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Impact of improper disposal of solid waste on ground water quality- A case study

S.C. Gupta and Seema Sambyal
Department of Environmental Sciences, University of Jammu, Jammu

Abstract

The present study has been made to evaluate the ground water quality of Samba town of Jammu division of J&K state. The solid waste generated in urban areas is increasing day-by-day. Many municipalities and corporations are facing the problem of managing large volumes of solid waste generated in their area. One of the alternatives for disposal of solid waste is filling the depressions, drains, nallah, open spaces etc. In the present study, a big nallah flowing through Samba town carries huge load of pollutants in the form of refuse and waste water opens at many places into self-created garbage pits. Ground water monitoring was carried out at two stations around garbage pit to assess the ground water quality of hand pumps used by the residents of the area for domestic and other uses. The study revealed that the quality of ground water, however, conform to the drinking water quality standards but there is need for periodic evaluation of various water quality parameters as well as adoption of proper water quality management practices as natural quality of groundwater is being degradaed near the garbage pit.

Keywords: *Solid waste, Ground water quality, Depressions, Drains, Nallahs, Open spaces*

Introduction

Due to rapid growth of population, urbanization and industrialization, there is several fold increase in generation of waste and waste water. Due to improper disposal of solid waste, there is a great threat to the quality of ground water.

In the present study, a nallah flowing through Samba town, carries huge load of pollutants in the form of waste and waste water was studied. This nallah opens at many places into self-created garbage pits before draining into the river Basantar. In garbage pits, solid waste stays on the top but water percolates deep inside into the surface. Therefore, it is important to monitor the surface and ground water quality parameters. The monitoring programme was planned to measure ground water quality with the objectives to evaluate, analyze and summarize existing ground water quality, and to correlate the results of the data with permissible standards for drinking water quality.

Materials and Method

Study Area

The present study has been aimed to assess the quality of ground water of Samba town of Jammu division of J&K state. The solid waste generated in Samba town is mostly dumped in open land fills in low lying areas, drains, nallah etc. Since there is no sewage treatment plant and recycling facilities in the area, the sewage and the solid waste is directed in the nallah which flows in the town. For this purpose, two different stations or study sites have been selected Station–I (hand pump located near the garbage pit) and Station-II (hand pump located at a distance of 300 meters from the garbage pit).

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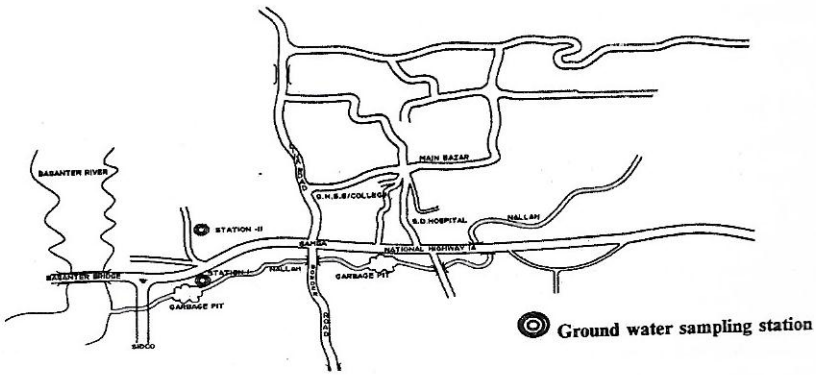

Fig. 1: Location map of ground water sampling stations

Since the town has developed in an unplanned manner, there is no underground drainage system in the area. Moreover, the nallah opens up at many places into self-created garbage pits. In these pits the solid waste stays at the top and the stored water seeps into soil cover. Once the soil cover is saturated, the infiltrated water moves to subsurface water through fissures and joints.

Methodology

A total of 6 representative samples were collected fortnightly from the study area during November 2005 to January 2006. The samples were collected from both hand pumps, which were being extensively used for drinking and other domestic purposes. The location of ground water sampling stations (Hand pumps) is shown in Fig. 1. Both physical and chemical analysis were carried out according to standard methods (APHA, 1998). The various analyzed parameters include pH, DO, COD, chloride , nitrate, calcium, magnesium and total hardness.

Results and Discussion

For studying the impact of refuse and waste water of the garbage pit on ground water quality, the water quality parameters were analyzed and are presented in Table I. A comparison of ground water quality of the study area with drinking water standards per guidelines laid down by WHO (1971) and BIS (1990) is presented in Table II. A critical examination of the tables reveals that quality of water considerably vary from location to location. pH is a measure of intensity of acidity or alkalinity and the concentration of hydrogen ions in water. The pH of the water samples collected around the garbage pit ranged from 6.92–8.21, where as the samples collected from the hand pump located at a distance of 300 meters away from the garbage pit showed a range of 7.42- 8.61. The pH values of both samples are normally acceptable as per guidelines suggested by WHO (1971) and BIS (1990). These findings are in conformity with Murugesan *et al.* (2005), *i.e.* 6.62 -8.07; Mor *et al.* (2003), *i.e.* 7.2- 8.6 and Aurangabadkar *et al.* (2000), *i.e.* 6.5 – 8.7 who have worked on the levels of ground water pollution in the urban environment.

Dissolved oxygen (DO) measured for all samples ranged between 1.48- 4.00 ppm and 1.65- 5.30 ppm at Stations I and II, respectively. These values of DO are below 5.00 ppm which clearly indicate pollution which may be due to the contents of decomposable matter in the samples which is more in the water

samples collected from Station-I as compared to those collected from Station-II. These findings are comparable with the findings of Ravinder *et al.* (2005) who recorded high DO values from wells situated away from the dumping site and low DO values in the nearby wells of Warangal town while studying the impact of dumping municipal solid waste (MSW) on ground water quality of Warangal. The COD values of Stations I and II are between 16.00- 36.00 ppm and 13.00- 24.00 ppm, respectively. These COD values illustrate that there is large amount of organic matter present in both the samples. However, it is clear from the study of Table-I that the COD value decreases with the increase in distance from the garbage pit. These findings are in conformity with Ravinder *et al.*(2005) who has recorded similar observation while assessing the ground water quality of Warangal town. The increase in COD value of water sample collected near the Station-I is due to high level of discharge of domestic sewage from nallahas.

Chloride concentration in the water samples collected from the Station-I ranged from 58.03 to 138.00 ppm whereas it ranged from 14.40 to 45.00 ppm at Station-II. Both these concentrations or levels of chloride are well within the permissible limits of WHO (1971) and BIS (1990). But chloride content from the Station-I showed higher content as compared to the Station-II. Therefore, it can be explained that there is regular addition of large quantities of sewage from nearby localities to the garbage pit, it is absorbed by the soil or it leached into the soil and move with the groundwater. Moreover, food waste also contributes to the chloride content in water.

Sulphate content in the water samples of present study ranged from 17.50 to 42.00 ppm from the Station-I and 1.50 to 18.00 ppm from the Station-II. The higher concentration of sulphate in water samples of Station-I is due to the seepage of pollutants from the waste water which is being regularly added to the garbage pit by the nallah. But both the values of the sulphate are found to be within the prescribed limits of WHO (1971) and BIS (1990). The present values of sulphate content are in agreement with the values recorded by Mor *et al.* (2003) who have tried to work out the pollution status of ground water of Jind city.

Nitrate content in both the samples collected from Stations I and II ranged from 0.70 to 16.80 ppm and 0.25 to 9.00 ppm respectively. Table-II shows that although both the values are within the permissible limits of 45-100 ppm as prescribed by BIS (1990), the Station-I values are higher as compared to the Station-II values which may be due to large addition of decayed vegetable and animal matter, sewage sludge, domestic effluents disposal to land, leachates from refuse dumps and atmospheric washout. Similar findings were recorded by Ravinder *et al.* (2005).

Table I: Physico-chemical analysis of ground water sample

Parameter	Station-I Hand pump located 5 m away from the garbage pit						Station-II Hand pump located 300 m away from the garbage pit					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
pH	6.92	8.21	7.7	8.2	7.6	7.4	7.42	8.61	8.0	8.4	8.0	7.8
DO	1.48	3.2	3.2	4.0	4.0	4.0	1.65	3.5	4.0	5.3	5.3	4.2
COD	28.8	36.0	26.0	16.0	17.0	17.0	14.4	24.0	16.0	13.0	13.0	15.0
Cl^-	58.03	109.9	83.8	113.6	120.4	138.0	24.87	14.4	20.40	30.55	45.0	24.0
SO_4^{2-}	33.0	17.5	28.0	26.0	42.0	26.0	1.5	6.0	18.	16.0	14.0	16.0
NO_3^-	9.5	3.5	0.7	6.6	3.8	16.8	0.25	1.1	2.2	9.0	2.8	1.2
Ca^{2+}	117.02	135.82	88.9	113.0	75.0	92.3	87.37	82.46	40.1	42.5	72.1	74.5
Mg^{2+}	23.16	29.39	35.1	38.5	25.0	31.7	17.96	13.71	7.3	18.0	21.9	25.3
TH	387.15	459.67	366.0	440.0	292.0	360.0	291.82	262.09	130.0	180.0	270.0	290.0

*All parameters are in ppm except pH

Table II: Physico-chemical analysis of ground water sample

Parameter	Station-I (handpump located at 5 m away from garbage pit)	Station-II (handpump located at 300 m away from garbage pit)	Indian Standard		WHO Standard
			Acceptable	Maximum	
pH	6.92- 8.21	7.42- 8.61	7.0- 8.5	6.5- 9.2	6.5- 9.2
DO	1.48- 4.0	1.65- 5.3	-	-	-
COD	16.0- 36.0	13.0- 24.0	-	-	10
Cl^-	58.03- 138	14.4- 45.0	200.0	1000.0	500.0
SO_4^{2-}	17.50- 42.0	1.5- 18.0	200.0	400.0	-
NO_3^-	0.7- 16.8	0.25- 9.0	45.0	100.0	-
Ca^{2+}	75.0- 135.82	40.1- 87.37	75.0	200.0	75.0
Mg^{2+}	23.16- 38.50	7.30- 25.30	30.0	-	150.0
TH	292.0- 459.67	130.0- 291.82	200.0	600.0	500.0

***All parameters are in ppm except pH**

Calcium concentrations from Station I and II ranged 75.00 to 135.82 ppm and 40.10 to 87.37 ppm, respectively and this level/ concentration of Ca^{++} content is found to be within the maximum limit prescribed (75-200 ppm) by the Indian Standards (1990) by above (75 ppm) WHO (1971) standards. Again Ca^{++} content is high in the water sample collected from the Station-I which is due to fact that domestic waste water contributes ions to the ground water. Magnesium concentration in the ground water samples collected from Stations I and II ranged from 23.16 to 38.50 ppm and 7.30 to 25.30 ppm, respectively and is well within the prescribed limits of WHO (1971) and BIS (1990). Hardness values ranged from 292.00 to 459.67 ppm and 130.00 to 291.82 ppm in water samples collected from Stations I and II, respectively.

These values of Ca^{++}, Mg^{++} and total hardness are in agreement with the values recorded by Mor *et al.* (2003), while assessing the pollution status of ground water due to landfills and septic tanks in Jind city of Haryana. Ca^{++} and Mg^{++} ions in greater quantities may be present in ground water either by leaching of soil deposits or through seepage of ions from domestic waste water. The hard water causes ill-effects on digestive system and moreover, the possibilities of forming Ca^{++} oxalate crystals (leading to stone formations) in the urinary tracts.

Summary and Conclusion

From the above results, it is concluded that the ground water of Samba town is not highly contaminated but there is an indication of increasing pollution due to discharge of sewage and solid waste into rivers and nallah along with other land sites which ultimately percolates into the ground and is thus responsible for ground water pollution. Hence, there is an urgent need to take immediate necessary steps for the protection of this valuable natural resource in Samba town.

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Studies on physico-chemical and biological parameters of Chorgaon Lake Distt. Chandrapur, India

P.M Telkhade*, N.R. Dahegaonkar*, S.B. Zade, C.J. Khune** and A.N. Lonkar*****
*A.C.S. College, Tukum, Distt. Chandrapur M.S.
**M.B. Patel Science College, Sakoli, Distt. Bhandara M.S.
***Nutan A.A.C. and Smt. M.H. Wegad Science College, Umrer, Distt. Nagpur M.S.

Abstract

Chorgaon lake is a man made fresh water reservoir at Chorgaon village, in Distt. Chandrapur. The present study has been made to investigate the physico-chemical and biological status of the lake. The study involves the physico-chemical analysis like DO, COD, BOD, Alkalinity, Total Hardness, Chloride, Sulphate and Phosphate along with other parameters and quantitative and qualitative analysis of phytoplankton and zooplankton in biological parameters. Samples were collected from four sampling stations of the lake.The results revealed that site S_2 and S_3 shows more Nitrogen and Phosphate, which favoured the growth of phytoplankton and zooplankton. Phytoplankton shows dominance of Bacillariophyceae. In zooplankton abundance of Rotifers, Cladocerons & Copepods were observed. The average value revealed that Dioptomus shows dominance in zooplankton and Diatoms in phytoplankton. At other sites parameters remained in constant range showing no much variation thus indicating better quality of water, which was free from pollution.

