till north. All these variations make India a rich Biodiversity area. Lots of research have been done to study biodiversity of India. But nature balances itself in changing surroundings. And these changes may be beneficial or may not be. Therefore, review and research of our precious ecosystems is necessary over a period of time.

Sirpur wetland is a fresh water ecosystem in Indore district in Madhya Pradesh. It is situated in western periphery of city and at the NH 59 (Indore-Dhar Road). It has designations of IBA status (Mekaad, 2017) [1] and Ramsar Site (Choukse, 2022) [2]. It is a shallow, alkaline and nutrient rich fresh water lake. The site possesses black cotton soil with fine granules. The site becomes important due to species richness in terms of flora and fauna, presence of rare and threatened species along with species of evolutionary significance and draw attention towards effective measures to be taken to maintain its biodiversity. The wetland supports 175 species of terrestrial flora, 6 species of macrophytes, 30 species of fishes and 8 species of reptiles and amphibians. Most importantly the site supports 130 species of resident and migratory birds. Sirpur wetland provides important ecological services like source of water, fisheries, cultivation of medicinal plants, buffering communities which protect from floods and storm and helps to recharge ground water. (Ramsar Information Sheet) [3]

Anthropogenic pressure on wetland led to direct impact on species diversity and population. The improper management, lack of implementation of conservation plan, population growth and increased need of water generated pressure on fresh water bodies and pushing these Eco balancers to extinction. (Indian National Trust for Art and Cultural Heritage, 1998) [4]

In India fresh water bodies are getting degraded due to unsustainable agriculture practice, chemicals as pesticides and fertilizers, discharge of untreated industrial and municipal waste. (Liu and Diamond, 2005) [5].

Due to changes in physicochemical parameter of wetland water, changes in composition of species may occur. Eutrophication due to massive algal growth and invasive growth of macrophytes act as a bioindicators of mixing of waste water, high nutrient and heavy metal contain in lake water.

The goal of this review to analyse comparison of physicochemical parameter of Sirpur lake and changes in composition of macrophyte communities over the period of time. To find out the way to convert water parasite (E. crassipes and P. stratiote) to medicinal remedy.

II. Water Quality Parameter by WHO-

For the assurance of quality of water as it is safe to use or not, we must need to test it on different physico-chemical parameters. Naturally available water possess variety of floating, dissolved, suspended, microbiological and bacteriological impurities. Quality of water of freshwater ecosystem should be monitored by following standard parameters given by WHO, EPA and Indian standard (Patil et al, 2012) [6].

Table 1: physico-chemical parameter of water with techniques of analysis and guidelines of standard values by who and indian standard-

Sr. No	Parameter	Technique used	WHO standard	Indian Standard	. EPA guidelines
01	Temperature	Thermometer	-	-	-
02	Colour	Visual/ color kit	-	5 Hazen units	-
03	Odour	Physiological sense	Acceptable	Acceptable	-
04	Electrical conductivity	Conductivity meter/ Water analysis kit	-	-	2500 us/cm
05	Ph	pH meter	6.5 – 9.5	6.5 – 9.5	6.5 – 9.5
06	Dissolved oxygen	Redox titration	-	-	-
07	Total Hardness	Complexometric titration	200ppm	300ppm	< 200ppm
08	Alkalinity	Acid – Base titration	-	200ppm	-
09	Acidity	Acid – Base titration	-	-	-
10	Ammonia	UV Visible Spectrophotometer	0.3 ppm	0.5 ppm	0.5 ppm
11	Bi carbonate	Titration	-	-	-
12	Biological oxygen Demand (BOD)	Incubation followed by titration	6	30	5
13	Carbonate	Titration	-	-	-
14	Chemical oxygen Demand (COD)	C.O.D. digester	10	-	40
15	Chloride	Argentometric titration	250 ppm	250 ppm	250 ppm
16	Magnesium	Complexometric titration	150 ppm	30 ppm	-
17	Nitrate	UV Visible Spectrophotometer	45	45	50 mg/l
18	Nitrite	UV Visible Spectrophotometer	3	45	0.5 mg/l
19	Potassium	Flame Photometer	-	-	-
20	Sodium	Flame Photometer	200 ppm	180 ppm	200 ppm
21	Sulphate	Nephelometer Turbidimeter	250 ppm	200 ppm	250 ppm

