A Case Study

APPLICATION OF *LEMNA* AND *PISTIA* FOR REMOVAL OF POLLUTANT FROM SEWAGE WATER OF BALRAMPUR, INDIA

NARENDRA SHANKAR PANDEY, D.S. SHUKLA AND D.D.TEWARI

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See end of the article for authors' affiliations

Correspondence to :
NARENDRA SHANKAR PANDEY,
Department of Botany
(P.G.) College,
BALRAMPUR, (U.P.)
INDIA

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SUMMARY

Present paper deals with the ecofriendly low priced ecobiotechnological method for the removal of pollutant releasing from the sewage water of Balrampur city. In this regard to free floating aquatic plant usually reported in fresh wetland are some times lead the problem of eutrophication. Application of *Lemna* and *Pistia* was found suitable for the pollutant free water. The increase in biomass of *Lemna* and *Pistia* and finding the physico-chemical analysis has proved that both plants are suitable as aquatic plants for phytoremediation of sewage water by absorbing inorganic and organic pollutants.

Key words : pH, Net primary productivity, COD, Dissolve oxygen.

Sewage water treatment has become a major challenge for Balrampur city of Uttar Pradesh.This is a growing city hardly has any treatment facility, simply diverting untreated sewage water in to aquatic bodies like rivers, ponds where it causes eutrophication. This practice is making water unhygienic for use. For this reason, *Lemna* and *Pistia* are utilized for eliminating pollutants. These plants have great potential in treating sewage water and to prevent an early eutrophication of water bodies. Many effort have been made earlier to utilize aquatic plants to remove trace metals from waste water , such as Rai *et al*. (1995) and Brix and Schierup (1989).

Although *Pistia* species is the main aquatic plant for removing the pollutant but the rate of pollutant removal enhances after addition of *Lemna* species which acts as auto catalyst for this phenomenon.

MATERIALS AND METHODS

Phytoremediation of sewage water of Balrampur city was done by using *Lemna* and *Pistia.* A fresh weight of 100 g of *Lemna* and *Pistia* were grown in cemented pots of 60cm dia. and 20 cm depth containing sewage water for a period of 10 days .The treatment potential of the plant and elimination of pollutant from sewage water were assessed on monthly basis by estimating quality of sewage water before and after the treatment. The quality was determined by analyzing physico-chemical standard (APHA, AWWA, WPCF, 1998. and the Standard Methods for the examination of water and wastewater).

RESULTS AND DISCUSSION

The result of physico-chemical analysis of sewage water of Balrampur city before and after 10 days of culture of *Lemna* and *Pistia* are presented in Table 1. Temperature being an essential physical factor, playing an important role in change of many chemical parameters in culture was given the due consideration. Reduction in temperature was observed after 10 days of culture and pH value around 7.0 before culture but increased after culture. Turbidity before culture was higher during summer month in May and June. Electrical conductivity was above 900 µmhos during the summer months from April to June.

Total alkalinity was recorded above 300mg/L as $CaCO_3$ during March to May and September to November. Free CO_2 value was below 105mg/L except in the month of February and March with minimum value observed 59.02 in month of August. Free CO_2 value was low in culture.

Very small change was reported in chloride content due to non-utilization by the plants. Dissolved oxygen value were increased in small quantity in sewage water after culture as *Lemna* and *Pistia* helped in oxygen transfer in water system by their roots. Chemical oxygen demand was recorded higher above 240mg/L during April to June and lower value of 98.9mg/L in August. The reduction in COD after culture was due to move availability of oxygen in water for oxidation of organic matter. The peak value of total hardness 421.0mg/L was observed in month of March. Calcium value was always above 90mg/L throughout the year. Ca being a useful nutrient absorbed by plant *Lemna* and *Pistia* for their growth and development which accounted from 90 to

Table 1 : Physico-chemical characteristics of sewage water in Balrampur city before and after the phytoremediation by *Lemna* and *Pistia*