Keywords: *Quantitative, Phytoplankton, Zooplankton*

Introduction

Water in its various forms is a major element of all the components of biosphere and one of the most needed factor for the existence of living organisms. Besides studying the physico-chemical parameters of lake water, the study of biological parameters also have equal importance. Chorgaon lake is a man made reservoir situated in the North-Eastern part of Distt. Chandrapur. The lake water is used for irrigation, aquaculture as well as for domestic purposes.

The present work was carried out during Aug. 2006 to July 2007 in which focus was given on the study of water quality in terms of physico-chemical parameters and biological diversity of the lake.

Materials and Method

The water samples were collected from Chorgaon lake from four location sites S_1, S_2, $S_3$and S_4. The water samples were collected in pre cleaned 5 liters plastic can. The sample collection was usually completed during morning hrs. between 8.00 AM to 10.00 AM. The parameters like DO, Temp., pH were analyzed on the spot while Total solids, Total alkalinity, BOD, COD, were analyzed in the laboratory by standard methods given in APHA (1998). The plankton were collected by plankton net and were preserved in 4% formaline.

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Table 1.1: Physico- Chemical parameter of Chorgaon lake during August 2006 to January 2007

Sr. No.	Mon/ Para	AUGUST				SEPTEMBER				OCTOBER				NOVEMBER				DECEMBER				JANUARY			
	Sites	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4
1.	Temp	29.1	29.2	29.1	29.1	28.9	28.6	28.8	29.1	28.2	28.4	28.2	28.2	27.1	27.1	27.2	27.1	26.00	26.2	26.3	26.00	25.6	25.7	25.7	25.7
2.	pH	7.2	7.4	7.3	7.1	8.1	8.2	8.00	7.99	7.91	7.98	7.99	7.92	7.76	7.71	7.69	7.70	7.22	7.82	7.86	7.70	7.91	7.89	7.96	7.90
3.	Alkalinity	158	172	165	156	169	175	167	167	174	184	186	179	187	168	182	179	182	189	187	190	198	197	199	189
4.	D. O.	3.8	4.1	4.00	3.9	4.00	3.6	3.8	3.8	4.1	4.6	4.2	4.1	5.1	4.9	4.7	4.8	5.7	5.4	5.5	5.4	6.4	6.1	6.2	6.4
5.	CO2	4.52	4.89	4.81	4.4	2.19	2.23	2.27	2.11	2.64	2.67	2.71	2.59	2.42	2.67	2.86	2.41	3.08	3.09	3.10	3.02	2.89	2.69	2.71	2.88
6.	Tot Hard.	268	279	271	262	252	284	276	258	212	217	229	240	196	203	210	188	106	157	168	42	217	219	225	154
7.	Ca- Hard.	189	180	198	181	160	201	189	179	158	171	162	158	154	149	153	142	82	120	123	111	164	172	173	122
8.	Mg - Hard.	79	99	73	81	92	83	87	79	54	46	67	82	42	54	5	46	24	37	45	31	53	47	52	32
9.	Chlorides	20.21	19.81	21.23	19.98	19.20	20.41	20.89	20.21	18.89	18.80	19.01	18.90	16.12	17.02	17.89	16.09	14.99	15.03	15.72	14.05	17.02	17.86	17.46	17.01
10.	T.D.S.	1630	1612	1590	1628	1487	1510	1521	1460	1300	1380	1372	12.89	1287	1350	13.64	1288	1265	1298	1290	279	1120	1210	1219	1189
11.	Sulphates	1.60	1.40	1.78	1.58	1.10	1.15	1.25	1.49	1.02	1.20	1.38	1.10	0.89	1.13	1.13	0.92	0.90	1.02	1.14	0.98	0.98	1.06	1.08	0.99
12.	Phosphates	2.80	2.89	2.87	2.71	2.20	2.33	2.39	2.58	2.01	2.14	2.17	2.05	1.92	2.01	2.03	1.99	1.88	1.99	2.01	2.10	1.80	2.03	2.06	2.15
13.	Nitrogen	7.10	8.12	8.16	7.12	7.13	8.01	8.04	7.13	6.15	6.23	6.27	6.69	5.02	6.01	5.98	5.12	4.20	4.65	4.93	4.18	3.53	3.89	3.60	3.83

***All parameters are in mg/l except pH and Temp. (^{0}C)**

Table 1.2: Physico- chemical parameter of Chorgaon lake during February 2007 to July 2007

S.N.	Mon/Para	FBRUARY				MARCH				APRIL			MAY				JUNE			JULY					
	sites	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4
1	Temp.	27.00	27.3	27.8	27.4	29.00	28.8	28.9	29.4	32.00	31.6	32.4	32.6	33.00	32.8	33.1	33.6	31.00	31.4	31.6	31.4	30.00	30.4	30.4	30.1
2	pH	8.1	7.9	8.1	8.3	7.9	7.9	7.6	7.7	8.3	8.1	8.4	8.3	7.7	7.3	7.9	7.9	7.6	7.5	7.3	7.9	7.3	7.4	7.5	7.6
3	Alkalinity	178	187	186	172	209	204	211	214	213	210	212	236	231	242	236	241	189	160	179	180	168	169	170	165
4	D. O.	6.17	6.12	5.9	6.1	6.95	6.90	6.80	6.70	5.70	5.2	5.5	5.2	4.1	3.9	4.3	4.1	3.9	3.6	3.8	3.9	4.1	4.2	4.6	4.5
5	Free CO2	2.20	2.50	2.40	2.44	3.74	3.60	3.71	3.50	3.9	4.11	4.18	4.12	3.50	3.12	3.5	3.25	3.40	3.39	3.33	4.20	4.41	4.42	4.32	4.19
6	Total Hard.	235	240	242	229	260	270	278	255	275	285	291	278	289	290	298	281	260	278	279	255	266	288	281	272
7	Ca- Hard.	162	166	166	160	182	176	186	167	176	189	204	177	186	206	195	175	172	174	169	124	163	176	172	165
8	Mg - Hard.	73	74	76	69	78	94	92	88	99	96	87	101	103	84	103	106	88	104	110	131	103	112	109	107
9	Chlorides	18.8	17.2	17.5	17.1	20.2	20.6	20.8	20.5	22.9	22.95	23.1	22.8	23.6	23.5	23.7	23.6	21.2	21.3	21.3	21.3	19.3	19.4	19.5	19.2
10	T.D.S.	1060	1068	1073	1058	1102	1112	1129	1128	1190	1198	1197	1192	1220	1223	1226	1223	1600	1664	1684	1631	1650	1658	1641	1638
11	Sulphates	1.10	1.12	1.11	1.09	1.23	1.24	1.24	1.23	1.61	1.69	1.67	1.59	2.12	2.12	2.12	2.10	1.90	1.95	1.96	1.95	1.98	1.98	1.98	1.96
12	Phosphates	1.95	1.96	1.96	1.95	2.01	2.12	2.12	2.03	2.35	2.37	2.33	2.39	2.80	2.89	2.92	2.78	2.65	2.68	2.68	2.66	2.99	2.99	3.01	2.99
13	Nitrogen	2.9	3.01	3.04	3.00	3.02	3.11	3.8	3.02	4.01	3.9	3.74	3.81	4.80	4.98	4.1	4.5	4.6	4.3	5.2	5.8	5.01	5.6	5.4	5.10

*All parameters are in mg/l except pH and Temp. (°C)

Results and Discussion

In an aquatic ecosystem physico-chemical environment has profound influence on its biotic components. They exert their influence both individually and collectively. The values of physico-chemical parameters of water samples collected from various sites are shown in Table 1.1 and 1.2.

During the study, the temperature of water ranged between 25.6 °C to 33.6 °C minimum temperature i.e. 25.6 °C was observed in month of Jan at Site S_1 and maximum temperature was recorded 33.6 °C in month of May at site S_4. Temperature variation is due to depth and inflow of water in catchment area. The permissible limit of pH for potable water ranges within 6.0 to 8.5. In the present investigation the pH value noted down minimum 7.1 in August at site S_4 and maximum 8.4 at site S_4 in April.

Total Alkalinity of water is a measure of weak acid present in it and of the cations balanced against them. The highest concentration is 24.2 mg/l in month of May at site S_2 and the lowest concentration i.e. 156 mg/l was noted down in month of Aug at site S_4. Throughout the investigation period, it was noted that the total Dissolved Oxygen ranges between 3.6 to 6.95 mg/l. Similar variation in oxygen was reported by Khatavkar *et al.* (1989) and Bhosle *et al.* (1994). Free CO_2 value was observed maximum 4.89 mg/l at site S_2 in month of Aug, this may be due higher turbidity. Minimum value 2.11 mg/l was noted down in month of Sept at site S_4. In winter season turbidity was lowest.

The value of Total hardness was maximum in month of May at site S_3 i.e.. 298 mg/l and minimum 106 mg/l at site S_1 in month of Dec. This may be due to presence of high content of Ca & Mg in addition to sulphates & nitrates. The maximum value of TDS was noted down 1684 mg/l in month of June at site S_3 and minimum value was 1058 mg/l in month of Feb at site S_4. Chloride concentration was recorded maximum 23.7 mg/l in month of May at site S_3 while the minimum was observed 14.05 mg/l in month of Dec at site S_4. The value are within permissible limit with respect to DIS, ICMR. Sulphate varied from minimum 0.89 mg/l to maximum 2.12 mg/l during the investigation period. It's value increased during month of May. Phosphate value was maximum in month of July at site S_3 i.e. 3.01 mg/l and minimum value recorded in month of Dec at site S_1 i.e.1.88 mg/l. The Nitrate shows the range of 8.15 mg/l to 2.9 mg/l. The Nitrate level was max. in the month of Aug at site S_3 & minimum was recorded in month of Feb at site S_1.

The phytoplankton communities were represented mainly by four groups. Chlorophyceae, Cyanophyceae, Bacillariophyceae & Charophyceae. Chlorophyceae was represented by Spirogyra, Clostridium, Cosmarium etc. showed its maximum value during the month of April & minimum during the month of Aug. Bacillariophyceae was represented by Navicula, Cymbella, Diatoma vulgare etc. Its maximum value was noted down during April and May and minimum was in Aug. Cyanophyceae was a significant group, this group includes Anabaena, Oscillatoria, Nostoc, Microcystis etc. It shows higher appearance during the month of Jan and minimum in month of June. Charophyceae was represented by Chara and Nitella during present investigation. They stand fourth in their dominance. Kumar (1990) estimated that density of phytoplankton is greater during summer, post monsoon and winter and is lowest in monsoon. In the present study also peak of the phytoplankton was observed during summer and lowest during monsoon. Verma & Mohanty (1995) recorded three peaks March, July and Jan for phytoplankton at Danmukundpur pond. In present study the phytoplankton shows their dominance as follows:

Bacillariophyceae > Chlorophyceae> Cyanophyceae > Charophyceae

The zooplankton communities were represented mainly by four groups Rotifers, Ostracoda, Copepoda & Cladocera. In the present observation Rotifer were found maximum in the month of April and May and minimum was in the month of Sept. They are represented by Asplanchnopus, Brachionus, Licane etc. The Cladocera represented by Moinodaphnia, Bosmina, Moina etc. They showed maximum value during the month of January and minimum in month of July. Copepoda was represented by Diaptomus, Cyclops etc. They showed their maximum value during month of December and minimum during month of August. Ostracoda represented by Cypris showed it's maximum value during month of August and minimum during month of May.

In present investigation zooplankton showed their dominance as follows:
Rotifers > Cladocera > Copepoda > Ostracoda.

The average value revealed that the physico-chemical and biological parameter were in permissible range showing no much variation, indicates better quality of water.

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The Anatomic responses of *Lycopersicon esculentum* Mill. due to the Tomato Leaf Curl Virus (TLCV)

Sarika Srivastava, G. P. Srivastava and J. P. Tewari
Plant Pathology Lab., M.L.K (P.G.) College, Balrampur (U.P.)

Abstract

An anatomical study of tomato plants infected by tomato leaf curl virus was conducted to elucidate the mode of infection of the causal virus. One to two months after whitefly transmission, the severe symptoms appear with thickening of the veins, curling of leaf and stunting of plant. Typically reorganization of leaf tissue consisted in replacement of the spongy parenchyma by a palisade parenchyma. Palisade parenchyma tissues were compact in comparison to healthy. Abnormal cambial activity was observed in conducting tissue. Weaker sclerenchyma rings were narrow and these were fewer narrow xylem vessels. Phloem necrosis was observed frequently in virus infected stem. Bronzing & discoloration sieve elements in phloem were also found in infected stem. The cortical parenchyma was wider and formation of mechanical and conducting tissues was reduced. In root of infected plant secondary thickening was less in comparison to healthy. Xylem vessels were narrow and with scanty phloem in diseased root. The no. of stomata was also reduced in infected leaves.

Keywords: *Anatomical changes, Tomato, TLCV, Stomatal index*

Introduction

Tomato leaf curl is a serious disease of tomato (*Lycopersicon esculentum* Mill.) that has been spreading in intensive tomato production area of eastern U.P. This disease can cause 50-90% yield loss (Sastry and Singh, 1973; Saikia and Muniyappa, 1986,1989). However, the incidence occasionally reaches up to 100%. TLCV infected plants show a variety of symptoms including leaf curling, vein clearing yellowing and stunting etc. Tomato leaf curl disease is caused by Geminivirus (Genus-Begmovirus) and is transmitted by *Bemisia tabaci* Genn. (Vasudeva and Samraj, 1948; Cozosnek *et al.*, 1988; Chakraborty *et al.*, 2003).