(WHO, USEPA, Indian Standard, National Primary Drinking Water Regulations, Drinking Water Contaminants US EPA) [7],[8],[9],[10] table 2: according to (tchobanoglous and schroeder,1985 and indian standard is: 2490) [11] threshold limit of some ions are as follows-

Ions	HCO_3^-	SO_4^{2-}	Cl^-	NO_3^-	PO_4^{3-}	Ca^{2+}	Mg^{2+}	Na^+	K^+	Zn^+
Threshold limit	200mg/l	200mg/l	200mg/l	45.0mg/l	0.25mg/l	75.0mg/l	30.0mg/l	50.0mg/l	10.0mg/l	5.0mg/l

III. Physicochemical Parameter of Sirpur Lake

Water is the most important component of the ecosystem as survival and growth of living being completely depends upon water. It is getting contaminated due to human activities in unsustainable manner like increasing demand for human consumption, discharge of industrial waste and waste water of surrounding areas, fertilizers used in agriculture flows off in water. This polluted water is harmful for human consumption and survival of aquatic flora and fauna, and a cause of imbalancement of aquatic ecosystem. Hence there is need to analyze quality of wetlands water at regular interval (Basavaraja Simpi et al. 2011) [12].

According to News published in Patrika newspaper on 13th December 2022, waste water of sewage of Prajapat Nagar Indore is getting mixed in Sirpur Lake and making it polluted. (Patrika News Paper, 2022) [13]

table 3: comparison of physicochemical parameter of water of sirpur lake

PARAMETER	MALHOTRA,2005[14]		JOHNSON,2015[15]		SOHANI et al,[16]
YEAR	2002- 2003	2003-2004	2010-2011	2011-2012	2009-2010
Temperature	12.17 to 40.35^{0}C	11.15 to 39.9^{0}C	19 to 34^{0}C	18 to 33^{0}C	
Ph	7.53 to 8.25	7.50 to 8.25	5.2 to 7.8 in both the study year		
Specific conductivity	309.5 to 441 µmhos/cm	303.5 to 405 µmhos/cm	148 to 292 µmhos/cm	144 to 292 µmhos/cm	
Turbidity	15.4 to 49.9 NTU	15.87 to 51.12 NTU	20% to 31%	18% to 49%	
Free carbon dioxide					
Dissolved oxygen	5.47 to 9.1 mg/l	5.34 to 9.12 mg/l	6.2 to 13.9 mg/l	6.2 to 13.2 mg/l	9.7 to 14 mg/l
Total alkalinity	161.00 to 197.25 mg/l	163.5 to 200.45 mg/l	89.00 to 182.00 mg/l	90.00 to 212.00 mg/l	
Total hardness	185 to 310 mg/l	157.5 to 275 mg/l	100 to 313 mg/l	101 to 313 mg/l	47 to 98 mg/l
Calcium	145.00 to 247.5 mg/l	120.00 to 225.00 mg/l	61.00 to 220.00 mg/l	56.00 to 313.00 mg/l	28 to 44 mg/l
Magnesium	40.00 to 62.5 mg/l	37.5 to 62.5 mg/l	35.00 to 110.00 mg/l	32.00 to 109.00 mg/l	0.68 to 02.73 mg/l
Potassium			0.4 to 1.99 mg/l	0.24 to 1.91 mg/l	
Sodium			10.00 to 25.00 mg/l	10.12 to 25.1 mg/l	
Chloride	18.22 to 30.25 mg/l	18.7 to 30.12 mg/l	20.00 to 51.00 mg/l	21.00 to 53.00 mg/l	60.5 to 79.71 mg/l
Sulphate	11.75 to 27.5 mg/l	14 to 27 mg/l			0.028 to 0.032 mg/l
Nitrate	0.003 to 0.014mg/l	0.002 to 0.015 mg/l	0.51 to 0.96 mg/l	0.51 to 0.97 mg/l	
Phosphate	0.36 to 0.76mg/l	0.27 to 0.86 mg/l	0.14 to 0.21 mg/l	0,11 to 1.012 mg/l	

IV. Heavy Metal Accumulation -

Water is getting polluted due to human settlement in the surrounding area of water body. As, Zn, Cu, Pb, Cd, Hg, Ni and Cr are some heavy trace metals present in waste water discharge. (Choudhary et al, 2014) [17]. According to (Mantoo et al,2020) [18] heavy metals are non-biodegradable and harmful for water population. Heavy metals accumulate in lower trophic organisms (algae) and reach to the higher organisms (human being) by food chain. They affect ecological balance and diversity of aquatic organisms. The study of freshwater Bivalves Lamellidens corrianus inhabiting in Sirpur Lake of Indore done to determine a local environmental monitoring network. Here this species is used as bio-indicator to calculate the mode of bioaccumulation of heavy metals in freshwater ecosystem. According to (Shinde, 2011) [19] metal concentration present in dry soft tissue of Molluscs is related to metal concentration present in water body.

table 4: seasonal variation of heavy metals accumulation in lamellidens corrianus sampled from sirpur lake.