Parameters	Unit	January		February		March		April		May		June	
		BP	AP	BP	AP	BP	AP	BP	AP	BP	AP	BP	AP
Temperature	°c	14	12	17	14.2	26	22	38	24	40	37	41.1	38.5
pH	-	7.02	7.05	6.98	7.20	7.03	7.11	7.04	7.13	7.08	7.19	6.96	7.07
Turbidity	NTU	28.1	21.8	29.2	20.5	34.2	24.5	36.9	27.0	42.1	30.1	49.8	38.9
EC	µmhos	902	835	815	721	924	879	940	898.2	983	918	946	899.8
TDS	ppm	608	560	535	488	597	564	609.8	587	647	621	610	592
Total alkalinity	$mgCaCO_{3/L}$	304	255	299	259	341	302	357	313.5	399.5	382	317	293.5
Free CO_2	mg/L	102	80	141	105	185	141.5	112	82.5	104	80.8	93.5	67.5
Chloride	mg/L	224.3	219.3	217	202	197.8	163.4	170.2	159	177	152	158	141.5
Dissolved oxygen	mg/L	1.8	6.1	1.4	6.9	1.6	5.0	1.2	4.7	1.01	4.2	0.90	5.20
COD	mg/L	207	140.1	252.2	202	185.4	139	263.7	224.3	273	231	248.8	206.8
Total hardness	$mgCaCO_{3/L}$	415	342	365	298	421.0	271	407	352	297	248	337	294
Calcium	mg/L	145.5	96.02	140	92	153	123	167	139	119	90	145	103
Ammonical-N	mg/L	10.04	6.12	12.01	7.44	8.04	5.50	19.0	16.02	15.5	14.0	18.00	13.80
Nitrate-N	mg/L	71.05	52.01	67.0	43.0	61.0	46.0	70.05	59.80	82.0	68.0	59.9	50.0
Phosphate	mg/L	0.361	0.207	0.382	0.229	0.341	0.209	0.485	0.378	0.499	0.397	0.605	0.501
Organic phosphate	mg/L	0.840	0.675	0.292	0.189	0.273	0.195	0.481	0.645	0.553	0.539	0.542	0.443

Table 1 Continue.....

Parameters	Unit	July		August		September		October		November		December	
		BP	AP	BP	AP	BP	AP	BP	AP	BP	AP	BP	AP
Temperature	°c	38.5	36.1	36.8	35	36.9	34.1	30	29.1	28.9	26.8	24	21
pH	-	7.25	7.42	7.19	7.4	7.01	7.36	7.41	7.24	7.20	7.65	7.08	7.44
Turbidity	NTU	32	26	30.1	24.8	29.0	21.0	25	20	25.8	19.0	24.80	19.0
EC	µmhos	925	901	642	605	795.1	725	740	703	736	701	636	594
TDS	ppm	571	512	380	348	489	447	427	398	425	392	411	397
Total alkalinity	$mgCaCO_{3/L}$	313	281	287	252	355	324	364	334	352	309	262	218
Free CO_2	mg/L	102	77	59.0	21.8	63.12	39.72	68.06	38.9	88.9	58.1	82	52.0
Chloride	mg/L	198	177	164	151	201	182	176	168	187	168	178	160
Dissolved oxygen	mg/L	2.8	5.7	4.1	6.9	3.8	7.1	4.4	6.1	4.5	7.7	4.9	802
COD	mg/L	208	171	98.9	71	134	123	168	151	170.2	157	179	142
Total hardness	$mgCaCO_{3/L}$	341	297	298	270	357	287	378	317	338	286	306.8	256.4
Calcium	mg/L	136	97	125	94	164	107	149	103	121	92.2	127.2	99.08
Ammonical-N	mg/L	22.9	19.08	7.43	3.89	10.8	7.02	9.08	7.86	5.88	2.03	9.01	4.02
Nitrate-N	mg/L	76.5	57.3	63.1	50.2	70.87	51.89	69.94	47.0	66.3	38.4	67.0	46.3
Phosphate	mg/L	0.472	0.397	0.484	0.371	0.502	0.298	0.407	0.336	0.372	0.267	0.397	0.272
Organic phosphate	mg/L	0.479	0.307	0.487	0.351	0.898	0.598	0.474	0.302	0.426	0.298	0.443	0.323

145.5mg/L.