Most of investigations carried on this disease are confined to symptology, transmission and physiological identification (Yassin and Nour, 1965). Generally virus infection is known to result in drastic histopathological changes. The effects of Tomato Leaf Curl Virus on the anatomic structure of plants have received less attention than comparable effects on plants infected with leaf curl virus. Therefore, the aim of present investigation is to analyse the anatomical changes of tomato roots, stems and leaf affected by TLCV.

Materials and Method

In March 2006, tomato plants were raised under green house condition. For transmission of TLCV, the adult whiteflies (*Bemisia tabaci* Genn.) were collected from TLCV infected tomato plants. These whiteflies were then fed on infected tomato plants for 48 hrs in an insect proof cage to ensure the acquisition of virus. Later 20 whiteflies were removed and transferred to each healthy tomato plant kept in an insect proof cage in three replications. An equal number of plants were kept in green house as uninoculated controls.

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Leaves, stems and roots were sampled from infected and healthy plants and fixed in FAA after 24 hrs, washed in 70% alcohol. The plant material were dehydrated with ethyl alcohol butanol grades and embedded in paraffin wax. Sections were cut on rotary microtome at 10μm thickness. These sections were stained with safranin & fast green and mounted in DPX (Johensen, 1940). The stomatal size, frequency and stomatal index were measured with a precalibrated stage & ocular micrometer. The stomatal index (SI) was calculated (Salisburg, 1928).

$$SI = \frac{\text{No. of stomata per unit area}}{\text{No. of stomata per unit area + No. of epidermal cell}} \times 100$$

Results and Discussion

Symptoms- Plants of tomato infected with TLCV were severely stunted, leaf curling and shrinking of leaves. Leaves were often bent downwards or upwards and were stiff. Fig. A to G shows T.S. of leaves and stems of infected and healthy plants.

Anatomical observations in root- The cells of epiblema were smaller in size & possessed lignified walls on its inner surface. The cortical and endodermal cells of diseased plants were relatively small with thicker walls. The pith region had large cells in middle region with less developed conducting tissue, viz; phloem and xylem (Fig. A). Almost similar observations had also been made in tomato root infected with TMV. The epidermal cells were smaller in size and had large pith region (Dubey *et al.* 1982). The urdbean leaf crinkle virus caused reduction in cell size of phloem and xylem in urdbean. Epiblema, cortex endodermis, medullary rays and pith were found thickened (Sharma and Dubey, 1985).

Anatomical observations in stem- In diseased stem, the xylem vessels were fewer narrow and reduced in number. Phloem necrosis was observed in infected stem (Fig. B). The cortical parenchyma was wider and formation of mechanical and conducting tissues was reduced. The cell wall of the infected ground tissues was reduced in thickness.These results were found to be in conformity with the findings reported in groundnut infected with mosaic rosette virus (Singh, 1970). There was found to be marked reduction in the size of all the tissue of *Solanum khasianum* infected with green vein banding virus. Vascular bundles were reduced in sized and pith region greatly affected (Garg *et al.*, 1977). The cortical region was enlarged in tomato stem infected with TMV (Dubey and Bhradwaj, 1982).

Anatomical observations in leaves- Epidermal cells and the tissues of the midrib region especially on dorsal surface of infected leaf were degenerate (Table-1). The development of midrib was irregular. In vascular region the xylem parenchyma, xylem vessels and phloem were greatly reduced. Leaf tissue consisted in replacement of the spongy parenchyma by a palisade parenchyma (Fig. C). The palisade cells of diseased leaves were thinner (Table-2) & less densely packed with chloroplast. The significant changes were shown in spongy tissues. The average stomatal frequency and stomatal index were significantly lower in diseased leaves, although their size was increased (Table-3). The chloroplasts were few and showed irregular shape. The epidermal, palisade and spongy cells reduced in *Vicia faba* infected by tomato ring spot virus (TRSV) (Smith and Mc Whorter, 1957). The leaf tissues consisted in replacement of the spongy parenchyma by palisade parenchyma and cambial activity was observed in the main phloem parenchyma of *Athea rosea* infected with Begmovirus (Bigare *et al.* 2001). In vascular region the

phloem, xylem parenchyma and xylem vessels were greatly influenced in diseased tomato leaves with TMV (Dubey and Bhardwaj, 1982). The changes in colour as primary symptoms due to chlorosis seems to be due to the disintegration and disruption of chloroplasts in tobacco leaves infected by tobacco mosiac virus (Carrol and Kosuge, 1969).

Table 1: Thickness of epidermal cells of healthy and diseased leaves (mean of three replicate)

S.No.	Healthy		Diseased	
	Upper epidermal cell+ cuticle (µm)	Lower epidermal cell+ cuticle (µm)	Upper epidermal cell+ cuticle (µm)	Lower epidermal cell+ cuticle (µm)
1	51.25	43.10	38.35	35.10
2	50.50	41.32	36.20	32.26
3	50.10	40.25	35.66	31.25
4	49.41	40.20	35.43	30.45
5	49.25	40.10	34.50	30.40
6	46.50	39.80	34.12	30.10
C.D at 5%	4.35	7.28	2.51	4.8

Table 2: Thickness of palisade cells of healthy and diseased leaves (mean of three replicate)

S.No.	Thickness in µm	
	Healthy	Diseased
1	143.50	136.68
2	142.75	132.45
3	141.75	132.32
4	141.20	130.34
5	140.61	128.25
6	140.50	120.10
C.D at 5%	1.52	2.28

Table 2: Thickness of palisade cells of healthy and diseased leaves (mean of three replicate)

S.No.	Healthy Size of stomata (μm)				Diseased Size of stomata (μm)			
	SF	Length	Breath	SI	SF	Length	Breath	SI
1	617	17.95	9.18	26.07	483	23.63	14.45	31.4
2	589	17.85	9.03	25.74	461	21.93	12.75	30.92
3	578	17.34	7.65	25.54	440	21.42	12.11	29.86
4	557	16.83	7.65	25.52	428	21.42	11.47	28.86
5	515	15.30	7.65	25.15	373	20.90	10.83	27.93
6	419	15.00	7.65	24.94	367	20.40	10.20	27.84
7	431	14.00	7.30	24.28	317	20.20	9.60	21.53
C.D at 5%	42.37	1.38	0.92		30.18	2.56	1.84	

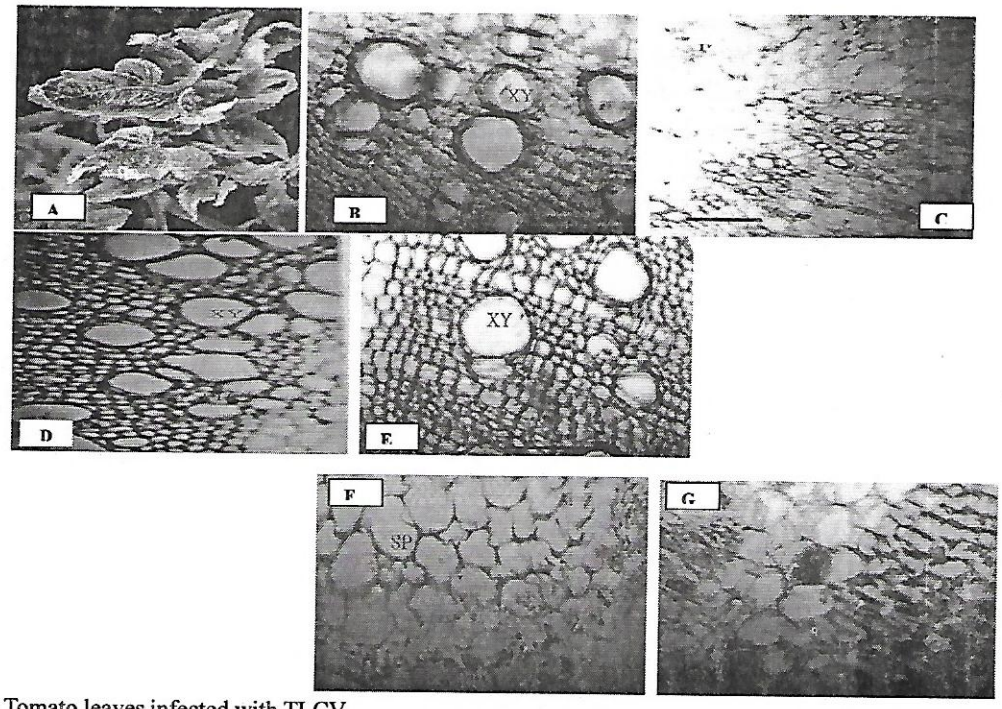

Fig. A : Tomato leaves infected with TLCV.
Fig. B : T.S. of healthy root.
Fig. C : T.S. of diseased root showing large pith region (P) & reduced xylem (XY), phloem (PH) Bar : 130 μm
Fig. D : T.S. of Healthy stem; Bar : 110 μm
Fig. E : T.S. of diseased stem showing enlarge reduced xylem (XY), necrosis of phloem (PH).
Fig. F : T.S. of health leaf; showing spongy parenchyma (SP).
Fig. G : T.S. of diseased leaf showing degenerating epidermal cells (EP) & thin and less densely palisade parenchyma (PP).

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Fungal ecology of BLSB infected maize fields

Nishat Asif and T.P. Mall
P.G. Department of Botany, Kisan P.G. College, Bahraich (U.P.)India

Abstract

Screening of fungal population was done from the rhizosphere/rhizoplane of BLSB infected maize fields from different locality of District Bahraich. Ninteen species were isolated from rhizoplane and twenty-three species from rhizosphere. *Rhizoctonia solani* and *Aspergillus flavus* were dominant in serial dilution whereas *Aspergillus flavus* was dominant by Warcup method.

Keywords: *Rhizosphere, Rhizoplane, Fungal population, Maize, BLSB, Rhizoctonia solani*

Introduction

Maize (*Zea mays* L.) is a cereal grain commonly known as corn, originally referred to a granular particle. It occupies 3rd rank among principle staple of the world i.e. wheat and rice. India produces 12 million metric tons in total maize production of world. Inspite of all advance agricultural practices, the crop suffers from severe losses every year. Poor seedling germination, attacks of pest and pathogen, microbial inoculum infested in the seeds also reduces the productivity. Maize suffers from number of diseases viz., bacterial stalk rot, pythium stalk rot, rusts, smuts, charcoal rot, maydis leaf blight, banded leaf and sheath blight (BLSB) etc. Among which bacterial stalk rot and banded leaf and sheath blight are economically important. Banded leaf and sheath blight is caused by the most versatile and dreaded pathogen *Rhizoctonia solani* which causes 15-20% yield loss annually (Saxena, 2002).

Rhizosphere is the well-recognized and specialized ecological niche for fungi, bacteria and actinomycetes. It is also a well-established region around root supporting beneficial and biotrophic microbes. Rhizosphere is the portion of the soil which is around root supporting diversified microorganism and is influenced by root exudates, soil factors, age and type of the host plant and molecular signals. Rhizospheric effect is indicated by the interaction of soil and rhizosphere microbes and their ratio. Significance of rhizosphere mycoflora in plant health has been reviewed. Present study has been undertaken to screen the mycobial population of maize plants infected with BLSB disease.

Materials and Method

Five fields in three maize growing blocks of district Bahraich that falls in Northern Tarai belt of U.P. were selected. Soil samples were collected from the rhizosphere of maize plants which were infected with BLSB disease in selected sites. The fungal population was recorded by Warcup method (Warcup, 1950). Fungal flora was isolated on PDA medium supplemented with streptomycin to supress the bacterial growth.

For isolation of rhizoplane mycoflora serial dilution method was followed (Kanaujia, 1972). Identification was done by mounting material in lactophenol and stained with cotton blue. Observations were done under microscope using standard manuals and monographs.

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Results and Discussion

Twenty-three species belonging to sixteen genera were recorded from rhizosphere. *Aspergillus flavus* was recorded with 60% frequency whereas *R.solani* and *Cercospora* sp.have 50%; *Alternaria alternata* was recorded with 40%; *A.tenuis*, *Aspergillus fumigatus*, *A.niger*, *A.terreus*, *Cladosporium herbarum*, *Monilia* sp., 30% *Chaetomium globosum*, *Curvularia lunata*, *Fusarium oxysporum*, *Macrophomina phaseolina*, *Phoma* sp., *Trichoderma viride* and *Syncephalastrum* sp., 20%; *A.ochraceous*, *Dreschelra* sp., *Fusarium roseum*, *Pythium* sp., *Penicillium citrinum* and *T.harzianum* frequency was 10% only. *A.flavus* showed highest density (6) whereas *A.ochraceous*, *Pythium* sp., *P.citrinum*, *T.harzianum* was recorded in minimum density (1).