Parameters	Metal	Summer		Monsoon		Winter	
		Site A	Site B	Site A	Site B	Site A	Site B
Dry weight whole body	Zn	2.22 ± 0.26	2.36 ± 0.23	2.36 ± 0.23	2.36 ± 0.23	2.36 ± 0.23	2.42 ± 0.26
	Cu	2.22 ± 0.26	2.36 ± 0.23	2.36 ± 0.23	2.36 ± 0.23	2.36 ± 0.23	2.42 ± 0.26
	Pb	2.22 ± 0.26	2.36 ± 0.23	2.36 ± 0.23	2.36 ± 0.23	2.36 ± 0.23	2.42 ± 0.26
	Cd	2.22 ± 0.26	2.36 ± 0.23	2.36 ± 0.23	2.36 ± 0.23	2.36 ± 0.23	2.42 ± 0.26
Metal concentration per unit body weight (µg/g)	Zn	412.56 ± 6.23	407.58±6.58	302.26±6.21	258.24±6.87	331.28±8.56	292.52±7.54
	Cu	109.75 ± 2.13	101.45±2.16	95.24± 2.86	85.67± 2.54	106.53±3.45	93.54± 2.98
	Pb	122.36 ± 2.45	102.57±2.42	99.12± 2.41	84.29± 2.10	109.72±3.02	95.27± 2.75
	Cd	19.24± 1.12	16.51± 1.36	14.23± 1.34	9.84± 1.21	15.86± 1.11	11.2± 1.05
Metal body burden µg /individual	Zn	915.86 ± 10.45	961.87±11.26	649.84±9.46	586.18±8.42	735.42±9.12	707.88±11.29
	Cu	243.63 ± 5.21	239.40±6.10	204.75±4.65	194.45±3.68	236.48±8.56	226.35±7.85
	Pb	271.62 ± 5.39	242.04±4.95	213.09±4.21	191.32±4.03	243.56±5.21	230.54±5.96
	Cd	42.69 ± 2.56	38.94± 2.21	30.57± 1.96	22.32± 2.12	35.19± 1.36	27.08± 2.10
Bio-water acumulation factor (BWAF)	Zn	3125.45 ± 70.26	3559.65±68.35	3369.68±67.42	3626.97±69.25	2783.87±85.23	2609.45±79.52
	Cu	4461.38 ± 76.24	4830.95±71.24	5702.99±80.54	5749.66±77.51	7149.66±96.24	5883.02±81.45
	Pb	4065.12 ± 73.29	3465.20±67.26	3698.51±67.21	1756.04±56.35	5458.71±74.26	3920.58±71.26
	Cd	2237.21 ± 51.28	2089.87 ± 41.02	1976.39 ± 41.28	1426.09 ± 39.85	2086.84 ± 42.15	1623.19 ± 38.57
Bio-sediment accumulation factor (BSAF)	Zn	1.86 ± 0.21	1.93± 0.19	1.87± 0.58	1.85± 0.12	1.51± 0.56	1.44± 0.46
	Cu	1.58 ± 0.12	1.69± 0.16	1.86± 0.29	1.73± 0.29	1.79± 0.33	1.92± 0.29
	Pb	4.62 ± 0.46	4.86± 0.39	4.72± 0.33	5.12± 0.51	4.75± 0.36	4.95± 0.68
	Cd	4.10 ± 0.41	4.12± 0.33	3.96± 0.37	3.06± 0.34	3.95± 0.24	3.33± 0.59

V. Role of Macrophytes in Wetland-

Macrophytes, aquatic micro-organisms and periphytons absorb nutrients from water (Vymazal,2002) [20]. Periphyton removes metal cations (Scinto and Reddy,2003) [21]. Periphyton absorbs nutrient anions like PO_4^{3-} and NO_3^- directly from water (Khatiwada and Polprasert, 1999) [22]. Macrophytes transfer around 90% of oxygen present in rhizosphere and enhance aerobic decomposition of organic matter and growth of nitrifying bacteria (Scholz, 2006) [23].