Nitrogen content was estimated as ammonical, nitrate forms. Nitrate nitrogen is the stable product of oxidation, hence, noticed maximum value above 45mg/L in most of months. An intermediate value of ammonical nitrogen in the range of 405 to 22.91mg/L. Plant preferred the nitrate form; hence, it was absorbed in greater amount. Phosphorus content was estimated as total phosphate. The peak value of total phosphate 0.605mg/L and organic phosphate 0.898mg/L were observed in the month of December, June, September and January respectively, phosphate exhibited its minimum value in the month of March.

The potential of *Lemna* species and *Pistia* species for phytoremediation of sewage water of Balrampur city was evident from the result of net primary productivity (NPP), which registered a significant increase in value after 10 days of culture. The higher value of NPP (in *Pistia*) 2.64 $g.m^{-2}$ day^{-1} was observed in month of December, while minimum 0.94 $g.m^{-2}$ day^{-1} in month May.

Like *Pistia*, in *Lemna* the higher value of NPP 0.54g m^{-2} day^{-1} in month of December (Table 2 and 3). The observed NPP value proved that rainy and winter season are best for phytoremediation of sewage water through *Lemna* species and *Pistia* species selected for such study.

Table 2 : Monthly variation in net primary productivity (g.m^{-2} day^{-1}) of *Pistia* after 10 days of culture in sewage water in Balrampur city during 2006 (initial biomass of *Pistia* used for culture = 8.1 g dry weight)

Months	Period	Production g.m^{-2}	productivity	N.P.P. g.m^{-2} day^{-1}
January	12^{th} -22^{nd}	10.40	1.04	1.39
February	16^{th} – 26^{th}	20.3	2.03	2.57
March	13^{th} – 23^{rd}	18.0	1.8	2.32
April	17^{th} – 27^{th}	6.9	0.6	0.98
May	14^{th} – 24^{th}	6.60	0.66	0.94
June	10^{th} – 20^{th}	9.13	0.91	1.24
July	7^{th} – 17^{th}	11.37	1.13	1.51
August	16^{th} – 26^{th}	11.74	1.17	1.55
September	15^{th} – 25^{th}	17.03	1.70	2.18
October	19^{th} – 29^{th}	11.92	1.19	1.57
November	11^{th} – 21^{st}	16.57	1.65	2.13
December	9^{th} – 19^{th}	20.91	2.09	2.64
Mean X				1.75

Table 3 : Monthly variation in net primary productivity (g.m^{-2} day^{-1}) of *Lemna* species after 10 days of culture in sewage water in Balrampur city during 2006 (initial biomass of *Lemna* used for culture = 2.7 g dry weight)

Months	Period	Production g.m^{-2}	productivity	N.P.P. g.m^{-2} day^{-1}
January	10^{th} -20^{th}	1.80	0.18	0.23
February	15^{th} – 25^{th}	4.30	0.43	0.51
March	9^{th} – 19^{th}	3.70	0.37	0.44
April	12^{th} – 22^{nd}	0.40	0.04	0.10
May	17^{th} – 27^{th}	0.70	0.07	0.11
June	11^{th} – 21^{st}	1.20	0.12	0.16
July	16^{th} – 26^{th}	1.50	0.15	0.20
August	7^{th} – 17^{th}	1.55	0.15	0.21
September	10^{th} – 20^{th}	3.40	0.34	0.41
October	14^{th} – 24^{th}	2.10	0.21	0.26
November	19^{th} – 29^{th}	3.10	0.31	0.38
December	12^{th} – 22^{nd}	4.50	0.45	0.54
Mean X				0.30

The result of *in vitro* culture has proved the application of aquatic plant *Lemna* and *Pistia* for removal of pollutant from sewage water of Balrampur city (Dings, R.(1978).Upgrading stabilization pond effluent by water hyacinth culture.J.*WPCF*, 50(5):833-845). Seeing the present scenario it is one of the most cheapest, free from any side effect and perfect biotechnological tool for the removal of pollutant occur in sewage water.

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Authors' affiliations

D.S. SHUKLA AND D.D. TEWARI, Department of Botany, M.L.K., (P.G.) College, BALRAMPUR (U.P.) INDIA

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