Isolation of rhizoplane mycoflora showed maximum frequency of *A.flavus* and *R.solani* 70% whereas *A.tenuis, A.alternata* showed minimum frequency 10%. *Fusarium oxysporum* and *A.niger* 60%, *A.ochraceous* 50%; *Fusarium roseum* and *Chaetomium globosum* 40%; *T.viride*, *T. harzianum*, *P.citrinum*, *Dreschlera* sp., *Curvularia lunata*, *Cercospora* sp.30%; *Phoma* sp., *Monilia* sp., *Cladosporium* sp.and *A.terreus* 20% frequency was recorded. Highest density was recorded of *A.flavus* and *R.solani* (7); *F.oxysporum*, *A.niger* (6); *A.ochraceous* (5); *F.roseum* and *C.globosum* (4);*T.viride*, *T.harzianum*, *P.citrinum*, *Dreschlera* sp., *Curvularia lunata* and *Cercospora* sp. (3). *Phoma* sp., *Monilia* sp., *Cladosporium* sp. and *A. terreus* (2); *A.alternata* and *A.tenuis* showed minimum density (1) only. Several other workers have also reported the rhizosphere mycoflora. (Singh *et al.*, 2006; Sooting and Dhkar, 2003; Wani *et al.*, 2006; Roy, 2006).

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Status of water quality of Masala Lake Durgapur, Dist. Chandrapur (M.S.)

P.M. Telkhade*, N.R. Dahegaonkar*, S.B. Zade and P.N. Charde*****

* A.C.S. College Tukum, Dist. Chandrapur. M.S.

** M.B. Patel Science College Sakoli, Dist. Bhandara. M.S.

*** Sevadal Mahila Mahavidyalaya, Nagpur. M.S.

Abstract

Masala lake is situated 6 Km. away from Chandrapur. The present study has been made to investigate the physico-chemical parameters of the lake. The present study was carried out from the month of Aug. 2006 to Jan 2007. Samples were collected on monthly basis from three sampling stations S_1,S_2 and S_3. The physico-chemical parameters like temp., pH, conductivity, DO, COD, BOD, free CO_2, chloride, total hardness, Ca hardness, Mg hardness, phosphate, sulphate, nitrate, nitrites, carbonates & bicarbonates were analyzed during the course of study. The study revealed that as compared to site S_1 and S_3, site S_2 showed higher concentration of sulphate, phosphate and bicarbonates during month of Nov and Dec 2006 and were recorded low during the month of Aug and Sept 2006 may be due to dilution, site S_2 shows more TDS value because of domestic activities. In all there is definite impact on the water quality due to domestic and agricultural activities.

Keywords: *Masala lake, Water quality, Physico-chemical*

Introduction

The water quality of lakes and tanks are deteriorating, mainly due to rapid increase in human settlement nearer to these places. Deforestation, grazing and removal of vegetation cover in the water shed results in silting of reservoir. The agricultural practices in the catchment area not only increased the siltation problem but are also responsible for the addition of large quantities of nutrients, pesticides and organic matter. The knowledge of physico-chemical characteristics of water bodies helps in planning and successful management of water bodies. To fulfill these criteria present investigation has been carried out.

Materials and Method

Water samples were collected from three sampling stations viz. Station S_1, S_2 and S_3 once in a month during study period for estimation of various physico-chemical parameters. Samples were collected and analysed according to APHA (1998). The samples were analyzed within few hours of collection. The pH, Temp. and DO were measured on the spot. Determination of chloride, sulphate, phosphate, carbonates, bicarbonates etc. were carried out by following standard methods given in the Table1.

Results and Discussion

Variations of physico-chemical characteristic during Aug 2006 to Jan 2007 are given in Table 2. Temperature

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is basically important for its effects on a certain chemical and biological activities. The surface water temperature of the lake ranges from 24.8 ^{0}C to 29.4 ^{0}C, maximum temp. was recorded in month of Aug. at site S_3 and minimum in month of Jan. at site S_1 and S_3 The temp. showed an inverse relationship with dissolved oxygen, which is consistent with result reported by Das and Shrivastava (1956) and Khanna (1997). The pH of lake water is alkaline and varied from 7.1 to 8.3. During the period of study, maximum pH value recorded in month of Sept 2006 at site S_2 and minimum was recorded in month of Aug 2006 at site S_2. Conductivity was minimum 0.25 µmhos in month of Jan 06 at site S_1 and maximum conductivity 0.411µmhos was observed in month of Sept. 06 at site S_3. The dissolved oxygen is one of the most important factor in any aquatic system. Self purification of water system depends on presence of sufficient amount of oxygen dissolved in it. The DO content fluctuated between minimum 5.88 mg/ l in Aug 06 at site S_1 and maximum 7.81 mg/l recorded at site S_2 in month of Jan 2007. Bahura (1998) reported an inverse relationship of DO, with temperature. While comparing dissolved oxygen data with that of above authors, it is observed that DO is inversely proportional to temp and free CO_2.

In present study BOD shows its maximum value 5.02 mg/l in month of Nov 2006 at site S_3 and minimum value 3.42 mg/l at site S_2 in month of Sept 06. The maximum COD value was recorded 15.20 mg/ l during month of Dec 2006 and minimum was recorded 10.50 mg/ l during the month of Sept 2006. TDS showed its high value during the whole study at site S_2 may be due to agricultural and domestric activities. TDS

Table 1: Method used to evaluate parameters

S.No.	Parameters	Methods/ Equipment utilised
1	Temp.	Direct measurement on site by thermometer
2	pH	pH meter (model EQ 610)
3	Conductivity	Conductivity meter (model EQ 660)
4	Alkalinity	Titrimetric method
5	DO	Modified Winkler's method
6	CO^2	Titrimetric method
7	BOD	Modified Winkler's method
8	COD	Modified Winkler's method
9	TDS	Gravimetric method
10	Hardness	Titrimetric method
11	Ca- Hardness	Titrimetric method
12	Mg- Hardness	Titrimetric method
13	Phosphate	Spectrophotometer (EQ. 820)
14	Sulphate	Spectrophotometer (EQ. 820)

Table 2: Physico-chemical parameter of Masala lake during Aug. 2006 to Jan. 2007

S.No.	Mon/ Para	Aug			Sept			Oct			Nov			Dec			Jan		
	Site	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3
1	Temp	29.3	29.3	29.4	28.4	28.3	28.1	28.1	28.0	28.1	27.1	27.3	27.2	25.4	25.9	25.7	24.8	24.9	24.8
2	pH	7.2	7.1	7.2	8.1	8.3	8.2	7.99	7.98	7.91	7.98	7.88	7.97	8.01	8.03	7.99	7.3	7.2	7.4
3	Conductivity	0.390	0.398	0.401	0.405	0.410	0.411	0.404	0.409	0.404	0.380	0.382	0.378	0.262	0.279	0.281	0.250	0.260	0.262
4	CO_2	3.52	3.56	3.41	2.19	2.27	2.38	2.22	2.42	2.38	2.58	2.67	2.59	3.01	3.04	3.03	2.97	2.81	2.86
5	DO	5.97	6.02	5.88	6.00	7.02	6.81	6.03	7.08	6.18	6.58	7.68	7.02	6.89	7.33	6.91	7.09	7.81	7.02
6	Chloride	20.2	21.0	20.5	19.2	20.2	19.3	19.4	20.1	19.0	18.6	19.12	18.4	16.3	16.5	16.2	17.8	17.9	17.7
7	Total- Hard.	238	245	231	240	257	245	189	198	186	151	159	157	131	140	139	132	150	139
8	Ca- Hard.	192	181	183	180	171	176	132	143	137	112	106	105	89	112	91	98	104	94
9	Mg- Hard.	46	64	48	60	86	69	47	45	49	49	51	52	42	38	48	33	46	35
10	TDS	980	1020	996	940	918	860	689	702	691	554	629	562	565	602	557	358	492	371
11	Alkalinity	162	178	162	161	171	158	187	192	180	191	205	189	182	219	179	212	187	182
12	Carbonate	98	102	78	69	90	62	102	56	70	68	64	62	81	78	62	90	86	79
13	Bicarbonate	64	76	83	92	81	96	82	136	110	123	142	127	101	141	114	122	101	103
14	BOD	4.12	4.09	4.08	3.69	3.42	3.54	4.12	4.00	4.02	4.97	4.02	5.02	4.86	3.86	4.76	4.86	3.82	4.09
15	COD	12.8	12.9	13.1	10.5	10.6	11.0	12.9	12.6	12.7	15.0	13.1	15.1	15.2	13.2	15.1	14.1	12.1	12.3
16	Sulphate	1.0	1.08	1.02	1.09	1.08	1.07	1.42	1.68	1.52	1.32	2.41	1.29	1.28	2.62	1.42	1.33	2.12	1.3
17	Phosphate	1.8	1.92	1.81	1.2	1.3	1.25	2.01	2.07	2.01	1.85	2.89	1.84	1.78	2.84	1.61	2.03	2.07	2.05
18	Nitrate	7.02	7.06	7.0	7.04	7.09	7.02	7.62	7.81	7.06	8.03	8.14	8.11	8.29	8.31	8.20	8.89	8.96	8.76
19	Nitrites	0.01	0.03	0.01	0.02	0.03	0.02	0.2	0.4	0.1	1.02	1.04	1.03	1.01	1.31	1.2	1.32	1.48	1.31

*All values are in mg/l except pH, Temp. (°C) & Conductivity (µmhos)

showed maximum value 1020 mg/ l in month of Aug at site S_2 and minimum value was recorded 358 mg/l at site S_1 in month of Jan 2007. Chloride content was found fluctuating between 16.02 mg/l to 21.01 mg/l. The maximum value was recorded in month of Aug at site S and minimum was at S_1 in month of Dec 2006. Total hardness range between 131 mg/l to 257 mg/l. The maximum value was observed in month of Sept 06 at site S_2 and minimum was in the month of Dec 06 at site S_1. It was may be due to presence of carbonates and bicarbonate.

Among the important nutrients Nitrates showed the range of 7.00 mg/l to 8.98 mg/l. The level was maximum in the month of Jan 2007 at site S_2 and minimum was in Aug 06 at site S_3. The level of phosphate ranges between 1.20 mg/l to 2.89 mg/l, values were maximum in Nov 2006 at site S_2 and minimum in Sept 06 at site S_1, may be due to dilution factor. Similar study was shown by Sanjeev (1991). Value of sulphate range between 1 mg/l to 2.62 mg/l. The maximum value was recorded in month of Dec 06 at site S_2 and minimum was recorded at site S_1 in month of Aug 06. In present study total alkalinity range between 158 mg/l to 219 mg/l. The maximum value was recorded at site S_2 in month of Dec 06 and minimum was at site S_1 in month of Sept 06. The values are within the permissible limit as suggested by WHO.

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Percentage generation and estimated energy content of municipal solid waste at commercial area of Janipur, Jammu

Subhash C. Gupta and P. Manhas
Department of Environmental Sciences, University of Jammu, Jammu

Abstract

The present study involves the analysis of percentage generation and energy content (kj/kg) of municipal solid waste. A regression equation was used for estimating the energy content of municipal solid waste and to correlate the energy content with variables derived from physical composition of solid waste. The regression equation is relatively simple than the modified Dulong equation (MDE), which is generally used for estimating energy content of municipal solid waste.

Keywords: *Municipal solid waste, Regression equation*

Introduction

Power industry has registered a phenomenal growth during the last three decades and investment in this sector has increased in a geometric proportion. Inspite of strong emphasis on the development of power sector, there has been a perpetual shortfall in the availability of power. This shortfall of energy has really become a major constraint in the develpoment of country, as it has severely affected our industrial and production enterprises.

Since the current energy crises has severely hit the socio-economic structure of developing countries including India, therefore energy output from indigenous commercial source have to be maximized and techniques have to be developed to explore the full potential of alternate sources of energy available within the country.

In this context, solid waste appears to be the most promising energy resource, as these are abundantly available, very inexpensive and renewable. Over 1000 million tones of solid waste are produced annually in our country, which can be converted into solid, liquid or gaseous fuel to cater the needs of four principal sectors viz; transport, household, industry and agriculture. So recycling of waste and their conversion into wealth have become very vital for the development of the country. Energy recovery from solid waste is on the upswing with a growing market share for the mass burning of fossil fuel (Agrawal *et al.*, 2004).

To evaluate the resource recovery and energy generating alternatives, the municipal solid waste energy content has to be essentially evaluated. The energy content of municipal solid waste is generally calculated by using modified Dulong equation (MDE). To use this method, percentage of waste components, such as food, paper, plastic and rubber etc. must be converted into percentage of carbon, hydrogen, oxygen and sulphur. But this conversion is a time consuming process.

Liu (1996) reviewed several relationships that have been applied to municipal solid waste. The limitation of the results of this analysis is that they are appropriate only for the specific type of solid waste. Khan and Ghararah (1991) developed a linear regression equation for predicting energy content values correctly and

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hence this is inadequate for estimating energy content for Indian cities.

The main objective of this paper is to present the calculated energy content values for the commercial area of Janipur, Jammu by regression equation which is an easier and simpler equation than MDE for estimating energy content of municipal solid waste.

The study area (commercial area of Janipur, Jammu) is situated to the north of Jammu city, comprised mostly of fruit/ vegetable shops and kirana shops. So, the bulk of waste is combustible and compostible in nature. The waste has great potential for energy. The conversion of waste to energy is a step towards cleaner environment with added advantage of providing some energy. Roy (1998) suggested recycling of municipal solid waste as a technique to create renewable source of energy and to solve disposal problem. Reid and Tittlebaum (1993) conclude that waste to energy conversion is necessary for energy recovery and waste minimization. Shah (1994) recommended the use of solid waste for energy generation to mitigate environmental problems.Though a lot of work has been done on generation, composition and management of solid waste from India and abroad by various workers, but no work seems to have been done on the study of solid waste at commercial area of Janipur. The present study will help to generate information on the generation, composition and estimated energy content of municipal solid waste and also help us to place before the management the problems arising out of its improper disposal.