Roots of E. crassipes absorb and accumulate metal ions, organic and inorganic substances. (Pinto et al. 1987) [24]. Growth of E. crassipes is affected by nitrogen, phosphorus and potassium concentration of water. (Mahujchariyawong and Ikeda 2001) [25]. E. crassipes is analyzed to uptake 777 mg N m^{-2}, day-1 and 200 mg P m^{-2}, day-1 at the time of rooting, flowering stage and at high temperature conditions (DeBusk et al. 1995) [26].

L. minor eliminates 70–80% Pb (lead) (Sternberg et al, 1999) [27] and Highest quantity of aluminium (Al) (Goulet et al, 2005) [28]. Various species of Lemna shows absorption of metals like Ni, Cd and Zn (Noraho and Gaur 1995; Miretzky et al. 2006) [29], [30].

P. stratiotes eliminates metals like Zn, Ni, and Cd and shows high growth rate (Sridhar 1986) [31]. According to (Miretzky et al, 2006) [30], P. stratiotes shows less growth in water containing metal ions of Cd, Ni, Cu, Zn and Pb. Pistia stratiotes is recognized to decrease the ammonium ions from the water. It consumes NH4–N prior to NO3–N as nitrogen source and does not switch to utilization of NO3– N until NH4–N gets used completely (Aoi and Hayashi 1996) [32]. P. stratiotes does not grow at higher COD levels (Sooknah and Wilkie 2004) [33]. P. stratiotes shows higher survival rate at high concentration of EC (electrical conductivity) with a killing strength >4000 µs/cm. (Haller et al. 1974) [34] This shows that P. stratiotes resist higher salinity circumstances and keeps the level of dissolved oxygen saturated.

Inorganic Hg converted biochemically into an organic form methyl-Hg, which is a potential toxicant (Boening 2000) [35]. According to (Go¨thberg et al. 2002) [36]. Ipomoea aquatica absorbs this methyl-Hg. It also accumulates higher concentration of metals such as Fe, Cu, Cr, Cd, Mn, Hg and Pb (Sinha et al. 1996) [37].

table 5: removal of metal ions by some common aquatic macrophytes, (>) symbolize the preference of metal removal, these plants may absorb other metals also.

Common macrophytes	Metal/s	Removing efficiency (%)	References
Eichhornia crassipes	Fe > Cu > Zn> Cd	80.0	Sahu et al. (2007) [38] Schneider et al, (1999) [39] Prakash et al. (1987) [40]
Ipomoea aquatica	Hg	90.0	Go¨theberg et al. (2002) [36]
Lemna spp.	Pb	90.0	Gazi and Steven (1999) [41]
Pistia stratiotes	Cd > Hg > Cr	85–90.0	Maine et al. (2001) [42]

VI. Macrophytes of Sirpur Lake-

About 40 species of macrophytes and 21 species of trees were present till 2005.16 species of macrophyte till 2015 and 6 species of macrophytes and 175 species of terrestrial plant in catchment area including trees, herbs, shrubs, grasses and climbers. (Malhotra,2005; Johnson 2015; Ramsar information sheet, 2022) [14] [15] [3]

table 6: comparison of macrophytic species over a period of time.

S.NO.	Variation in species composition of macrophytes		
	Malhotra 2005	Johnson 2015	Ramsar Information Sheet 2022
1	Azolla pinnata	Trapa natans	Nymphaea
2	Trapa natans	Hydrilla verticillate	Ipomoea aquatica
3	Chara vulgaris	Myriophyllum heterophyllum	Lemnasps
4	Hydrilla verticillate	Najas minor	Alternanthera philoxeroides
5	Myriophyllum heterophyllum	Ottelia alismoides	Eichhornia crassipes
6	Najas minor	Potamogaton crispus	Pistia startiote L.
7	Nitella species	Potamogeton pectinus	
8	Ottelia alismoides	Potamogeton natans	
9	Potamogaton crispus	Vallisnaria spiralis	
10	Potamogeton pectinus	Nellumbo nucifera	
11	Potamogeton natans	Nymphaea stellata	
12	Vallisnaria spiralis	Nymphoides cristatum	
13	Nellumbo nucifera	Cyperus rotandus	
14	Nymphea stellata	Ipomoea aquatica	
15	Nymphoides cristatum	Ipomoea fistulosa	
16	Cyperus rotandus	Polygonum glabrum	
17	Ipomoea aquatica		
18	Ipomoea fistulosa		
19	Marsilea quadrifolia		
20	Polygonum glabrum		
21	Scirpus articulates		

The decrease in macrophytic species is noticeable. Simultaneously growth of highly invasive species like water hyacinth, water lettuce and alligator weed indicate that lake water is being polluted by high nutrient load, higher concentration of heavy metals and free ions. These species are dominating over other macrophytic and aquatic species and create threat to their survival. These invasive species create threat to planktons and fishes. Due to lack of oxygen and solar radiation suffocating atmosphere created inside the lake. It is tough task to complete elimination of these species.