Materials and Method

Study area: Commercial area of Janipur lies to the north of Jammu city. For the purpose of waste collection, study area was divided into four sites. Waste samples were collected at weekly intervals and segregated into different components and weighed separately with the help of spring balance. The components of waste identified in the analysis were straw, leaves, cardboard, food and fruit waste, plastic and polythene waste, glass, metallic containers and inert waste were present in the waste details of the MSW components for commercial area of Janipur as shown in the Table-1. The percentage by weight of different components was calculated and then the solid waste energy content (kj/ kg) was calculated with the help of regression.The regression equation, which uses the percentages by weight of MSW components directly in it is as follows:

$$EC = 37.658 + 241.054\,(PR) + 55.153\,(HF) + 174.87(PC)$$

Where,

EC = Energy content of waste (kj/ kg).
PC = Percentage weight of plastic and other synthetic materials.
HF = Percentage weight of straw and food waste.
PC = Percentage weight of cardboard/ paper.

The standardized co-efficient (241.054) is high for plastic and other synthetic materials which showed that plastic and other synthetic materials generate maximum energy from the waste.

Results and Discussion

During the course of present study on solid waste at commercial area of Janipur (Jammu), it has been observed that at Site-I energy content was found to be maximum during January- March (10505 kj/ kg) and

minimum during the months of April- June (6332.2 kj/ kg). The site-II showed the maximum value of energy content (8010.4 kj/ kg) during the months of April- June and minimum value (7059.8 kj/kg) were observed in the months of January- March.The energy content values at Site-III and at Site-IV were observed to be maximum during the months of April- June (8536.89 kj/ kg) and January- March (8173.94 kj/ kg) respectively.

Table-1: Percentage by weight of municipal solid waste components for four sites of commercial area of Janipur, Jammu and their computed energy contents (kj/kg)

Site-I

	Straw	Thread/ Cotton	Cloth/ Bits	Food/ Waste	Fruit/ Veg	Meat Waste	Wood Waste	Card Board	Plastic Waste	Energy Content
Jan-Mar	5.56	1.62	3.32	11.87	22	11.2	13.5	25.83	5.06	10505.1
April-June	8.03	0.59	0.67	9.00	19.21	8.56	6.71	12.43	4.03	6332.2
July-Sep	6.18	0.07	0.76	14.9	33.93	6.14	10.2	17.53	2.69	7892.1
Oct-Dec	3.30	0.10	0.53	9.62	26.9	8.98	12.2	24.07	4.33	8812.4

Site-II

	Straw	Thread/ cotton	Cloth/ bits	Food/ waste	Fruit/ veg.	Meat waste	Wood	Card-board	Plastic waste	Energy content
Jan- Mar	3.92	0.51	0.81	22.76	9.51	25.50	11.70	9.68	4.04	7059.8
April- June	3.96	0.67	0.38	19.66	10.40	20.60	7.26	17.57	5.10	8010.4
July- Sep	3.18	0.41	0.42	8.67	29.01	18.80	10.70	14.64	4.66	7806.3
Oct- Dec	4.07	1.12	0.85	14.58	8.878	26.30	7.07	16.67	3.19	7559.0

Site-III

	Straw	Thread/ cotton	Cloth/ bits	Food/ waste	Fruit/ veg.	Wood	Card-board	Plastic waste	Energy content
Jan- Mar	8.74	0.41	0.43	22.39	13.62	9.89	24.1	3.58	8328.5
April- June	3.91	0.61	0.29	19.65	20.71	9.24	20.2	7.89	8536.9
July- Sep	3.80	0.76	0.88	21.11	22.94	5.74	19.9	3.33	7669.0
Oct- Dec	6.97	0.25	0.71	29.33	13.08	6.74	19.0	7.86	8526.1

Site-IV

	Straw	Thread/ cotton	Cloth/ bits	Food/ waste	Fruit/ veg.	Meat waste	Wood	Card-board	Plastic waste	Energy content
Jan- Mar	2.71	0.54	0.91	17.39	13.77	23.90	3.38	21.17	2.94	8173.9
April- June	4.47	0.28	0.85	12.67	22.30	28.90	6.36	10.27	2.25	6773.1
July- Sep	5.72	0.54	0.66	33.03	18.01	15.90	5.24	14.88	1.74	7647.7
Oct- Dec	1.91	0.16	0.82	16.70	12.47	29.52	5.27	17.32	4.48	8015.6

At first three sites precentage by weight of plastic/ polythene was observed to exhibit the maximum value during the months which showed maximum value of energy content viz. 5.06% (January- March) at site-I;

5.10% (April- June) at Site-II and 7.89% (April- June) at Site-III. At Site-IV percentage of plastic/ polythene waste was observed to exhibit the maximum value during the months of October- December (4.48%) as compared to percentage of plastic polythene during the months of January- March (2.94%) which was observed to exhibit the maximum value of energy content, but the percentage of other synthetic materials e.g. cloth bits and cotton/ thread waste was observed to exhibit the maximum value of 0.53% and 0.91% respectively during January- March as compared to 0.16% and 0.825% of cloth bits and cotton/ thread waste respectively during October- December. This observation showed that plastic/ polythene waste and other synthetic material contains maximum energy content.

Further the total average solid waste kg/day was observed to be 585.57 kg, which contain average 7977.98 kj/ kg of energy content. Also, the average energy content was observed to exhibit the maximum values at Site-I (8385.25 kj/kg) and minimum values at Site-II (7608.92 kj/kg) (Table-2).

Table-2: Seasonal variation in average solid waste (kg/day) and average energy content (kj/ kg) at four different study sites of commercial area, Janipur (Jammu)

	Average solid waste					Average energy content				
	Jan.- Mar.	Apr.- June	July- Sept.	Oct.- Dec.	Average	Jan.- Mar.	Apr.- June	July- Sept.	Oct.- Dec.	Average
Site-I	620.47	661.83	697.24	578.9	639.61	10505	6332	7892	8812	8385.25
Site-II	644.49	788.58	953.67	822.64	802.34	7059.8	8010.42	7806	7559.08	7608.92
Site-III	363.23	320.57	517.61	394.73	399.03	8328.5	8536.9	7669	8526.17	8265.16
Site-IV	455.19	488.71	670.99	390.38	501.32	8173.9	6773.1	7648	8015.61	7652.59
Average	520.84	564.92	709.88	564.66	585.58	8516.8	7413.1	7754	8228.21	7977.98

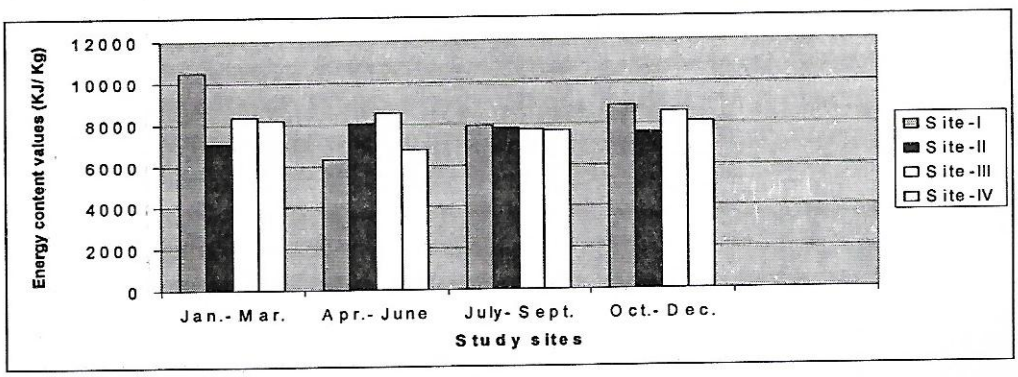

Fig. 1: Seasonal variation in energy content values at four study sites

During the course of present study it was also observed that solid waste collection system as employed in the study area was not satisfactory as it is open type. Further the number of storage bins were not enough as a result of which most of the waste is dumped near roadside or in the open plots e.g. solid waste at the Site-II of the study area is dumped near the children park thereby exposing children to various serious health hazards. Though the bulk of waste was organic in origin yet its decay provides breeding grounds

for flies and other disease causing vectors, thereby posing threats to the health of people residing in the vicinity. So, in order to avoid the harmful effects arising out of improper solid waste disposal, proper management should be done to maintain the beauty of the area. One of the useful methods of proper solid waste disposal is the conversion of waste to energy. It is a step towards cleaner environment with added advantage of providing some energy. Even though it will not make any significant dent in the overall energy situation, but waste conversion might make some contribution to overcome the present day energy crisis.

Tripathi *et al.* (2006), suggested vermicomposting for purposeful and systematic dealt with the problem of solid waste. Wal (2007) in an article on solid waste management disclosed a new technique for the conversion of plastic into substitute diesel. Vijifder (1985) also recommended the implementation of new methods for disposal of solid waste.

Conclusion

From the present study, it is concluded that waste obtained from commercial area of Janipur, Jammu, has a good potential of energy and this can be utilized for the production of energy in various forms. Improper solid waste disposal is creating environmental pollution and health hazards. The conversion of waste to energy seems to be on the right social tract.

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Maida leaf and Ama haldi– A potent ethnomedicine for bone fracture

Babli Singh, Manjulla Srivastava and T.P. Mall
Post Graduate Department of Botany, Kisan P.G. College, Bahraich (U.P.)

Abstract

A survey trip for Dudwa tiger reserve, Kheri Lakhimpur and Kakarha forest range, Bahraich along with M.Sc. Botany students was organized on November 24, 2006 and on January 05, 2007 respectively, to collect the ethnomedicinal plant and document their medicinal uses by native tribal people. This survey area is one of the hot spot of plant diversity representing north western tarai forest of Uttar Pradesh. We collected about 55 plants of ethnomedicinal importance belonging to different families. The most astonishing scene was observed in Dudwa when our vehicles were stopped near Banke tal in Sonaripur forest range and our drivers started to dug something. They were not in a position to waste their time for conversations with us. They want to collect the material in maximum quantity. We asked them not to do so because it is an offensive act. Our driver later told that the rhizome which they have collected is locally known as Ama Haldi and since it has countless ethnomedicinal uses, we try to keep always in house in one way or other. The most important information we got was that Ama Haldi is very useful in bone fracture along with Maida leaf. Later on the same driver introduced us about the Maida plant. We were later confirmed by our guide Mr. Baddal Singh Rana who is a local Tharu tribe, that if the poultice of Maida leaf along with Ama haldi is tide over bone fracture after setting the same by local orthopedic healer and taken orally also, the pain and inflation is vanished and the fracture heals within a very short span of time. We later identified Meda or Maida as *Litsea glutinosa* (Lour.) CB (Lauraceae) and Ama Haldi as *Curcuma amada* Roxb., (Zingiberaceae). In addition to the healing power of Maida leaf and Ama Haldi in bone fracture both have countless other ethnomedicinal uses especially Ama Haldi.

Keywords: *Maida Leaf, Ama Haldi, Bone fracture, Ethnomedicine*

Introduction

India possess a total of 427 tribal communities and over 275 papers have been published on specific ethnic group (Ignacimuthu *et al.*, 2006). There is large demand for medicinal herbs due to increase in the use of herbal formulations. Globally, about 85% of the traditional medicines used for primary health care are derived from plants. These herbal medicines are safe as well as eco friendly and have good values in treating many diseases including infectious diseases, hypertension etc. In India, the sacred Vedas, which date back between 3500 B.C. and 1800 B.C. give many references of medicinal plants. (Behera, 2006).

Rich phytodiversity and Tharu tribal population characterized Dudwa tiger reserve of Kheri district situated in North Western Tarai forest of Uttar Pradesh. The tribal people living in villages of Kheri district are greatly dependent on medicinal plants for variety of uses. Currently medicinal plants are under severe threat of extinction due to rapid deforestation, over and improper collection, over grazing etc. The tribal cultures of rural area are now fast changing due to transformation of traditional culture, so the present study is undertaken with a view to collect and document the ethnomedicinal plant and their uses by the tribals of the area. The study area lies between 28° 30' 60" N and 80° 41' 0" and comprises 884 km² of Kheri district. The Tharus of Kheri district live in villages situated in the vicinity of the Dudwa national park and adjoining the territory of Nepal. The district is bounded on the east by the district Bahraich, on the south by Sitapur and Hardoi, on the west by Shajahanpur and Pilibhit district, and on the north by the territory of Nepal seprated by the river Mohan. There are 41 Tharu villages in Kheri district, occupying an area of 8,149 hectare in the vicinity of Dudwa national park

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Materials and Method

For collecting the ethnomedicinal plant and documenting their ethnomedicinal knowledge by native tribals, a survey trip for Dudwa tiger reserve, Kheri Lakhimpur and Kakarha forest range, Bahraich along with M.Sc. Botany students was organized on November 24, 2006 and on January 05, 2007 respectively. Questionnaire method was adopted for documentation of traditional indigenous knowledge about medicinal plants and herbs. The collected plants were pressed, dried, preserved and mounted following the method as described by Jain and Rao, 1989. The collected plants were identified by the help of available literature (Joshi, 2000). All the collected and preserved plant specimens were deposited in the herbarium maintained in the department.