VII. Problem Due to Massive Growth of Macrophytes-

Aquatic or wetland habitats are highly attacked by invasive species due to mixing of waste water and high nutrient contain in lake water. Less than 6% and less than 9% of earth's land area covered by wetland and shallow water respectively. But aquatic and wetland invasive plant species covers 30% of global area. (Zedler, 2011) [43]. Most problematic free floating invasive species of lakes are, Azolla pinnata, Eichhornia crassipes, Pistia stratiotes, Salvinia molesta common in tropical and sub-tropical regions. Some other global level invasive species are Lythrumsalicaria, Myriophyllum spicatum, Potamogeton crispus and Trapa natans. (Rajmonkova, 2011) [44].

The invasive species create monocultures and becomes dominant over native vegetation but tolerates some co-occurring plants to continue. (Ervin et al. 2006) [45]. The floating-leaved introduced Eurasian Trapa natans in the tidal flats of Hudson River in North America dominates over native submersed Vallisneria americana plant. The alteration of native species leads to possible extinction, altering food webs, and revising the system biogeochemistry (Caraco et al. 2006) [46].

(Agami and Reddy, 1990) [47] recognized, there is a competition for space between Eichhornia crassipes and Pistia stratiote when cultured in nutrient rich water. E. crassipes showed dominance over P. stratiote when both are cultivated together. According to (Ramsar information sheet of Sirpur wetland, 2022) [3] E. crassipes and P. stratiote are growing together in Sirpur Lake, Indore. There is a problem of E. crassipes is being invasive in Chhota Sirpur Talab Indore and covers 200 acres of water surface as green mat. The Golden pheasant birds are not able to stay there because of water hyacinth. (Patrika Expose, 2022) [13]. Published on 13 December 2022.

The problem of invasiveness of E. crassipes in Sirpur Lake is Occurring every year from 4 years as mentioned by Bhalu Mondhe sir (Founder of TNV and taking care of lake with his associates).

(Aboul-enein et al, 2011) [48] mentioned in his article E. crassipes (water parasite to medicinal remedy) is a warm water aquatic plant and originated in Amazon basin. It is a most productive plant and worst weed on earth (top ten in world). It is invaded in 62 countries. It is a dense weed, forms monoculture, threaten to native species, alter the physical and chemical parameter of ecosystem by disturbing food web and nutrient cycling. When it died, the decomposition process releases nutrients into the water, which makes water unsuitable for human health. When temperature exceed by 35 degrees with high solar radiation and long light duration, it becomes invasive and covers water surface and made green carpet over water. Due to which oxygen does not reach to lower surface and reduces fish population by creating suffocation in the lack of oxygen.

VIII. Beneficial Uses of Invasive Macrophytic Species (Water Hyacinth)-

Macrophytic species with invasive growth are harmful for other aquatic organisms. But they are useful also in some way.

(Mishima and Kuniki, 2008) [49] investigates fermentation modes and microorganism related to E. crassipes and P. stratiote for using them in ethanol production. The ethanol production per unit biomass was: 0.14-0.17 g g-dry^{-1} for water hyacinth and 0.15-0.16 g g-dry^{-1} for water lettuce.

(Mishra and Tripathi, 2008) [50] investigated removal and accumulation of heavy metals by P. stratiote (water lettuce), Spirodelapolyrrhiza (Duckweed) and E. crassipes (Water hyacinth). They observed for removal of five heavy metals (Fe, Zn, Cu, Cr and Cd) and find that E. crassipes was the most effective for removal of selected heavy metals with P. stratiote and S. polyrrhiza.

(Rajeshkumar, 2011) [51] mixed Food waste, Garden waste and Municipal solid waste with Eichhornia crassipes in different ratios with Cow dung for preparing biogas by bio methanation. Remaining sludge collected from biogas digester used to form fuel pellets and vermicompost.