Results and Discussion

After the survey of Dudwa tiger reserve about 55 plant species belonging to different families were collected. Out of these species the present work concentrates on the ethnomedicinal value of *Litsea glutinosa* C.B. Robins. (Lauraceae) locally called as Maida and *Curcuma amada* Roxb. (Zingiberaceae) locally called as Ama haldi. Both wonderful plants were collected near Banke tal in Sonaripur forest range of Dudwa national park. Our guide Mr. Baddal Singh Rana is a local Tharu tribe, resident of village Muin Nuchani (a Tharu village) P.O. Parsia, P.S. Chandan Chauki, Distt. Kheri Lakhimpur. He told us about the medicinal use of Ama haldi and Maida plant that if the poultice of Maida leaf along with Ama haldi is tide over bone fracture after setting by local orthopedics and taken orally also, the pain and inflammation is vanished and the fracture heals with in a very short span of time. *Litsea glutinosa* C.B. Robins (Lauraceae) is locally known as Meda or Maida whose leaf is effective in bone fracture. The powdered bark mixed with water is warmed and applied as poultice to cure pain surrounding the umbilicus. (Maheswari *et al.*, 1986). We got only few tree of Maida during the survey of Kakarha forest range of Bahraich.

Curcuma amada Roxb. (Zingiberaceae) is locally known as Ambe halleda, Am haldi, Ama haldi. It is wild in parts of Bengal, Konkan, Tamilnadu as well as in north western tarai forest of Uttar Pradesh. The root with a bitter taste is diuretic, maturant, emollient, expectorant, antipyretic and appetiser. It is also used in inflammations, diarrhoea and gleet. Rhizome is acrid, hot anodyne, antirheumatic, carminative, cooling, aromatic, bitter, stomaichic, diuretic, aphrodisiac and astringent. It provides digestive power, cleans throat, tongue, dispels cardiac disorders and cures vomiting, cough, dyspnoea, anorexia, fever, anaemia, flactulence, colic constipation, dysuria, swelling and elephantiasis. It has specific action in rheumatism and inflammation of liver. Tubers are useful in purigo. They are used externally in the form of paste as on application for bruises and skin diseases (Joshi, 2000).

Forest is the reservoir of medicinal plants and play a vital role in the economy of the Tharus. The tribals of Kheri district are mostly dependent on forest wealth for their food, clothing, oil, fibre, housing and medicine. There are ample of evidence that increasing numbers of people across various parts of the world depends on traditional herbal remedies for their health care. The local uses of plants are in health care products are even much higher in particularly those areas with little or no access to modern health services (Saeed *et al.*, 2004). It is hoped that chemical analysis of the plant and their pharmatotherpuics will provide much lead role for future research and new drug development.

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Quantitative analysis of phytoplankton and zooplankton of Masala lake, Masala, Distt. Chandrapur, Maharashtra

P.M. Telkhade*, N.R. Dahegaonkar*, S.B. Zade and A.N. Lonkar*****
*A.C.S. College, Tukum, Distt. Chandrapur. M.S.
**M.B. Patel Science College Sakoli, Distt. Bhandara M.S.
***Nutan A.A.C. and Smt. M.H. Wegad Science College, Umrer Distt. Nagpur. M.S.

Abstract

Quantitative analysis of both phytoplankton and zooplankton have greater importance in limnological studies, Masala lake is situated at 6 km north east from Chandrapur city. The phytoplankton and zooplankton samples were collected from sampling site S_1, S_2 and S_3 in month of September 2006. At site S_1 the phytoplankton were found in larger number in comparison to sites S_2 and S_3, however at site S_3 the species variation is noted. About zooplankton the larger amount of zooplankton were reported at site S_2. Along with all these zooplankton some Nematode species were also noted, these species were *Diplogaster fictor* and *Rhabdolaimus minor*. In the present study the result of the quantitative analysis of both phytoplankton and zooplankton noted at different collection sites are discussed.

Keywords: *Quantitative, Phytoplankton, Zooplankton, Lake*

Introduction

Amongst the aquatic ecosystems the lake ecosystem have unique characteristics and importance. The lake water at many places used for drinking as well as for domestic purposes. Besides studying the physico-chemical parameters of lake water, the study of phytoplankton and zooplankton have equal importance. Various workers contributed their studies on this aspect such as Hutchinson, 1967; Prasadam, 1977; Jyoti and Sehgal, 1979; Balki *et al.*, 1984; Kaur *et al.*, 1999; Khanna and Bhutiani, 2003; Sawane *et al.*, 2006 and Veerendra *et al.*, 2006. Masala lake is situated at 6 km north east from Chandrapur city, Maharashtra. This lake has greater importance for its domestic use, so the study of biological parameters as quantitative analysis of phytoplankton and zooplankton were attempted at 3 collection sites.

Materials and Method

Lake Masala having earthen embankment from one side and have a additional attached depression site. The samples were collected in the month of September 2006 from collection stations, S_1, S_2 and S_3. For studying the quantitative analysis of phytoplankton and zooplankton at each collection site separately, 70 liters of water was passed through the plankton net. The plankton samples were preserved in 4% formaldehyde and brought in the laboratory for quantitative and qualitative analysis. With the help of broad mouth dropper the sample was transferred to the Sedgwick Rafter cell and the plankton were counted. The identification was made with the help of available current literature (Penak, 1978). The quantitative analysis are presented in Table 1.1 and Table 1.2.

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Observation

In the present study 12 species of phytoplankton and 7 species of zooplankton with their quantitative estimates were noted at collection station S_1, S_2 and S_3. The result of quantitative analysis of phytoplankton is presented in Table 1.1 and zooplankton is in Table 1.2.

Table 1.1: Quantitative analysis of Phytoplankton at collection stations S_1, S_2 and S_3

S.No.	Name of phytoplankton	Number of phytoplankton		
		S_1	S_2	S_3
1	*Spirogyra*	76	23	32
2	*Acanthes lanciolate*	67	16	21
3	*Anabaena*	69	74	88
4	*Nostoc linekia*	102	98	83
5	*Spirulina*	87	39	56
6	*Diatom vulgare*	103	78	94
7	*Phacus succica*	20	37	18
8	*Geodinium montanum*	37	46	30
9	*Closterium*	18	17	12
10	*Chlorocloster pirenigera*	22	188	24
11	*Dinobryon stipitatum*	-	-	7
12	*Volvox*	-	3	11

Table 1.2: Quantitative analysis of Zooplankton at collection stations S_1, S_2 and S_3

S.No.	Name of Zooplankton	Number of zooplankton		
		S_1	S_2	S_3
1	*Cyclops*	4	6	5
2	*Brachionus forficula*	12	14	17
3	*Keratella tropica*	9	11	7
4	*Asplanchnopus*	4	3	4
5	*Lepadella oralis*	1	4	3
6	*Diplogaster factor* (Nematode)	4	5	6
7	*Rhabdolaimus minor* (Nematode)	3	6	2

Results and Discussion

The phytoplankton were found more in number at collection station S_1, however the species variation is more at station S_3, where *Dinobryon stipitatum* was noted as well as more number of Volvox were noted. Khanna and Bhutiani, 2003 reported 3 genera of Cynophycae, Oscillatoria, Anabena and Nostoc. These were recorded highest in winter in Sitapur pond at Hardwar. Veerendra *et al.*, 2006 identified 34 species of phytoplankton under 4 classes, among them maximum density was recorded under Bacillariophyceae, Chlorophyceae, Cynophyceae and Euglenophyceae, in Mani reservoir, Hosangar, Karnataka. In the present investigation the phytoplankton Nostoc and Anabena are noted, the findings agrees with the findings of Khanna and Bhutiani, 2003, and Veerendra *et al.*, 2006. In the quantitative analysis of zooplankton 7 species of zooplankton were noted these includes *Cyclops*, *Brachionus forficula*, *Keratella tropica*, *Asplanchnopus*, *Lepadella oralis*, *Diplogaster fictor* (Nematode) and *Rhabdolaimus minor* (Nematode). Hutchinson, 1967 and Prasadan, 1977 noted presence of Cladocerons in lower profile in both annual cycle and such as no definite pattern of their variations were observed. However they are mostly abundant in winter and summer seasons.

Jyoti and Sehgal, 1979 and Balki *et al.*, 1984 observed Rotifera form the dominant zooplankton fauna in many aquatic habitats, Kaur *et al.*, 1999 identified 6 taxas of Protozoa, 12 Rotifers, 11 Crustaceans, 14 Insects, 7 Annelids, 8 Mollusca, 2 Nematodes, 1 Nemartina, from 6 sites of Kanjali lake from Nov. 1996 to March 1997. In the present work the Nematode species *Rhabdolaimus minor* and *Diplogaster fictor* are noted. Pathak and Mudgal, 2002 reported 19 species belong to Protozoa, Cladocera, Ostracoda, Copepoda and Rotifera. Sawane *et al.*, 2006 noted the 8 zooplankton species in Irai dam Chandrapur. These are *Difflugia*, *Cyclops*, *Diaptomus*, *Chydorus*, *Moina*, *Brachionus calciflorus*, *Brachionus fulcatus* and *Cypris*. The density of zooplankton were noted more in winter and less in summer. The present study showed that the phytoplankton *Nostoc linekia* and *Diatoms vulgare* are abundant in number and *Dinobryon stipitatum* are least. The species variation is more at collection station S_3. Amongst zooplankton *Cladoceras* are absent. *Brachionus* are found more in number and *Lepadella oralis* are least in number. It was noted that the Rotifers were present in larger number as well as the algae like Anabena and Nostoc were present, this shows the lake water may be contaminated with domestic pollutants. The plankton both phytoplankton and zooplankton were considerable present in good amount, it may be due to favorable physico-chemical conditions in the month of September or approaching winter as many worker noted abundance of plankton in the winter season.

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Ethnomedicinal investigations among Tribes of Vindhyan-Kaimur region of Uttar Pradesh

Ramesh Pandey*, Babli Singh and T.P. Mall****
*Katarniaghat Wild life Division, Bahraich (U.P.)
**Post Graduate Department of Botany, Kisan P.G. College, Bahraich (U.P.)

Abstract

The study was carried in Vindhyan Kaimur region of Uttar Pradesh, India, which is full of phytodiversity and nine tribal community. The aim of the study is to document the traditional indigenous knowledge of local inhabitants about use of native medicinal plants and herbs which are being utilized by the people for the treatment of their different ailments. The method adopted for documentation of indigenous knowledge was based on questionnaire, consisting of semi-structured interviews employing a checklist of questions and direct observations. The present report elucidates a rich and unique profile of phytodiversity of the research area surveyed with 81 plant species which belongs to 73 genera and 44 families.

Keywords: *Ethnomedicinal Plants, Folk medicine, Tribe*

Introduction

India presents a colourful mosaic of about 563 tribal communities which have acquired considerable knowledge of uses of plants for their livelihood and health care through their long association with forests, inheritance, practices and experiences. This is the only fact due to which the plants with medicinal properties enjoyed the highest reputation in the indigenous system of medicines for treatment of various ailments (Mehrotra, 1989). All plants of the earth have a potential medicinal value and is defined by the traditional definition of medicinal plants given in Ashtaanga Hardaya (600 A.D.) Sutra sathna Ch-9 verse 10 as:

"Jagatyeum anousdhamna,
kinchit vidyate dravyam,
Vashaanaarthayagayoh".

"There is nothing in this universe, which is non-medicinal which can not be made use of for many purposes and by many modes" (Shanker *et al.*, 2000).

This is the fact due to which plants have been in continuous use in one way or the other for the treatment of various ailments, but inspite of above fact there are various plants whose medicinal value is either not known or is confined to only few people because the knowledge is undocumented and transmitted orally from generation to generation. The present study is undertaken with a view to explore the possibility of utilizing the plant resources with special reference to ethnomedicinal plants for the economic development and upliftment of the native tribes and other new resources which are utilized by the people of the area. Vindhyan Kaimur region is very rich in plant resources and tribal population. The study area concentrates on ethnomedicinal value of plants and herbs that is used by the tribals of those area. The area lies between 24° 42' to 25° 3' 35" N° latitude and 83° 23' to 83° 24' 55" E° longitude in Chandauli district. The forest region is bounded on the north by Chandauli District, on the east by Bihar, on the south by Sonbhadra forest and on the west by Narayanpur, Ahraura and Mirzapur forest region of U.P. The total

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forest area is 74009.46 hectare, covering Sal forest, Tatiya seemavarti forest, Salai forest and Palash forest. The region is inhabited by a number of tribes namely Kols, Kharwars, Bhuiyas, Gond, Oraons,Panikas,Dharkars,Ghasias and Baigas are totally dependent on plants and plant resources for their livelihood. The tribals collect and utilize different plant species growing in their vicinity and in the forest for food, fibre and medicine.

Materials and Method

Plant collection and preservation

Frequent field trips in different seasons were arranged in order to collect information about the ethnomedicinal uses of plants by the local people from January 04 to December 05. The specimens were collected, pressed, dried, preserved, mounted and identified through the available taxonomic literature manuals and floras. The specimens were deposited in the herbarium maintained by the DFO of the region. The data taken in the field was transferred to the slip pasted on the herbarium sheets.