(Aboul-enein et al, 2011) [48] separated and identified 9 fractions from water hyacinth and they observed promising therapeutic activities. Several secondary metabolites like alkaloids, phthalate derivatives, propanoid and phenyl derivatives etc. were found. It also shows high capability of antibacterial, antifungal, antioxidant and anticancer remedy. The crude extract of E. crassipes showed moderate activities against Gram+ and Gram- bacteria. Which is as effective as tetracycline. Antifungal activities of extract and different fractions were display against C. albicans (yeast) only. The antioxidant activity may be responsible for the presence of hydroxyl group and unsaturated bonds in the chemical structure of isolated compounds. Which was showing high free radical scavenging ability of E. crassipes. Anticancer activity of crude extract of E. crassipes showed highest effect over several tumour type. The crude extract is a stable material, which is favourable for economic and industrial purpose to make it commercial product for clinical use. This information may inspire for collecting water hyacinth and making it a pharmaco-economic important weed.

IX. Discussion-

Sirpur Wetland is an important fresh water resource of Indore. It is an important Bird and Biodiversity Area. But due to anthropogenic pressure over the lake (Industrial and sewage waste water, agricultural runoff, deposition of biomass at the bed of lake), it is getting polluted and biodiversity of lake is also affecting.

The comparative study of Physicochemical parameters of Sirpur Lake shows that Dissolved O_2 is increasing (because photosynthesis increasing), Magnesium concentration is also going above threshold limit (main component of chlorophyll and supports absorption of sunlight), Nitrate increasing (under threshold limit) and phosphorous increasing (above threshold limit). All this parameter showing increased rate of photosynthesis means Eutrophication. According to (De, Dey, Roy et al,2019) [52] when macrophytes start to grow rapidly they compete with phytoplankton and algae for nutrient and space and reduces the growth of algae.

In 2005 parameters were under permissible limit but sign of pollution was observed in many areas. Hence it supports growth of aquatic vegetation. In 2015 it shows high pH means alkaline nature of lake throughout the year (presence of bicarbonates). (Rawson,1960) [53] discover that electrical conductivity from 126micro mohs to 260 micro mohs is indication of Eutrophic nature of water. And water of Sirpur lake growing towards Eutrophication. Study done by (Mantoo, 2020) [18] reveals higher concentration of heavy metals present in Sirpur Lake.

In the present scenario lake is facing invasive growth of E. crassipes. Due to which number of migratory birds are decreasing.

Now a days, use of metal-based fertilizers is increased as a part of agricultural revolution and a big reason for increase in metal pollution in fresh water resources (Adefemi and Awokunmi, 2010) [54]. Sewage effluent thought to be rich in organic matter, nutrients and fertilizers for the plants (Riordan, 1983) [55]. Farmers attracted towards use of these effluents as source of nutrients and organic matter, low-cost water sources, best option for effluent disposal and growth in agricultural production. But they don't know the destructive effects of using sewage effluents i.e., heavy metal contamination of soil, water and crops (Quinn,1978 and Hemkes,1980) [56] [57]. Plant tissues can gather heavy metals (Fe^{2+}, Cu^{2+}, Zn^{2+}, Mn^{2+}, Ni^{2+}, Pb^{2+}) more than permitted limit that is dangerous for human and animal life and ultimately these contaminations reach to food chain (Adnan Amin, 2010) [58]. Macrophytes absorbs and accumulate metal ions, organic and inorganic substances and shows massive growth. By absorbing such toxic substances these plants act as a water purifier. But it is harmful too, if not harvested. There is need to further research to use these invasive species sustainably and convert this water parasite like Water hyacinth (E. crassipes) to useful substance

(Aboul-enein et al, 2011) [48] analyze anticancer activity of crude extract of Eichhornia crassipes (water hyacinth) which showed highest effects over several tumour type.

(Mishima and Kuniki, 2008) [49] investigates preparation of ethanol from E. crassipes and P. stratiote by fermenting them.

(Rajeshkumar, 2011) [51] mixed Food waste, Garden waste and Municipal solid waste with Eichhornia crassipes in different ratios with Cow dung for preparing biogas by bio methanation. Remaining sludge collected from biogas digester used to form fuel pellets and vermicompost.

By reviewing different aspects, we can suggest that Invasiveness of aquatic macrophytes may be beneficial if managed sustainably. Regular harvesting and convert it into useful substances need further research.

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