Survey of traditional knowledge

Questionnaire method was adopted for documentation of folk indigenous knowledge. The interviews were carried out in local community to investigate local people and knowledgeable local healers, village Pradhans and elder persons viz Hakims, Women, Ojhas who are the main user of medicinal plants. About 100 informants have been interviewed on random basis. The people having traditional knowledge of utilization of indigenous medicinal plants have been selected as reference.

Results and Discussion

The data on 81 ethnomedicinal plants species belonging to 73 genera and 44 families were collected in different season. Information regarding their botanical name, vernacular name, family, parts used ethnomedicinal use and their status in the region are listed in the check list (Table-1).

Herbal medicine, there pharmacognostic characterization and their uses are actually the culture assets lying viable and remained preserved in the remote cut off areas like Vindhyan Kaimur region which has a diverse flora having several hundred species of higher plants. A large number of species are being used as medicinal and aromatic plants. In India more than 80% of the people belonging to the rural areas still depends upon herbal medicines specially to prevent abortion, achieve easy delivery, eye, gastric and respiratory problems, fever, antidote for snake and scorpion bites, sunstroke, arthritis, rheumatism, hydrocoel, toothache, bodyache, cough, dysentery, jaundice, induce sleep, sexual power and sexual diseases. In recent years, more efforts have been made to document the traditional knowledge.

The people of the area are entirely rural and mostly poverty-stricken, under nourished and illiterate. They have to cut forests to sell timber and fuel wood. As a result several plant species are disappearing at an alarming rate. A number of medicinal plants like *Acorus calmus, Rouwolfia serpentina, Chlorophytum tubrosum, Litsea glutinosa, Plumbago zeylanika, Sterculia urens, Withania sominifera* are on the verge of extinction due to over exploitation. The conservation programmes can protect the medicinal plants with the help of local people. Regeneration of plants is also badly affected due to heavy grazing. The local

people and researcher face the challenging task of not only recording knowledge of plants but also applying the results to their studies to biodiversity conservation and community development. Most of the species are under severe pressure due to their extensive uses in many fields. The community people collect these plants with an unmechanised method because of their great medicinal importance. So there is a necessity for the conservation of all the medicinal plants. It is hoped that chemical analysis of the medicinal plants and their pharmacotherapeuties will provide much needed lead for further research and new drug development.

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Table 1: Medicinal plants of Vindhyan- Kaimur region of Uttar Pradesh

S.No.	Botanical Name	Local Name	Family	Parts used	Ethnomedicinal Use	Status of Plant in the Region
1	*Acacia catechu* (L.f.) Willed	Khair, Khairo, Kehera	Mimosaceae	Leaves, Stem	The decoction of heart-wood and tobacco leaves are mixed with cow dung and inhaled three times a day for three days to stop nose bleeding.	Sufficient
2	*Acacia nilotika* (L.) Willed ex. Del.	Babul, Kikar	Mimosaceae	Stem, Bark	Bark is used in asthma, bronchitis, leucorrhoea, dysentery, leucoderma and skin diseases.	Sufficient
3	*Acoras calmus* L.	Bach	Araceae	Rhizome, leaf	The rhizome is chewed for curing bronchitis, cough and cold. Leaf paste is applied externally on wounds of animals to kill the worms.	Endangered plant species, need of conservation
4	*Adansonia digitata* L.	Gorakh-imali	Bombacaceae	Leaves	Tender leaves of plants are applied over inflannations to reduce burning and pain of swellings.	Insufficient need of conservation
5	*Albizzia libbeck* (L.) Benth	Siris	Mimosaceae	Bark, leaves	The plant used in snake bite and scorpion sting. Root is used in hemicornia. Leaves are good for opthalmia and flowers for chronic cough and asthma.	Need of conservation
6	*Alstonia paniculata* (L.) R. Br.	Saptpaji Satpami	Acanthaceae	Bark, leaves	Decoction of leaves is used in Beriberi Bark is Stimulant carminative, cures gastro intestinal troubles.	Need of conservation
7	*Andrographis paniculata* (Burm.f) Wall. ex. Nees	Kalmegh, Chiretta	Acanthaceae	Whole plant	The herb is used for bronchitis dyspepsia, influenza etc. The decoction of plant and the powder of seeds is used in fevers.	Sufficient
8	*Aristolochia indica* L.	Kali gulisar	Aristolochiaceae	Roots, Stem	Dried roots and stem of plant constitute the drug which is used in small doses. Drug promotes digestion and regulation.	Insufficient need of conservation
9	*Artocarpus heterophyllus Lamk.*	Kathal	Moraceae	Root, leaves	Roots are used for toothache and are useful in skin diseases, sores and sterility in women.	Sufficient
10	*Asparagus racemosus willed*	Satawar	Liliaceae	Root	It is mainly use to increase milk in animals and ladies.	Insufficient need of conservation
11	*Azadirachta indica* A. Juss.	Neem	Meliaceae	Leaves, bark	The poultice of leaves and bark is applied externally on boils as antiseptic.	Sufficient
12	*Baliospermum montonum* (Willd Muell-Arg)	Danteemul	Euphorbiaceae	Root	Roots are used in dropsy and jaundice.	Insufficient need of conservation
13	*Bauhinia variegata* L.	Kachnar	Caesalpiniaceae	Bark	The bark is alterative, tonic, blood purifier and astringent, its decoction is being given in ulcers, syphilis, leprosy and other skin disease.	Sufficient
14	*Boerhavia diffusa* L.	Purvanivamul	Nyctaginaceae	Whole plant	Decoction of plant (15ml) is given once a day in the early morning for fifteen days for the treatment of Leucorrhoea and dried plant powder is smoked as cigarette once a day for the treatment of Astluma.	Sufficient
15	*Bombax ceiba* L.	Semal	Bombaceae	Fleshy roots	Paste of fleshy roots of young plant (1gm) mixed with unboiled cow milk (2ml) is taken once a day in the early morning for a week by women to regularise irregular menstruation.	Sufficient
16	*Buchanania langan* Spreng.	Chironji	Anacardiaceae	Leaves, fruit	It is used in fever, burns, cholera, bronchitis and asthma. Root is acrid removes Kapha and biliousness.	Insufficient need of conservation

Contd...

17	*Butea monosperma* (Lamk) Taubert	Tesuphool	Papilionaceae	Bark, Seed	The decoction of bark is given three times a day to cure dysentery. Its seed and those of 'Neem' (*Azadirachta indica*) are powdered together and given to animals to kill worms.	Need of conservation
18	*Cuscuta reflexa* Roxb	Amarbel	Convolvulaceae	Whole plant	Plant paste (2gm) with paste of long pepper (*Piper longum*) (1gm) is applied on the swelling portion of scortum before going to bed for the treatment of Hydrocele.	Sufficient
19	*Cassia tora* Linn	Chakunda	Caesalpiniaceae	Leaves	Leaves pounded and applied on cuts act like tincture iodine applied against eczema.	Sufficient
20	*Carissa carandus* L.	Carounda	Apocynaceae	Root	It is used in paralysis.	Need of conservation
21	*Costus speciosus* (Koenig) Smith	Kenvati	Zingiberaceae	Tubrous roots	Tubrous root stock are used for sexual problems.	Need of conservation
22	*Cardiospermum helicacabum* L.	Kavani gul fulla	Sapindaceae	Whole plant	Plant is used for stiffness of limbs and leaf juice is used as cure for ear-ache.	Need of conservation
23	*Cassia fistula* L.	Amaltas	Caesalpiniaceae	Root	The powdered root mixed with water is taken orally as an antidote to snake bite.	Sufficient
24	*Chlorophytum tubrosum*	Safed musali	Liliaceae	Rhizome	Root of plant has a pungent bitter and acrid taste and is antispasmodic, carminative, expectorant, febrifuge and tonic.	Insufficient need of conservation
25	*Clerodendron phlomoids*	Agadi	Verbenaceae	Tuber	The paste of leaves are used to cure in wounds.	Need of conservation
26	*Coccinia indica* Wight and Arm	Kandari	Cucurbitaceae	Whole plant	Plant is alterative ad used internally in gonorrhoea. Juice of plant cures ear pain.	Need of conservation
27	*Corallocarpus opigaeus* (Rottl and Willd) Clorke.	Kaira, Mirichiakand	Cucurbitaceae	Roots	Roots are used in dysentery and rheumatism.	Need of conservation
28	*Curculigo orchiodes* Gaertin	Kali-musali	Amarlidaceae	Tubrous roots and rhizome	Roots are alterative and tonic and rhizome is used in piles, jaundice, asthma, diarrhoea and gonorrhoea.	Insufficient need of conservation
29	Cyprus rotundus	Nagarmotha	Cyperaceae	Tuber or bulbous roots	It is used for indigestion and in diarrhoea	Sufficient
30	*Datura stramonium* L.	Dhatura	Solanaceae	Whole plant	The plant is used to improves digestion, cures skin diseases such as itching, scabies, ulcers and leprosy. Leaves and seeds are useful in respiratory ailments, rheumatism and eye-diseases,	Sufficient
31	*Eclipta alba* L.	Bhringraj	Asteraceae	Whole plant	The plant is good for the hair and skin, expels intestinal worms, cures cough and asthma and strengthens body.	Sufficient
32	*Elephantopus scaber* L.	Sahus muli	Asteraceae	Roots	The roots are used in healing of wounds and to cure filaria.	Insufficient need of conservation
33	*Emblica officinalis* Gaertn.	Aanwala	Euphorbiaceae	Fruit	The aqous extract of fruits mixed with the fruis of Harr (*Terminalia Chebula*) and Bahera (*Terminalia bellirica*) is used in constipation.	Sufficient

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34	*Ficus bengalensis* L.	Bargad	Moraceae	Bark	An infusion of bark cures dysentery nervous disorders, diarrhoea, leucorrhoaea and reduces blood sugar in diabetes.	Sufficient
35	*Ficus glomerata* Roxb.	Gular	Moraceae	Whole plant	It is highly efficacious in threatened abortions, menorrhagia or flodding and failure of lactation, gonorrhoea, skin diseases and ulcers.	Sufficient
36	*Ficus religiosa* L.	Peepal	Moraceae	Whole plant	The plant parts used in mouth sores, atrophy, emaciation, rheumatism small in urine, spermatorrhoea, gravel, cholera etc.	Sufficient
37	*Fumaria indica* L.	Pitta papda, parpat	Fumariaceae	Whole plant	The dried plant is used as anthelmintic, diuretic and diaphoretic.	Insufficient need of conservation
38	*Gloriosa superba* L.	Kali hari	Liliceae	Tuber	Tuber are used in medicines as anthelmintic and leaf is used to kill lice in hair.	Need of conservation
39	*Grewia asiatica*	Dhamin	Teliaceae	Root	The root decoction is given in urinary troubles.	Insufficient need of conservation
40	*Gymnema sylvestre* L.	Gurmar (Affo)	Asclepidaceae	Root and Leaves	Root and Leaves are used in stomach pain.	Need of conservation
41	*Helicteres isora*	Marorphali	Sterculiaceae	Root, bark	Juice of roots is benefical in stomach affections and used in diabetes. Bark is used for diarrhoea and dysentery .	Insufficient need of conservation
42	*Holorrhena antidysenterica* (Roth) A.DC.	Indra jav	Apocynaceae	Bark	The bark decoction is given orally in the morning for 7 days in the treatment of malarial fever.	Need of conservation
43	*Holoptelea integrifolia* (Roxb) Planch.	Chilbil	Euphorbiaceae	Stem bark	Stem bark is tied on arm to cure hydrocoel.	Sufficient
44	*Lannea coromandelica* (Houtt). Merr.	Zinghan	Anacardiaceae	Bark	The bark decoction is applied on wounds for healing.	Sufficient
45	*Leea macrophylla* Roxb. ex Hornem	Badi Hansia	Leeaceae	Roots	Roots are used as remedy for ring worm and in cure of guinea worm.	Insufficient need of conservation
46	*Litsea glutinosa*	Med	Lauraceae	Seed	It is used in medicines for curing rheumatism and bark is used in diarrhoea and dysentery.	Endangered plant species, need of conservation
47	*Mangiphera indica* Lim,	Aam	Anacardiaceae	Leaves	Leaves are acrid, astringent cure for vaata, pitta, and kapha and are used in scorpion sting.	Sufficient
48	Martynia annua L.	Hathajori	Martyniaceae	Leaves	Leaves are used in epilepsy and applied to tuberculous glands of the neck.	Need of conservation
49	*Mallotus philippinensis* Muill-Arg.	Rohini	Euphorbiaceae	Fruit	The powder obtained from the fruits and mixed with coconut oil is applied externally as an antiseptic in skin diseases.	Need of conservation
50	*Moringa oleifera* Lam	Sahjana	Moringaceae	Bark, Root	The paste of root bark is applied on boils for supperssion as well as suppuration.	Sufficient
51	*Melothria heterophylla* (Lour.) Cogn.	Gulakhari	Cucurbitaceae	Tubrous root	Decoction of root is useful in toothache.	Insufficient need of conservation
52	*Murraya koenigii* L. Spreng	Kadi patta	Rubiaceae	Roots and bark	Bark and root are stimulant externally used to cure eruptions and bites of poisonous animals.	Sufficient
53	*Nyctanthus arbortristis* L.	Harsinghar	Oleaceae	Whole plant	The plant is cholagogue and laxative.	Need of conservation

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54	*Ocimum basilicum* L.	Van-Tulsi	Lamiaceae	Whole plant	It cures disorder due to kapha, vaata, dyspepsia, cough, bronchitis, intermittent fevers. Seeds are used in dysentery and diarrhoa.	Sufficient
55	*Operculira turpenthum* L.	Nishoda	Convolvulaceae	Root	The white tuberous root is used as a mild hydragogue in chronic constipation, enlargement of the spleen and other disorders.	Insufficient need of conservation
56	*Plumbago zeylanika* L.	Chitawar	Plumbaginaceae	Root and Milky Juice	Root is an appetizer, used in skin diseases, diarrhoea, piles, Milky juice is used as application in scabies and ulcers.	Endangered plant species, need of conservation
57	*Phyllanthus niruri*	Bhumi aawala	Euphorbiaceae	Whole plant	It is used as diuretic in dropsical affections, gonorrhoea and other troubles of genito urinary tract. Fresh root is remedy for jaundice.	Need of conservation
58	*Piper longum* L.	Pipali	Piperaceae	Unripe fruit	It is given with honey to indigestion, dyspepsia, cough bronchitis, asthma, cholera, fever, leprosy, piles etc.	Need of conservation
59	*Pterocarpus masupium* Roxb.	Vizaya-Sal	Fabaceae	Leaves and gum	Leaves are applied on sores and boiles. Gum is used in diarrhoea and for toothache.	Need of conservation
60	*Rauwolfia serpentina* (L.) Benth	Jhabarbarua	Apocynaceae	Roots	The roots are used in fever as an antidote to snake bite.	Need of conservation
61	*Sapindus emarginatus* Vahl	Reetha	Sapindaceae	Roots	Roots and bark are used as mild expectorant and demulcent.	Insufficient need of conservation
62	*Schrebera swietenoides*	Jamarali	Oleaceae	Stem bark	The decoction of stem bark is used to cure mental depression.	Need of conservation
63	*Schleichera oleasa* (Lour) Oken.	Kusum	Sapindaceae	Stem bark	The stem bark is warmed and used as a poultice to cure rheumatic pains.	Need of conservation
64	*Smilax zeylanica* L.	Ramdatun	Smilacaceae	Root	It is used in sexual troubles.	Need of conservation
65	*Sterculia urens*	Karmahra	Sterculianceae	Powder root	The powder root of young plant is mixed with water and given orally to pregnant women at the time of childbirth for easy delivery.	Endangered plant species, need of conservation
66	*Sterculia foetida* L.	Jangli badam	Sterculiaceae	Gum	It is used in rheumatism and dysentery.	Need of conservation
67	*Strobilanthus ciliatus*	Kaira	Acanthaceae	Rhizome	Rhizome is used as antidote in snakebite.	Insufficient need of conservation
68	*Shorea robusta* Gaertn. f.	Sal	Dipterocarpaceae	Gum	The gum mixed with curd is given in dysentery.	Sufficient
69	*Soymida febrifuga* A. Juss	Rohini	Meliaceae	Bark	The powdered bark is mixed with water and given to cattle to cure diarrhoea and body inflammation.	Need of conservation
70	*Syzygium cumini* (Linn.) Skeels.	Jamun	Myrtaceae	Bark and seed	A decoction of bark and seeds is useful in diarrhoea and dysentery.	Sufficient
71	*Tamarindus indica* L.	Imali	Caesalpiniaceae	leaf	The leaf juice is applied on eyes to cure inflammation .	Sufficient

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72	*Terminalia allata*	Asan	Combretaceae	Bark	The powdered bark is applied for healing of cuts and wounds.	Need of conservation
73	*Terminalia* arjuna (Roxb.) Wight & Arn.	Arjuna	Combretaceae	Stem bark	The decoction of the stem bark. mixed with the decoction of seeds of 'Sakhu' (*Shorea robusta* Gaertn) and 'Anar' (*Punica grnatum* L.) is used in dysentery.	Need of conservation
74	*Terminalia chebula* Retz.	Harara	Combretaceae	Fruits	Fruits are also used in medicines as laxatives, stomachic, tonic and purgative.	Need of conservation
75	*Terminalia bellirica* Gaertn	Baheda	Combretaceae	Fruit pulp	Fruits pulp is used in drops, diarrhoea and leprosy, and holy ripe fruit as purgative.	Insufficient need of conservation
76	*Tinospora cordifolia* (Willd.) Miers ex Hook. f & Thoms.	Gumuchi	Menispemaceae	Stem	The aqueous extract of the stem is given to cure nocturnal emission and to impact strength.	Insufficient need of conservation
77	*Urgenia indica* (Roxb.) Kunth	Kad, Kanda	Liliaceae	Bulbs	Alcoholic extracts of the bulbs posses against human epidermal carcinoma.	Insufficient need of conservation
78	*Ventilago-maderspatane* (Gaerten)	Gulisar	Rhamnaceae	Root bark	Root bark is stomachic, tonic and stimulant.	Need of conservation
79	*Withania sominifera* (L.) Dunal	Asagandha	Solanaceae	Root	It is useful in cough, dropsy, leucorrhoea and menstrual troubles. It restores loss of memory and is used in cases of nervous exhaustion spermatorrhoea and senile debility.	Endangered plant species, need of conservation
80	*Ziziphus jujuba* L.	Ber	Rhamnaceae	Fruit and Leaves	The plant root is bitter and cooling cures kapha, biliousness and headache.	Sufficient
81	*Ziziphus oenoplia* L. Mill	Makoya	Rhamnaceae	Stem bark	Mixture of decoction of stem bark (3ml) with paste of long peppers (*Piper longum*) (2gm) is taken with empty stomach in early morning for cure of dysentery .	Need of conservation

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Water quality assessment of Neri nala at Durgapur, Distt. Chandrapur of Maharashtra

P.M. Telkhade*, N.R. Dahegaonkar* and S.B. Zade**
*Department of Zoology, Arts, Com. & Science College, Tukum Distt. Chandrapur. M.S.
**P.G. Department of Zoology, M.B. Patel Science College, Sakoli Distt. Bhandara. M.S.

Abstract

The Neri nala is a small rivulet flowing between Chandrapur and Durgapur cities. Seasonal Studies were made to know the water quality of this small rivulet for assessing the water quality parameters viz. BOD, COD, TDS, Chloride, Sulphate, Phosphate along with other physico-chemical parameters. The additional burden to this small rivulet is received from washing, bathing and other domestic activities of adjoining slums. The studies indicate the polluted status of this rivulet due to inputs from adjoining localities and the degraded water quality, subsequently points out that it is unfit for bathing or any other activity. The presence of phosphate in large quantity originates due to surfactants utilized by local slum dwellers which might cause the eutrophication problem in long run.

Keywords: *Neri nala, Surfactant, Eutrophication*

Introduction

The Neri nala is a small rivulet which is situated about 2.5 km away from Chandrapur city. The slum area is situated on both the sides of this rivulet. The surrounding locality uses water for bathing, washing and other domestic purposes. The water after utilization is directly discharged into this rivulet which contain harmful detergents and domestic wastes. The study of water pollution of this rivulet has not been reported earlier, so keeping this in view, the present communication is an attempt to study the water quality. The samples were taken in month of March (summer) and August (monsoon) to study the physico-chemical variations during premonsoon and monsoon season. The present study deals with the assessment of different physico-chemical parameters like DO, BOD, COD, TDS, Chloride, Sulphate, Phosphate and other parameters of relevance. The assessment of these parameters is vital for knowing the water quality thoroughly.

Materials and Method

Water samples were collected from three sampling stations viz. station S_1, S_2 and S_3 once in a month of March and August for estimation of various physico-chemical parameters. Samples were collected and analysed according to APHA (1998). The samples were analysed within few hours of collection. The pH, Temp. and DO were measured on the spot. Determination of Chloride, Sulphate, Phosphate etc. were carried out by following standard methods in the laboratory.

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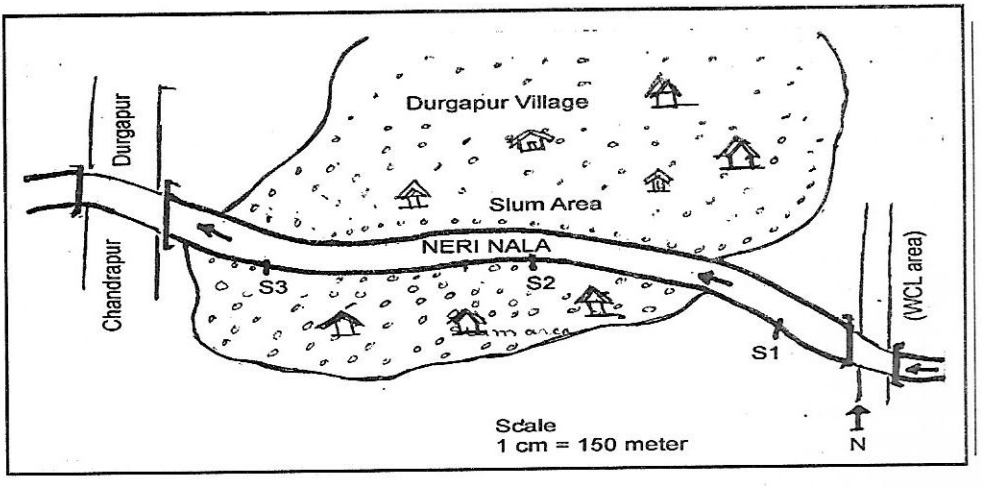

Fig. 1: Sampling station of Neri nala

Table 1.1: The parameters estimated and methods used are given in table

S.No.	Parameter	Method/ Equipment utilized
1	Temperature	Direct measurement on site by thermometer
2	pH	pH meter (Model- EQ- 610)
3	Conductivity	Conductivity meter (Model-EQ-660)
4	Alkalinity	Titrimetric method
5	DO	Modified Winkler's iodide- azide method
6	BOD	Modified Winkler's iodide (as per std. method)
7	CO_2	Titrimetric method
8	COD	Titrimetric method
9	TDS	Gravimetric method
10	Chlorides	Argentometric method
11	Sulphate	Spectrophoto meter (EQ- 820)
12	Phosphate	Spectrophoto meter (EQ- 820)

Results and Discussion

Variations of physico-chemical characteristics during March and August months are given in Table 1.2. The waters were discharged in the Neri nala from surrounding village Durgapur. The chemical analysis of the nala water showed that it is rich in organics as reflected by high BOD & COD values. Temperature is basically important for its effects on a certain chemical and biological activities. In present study maximum temperature was recorded 32.22 °C in month of March at site S_3 and minimum temperature recorded 28. 00 °C in month of August at site S_2.The temperature showed an inverse relationship with the dissolved oxygen, which is consistent with result reported by Das and Shrivastava, 1956 and Khanna , 1997. pH is the scale of intensity of acidity and alkalinity of water and measures the concentration of hydrogen ions. Maximum pH values recorded in month of August was 7.62 at site S_2 and minimum pH value recorded in

Table 1.2: Physico-chemical Parameters of Neri nala in summer and monsoon month (March 2006 and August 2006)

S.No.	Parameter	March			Mean	August			Mean
		S_1	S_2	S_3		S_1	S_2	S_3	
1	Temp. (^{0}C)	32.1	32.17	32.22	**32.16**	28.5	28.0	28.02	**28.17**
2	pH	7.02	7.06	7.12	**7.06**	7.3	7.62	7.46	**7.46**
3	Alkalinity (mg/l)	89.0	96.0	102.0	**95.66**	42.9	45.77	46.96	**45.21**
4	Conductivity	530.0	580.0	610.0	**573.33**	410	422.0	489.0	**437.0**
5	DO (mg/l)	3.8	4.1	4.6	**4.16**	5.8	6.7	7.1	**6.35**
6	BOD (mg/l)	12.24	13.05	13.89	**13.6**	15.6	17.2	17.89	**16.71**
7	CO_2 (mg/l)	8.02	9.11	12.1	**9.74**	5.21	6.29	7.62	**6.37**
8	COD (mg/l)	10.9	11.18	11.89	**11.32**	8.2	9.67	10.2	**9.29**
9	TDS (mg/l)	290.0	379.0	420.0	**363.0**	490	580.0	632.0	**567.33**
10	Chlorides (mg/l)	21.22	22.89	24.22	**22.72**	34.0	35.5	36.2	**35.23**
11	Sulphate (mg/l)	3.2	3.6	3.7	**3.5**	2.0	2.29	2.4	**2.48**
12	Phosphate (mg/l)	5.0	5.2	5.8	**5.4**	3.2	3.7	3.85	**3.58**

month of March was 7.02 at site S_1. Identical results were reported by Sangu and Sharma, 1985 and Prapurna and Shashikanth, 2002. The high pH in rainy season is due to dissolved organic substances from the catchment area. During the study, the highest concentration was observed in month of March at site S_3 102.00 mg/l and lowest concentration was observed in month of August 42.90 mg/l at site S_1. Alkalinity was mainly due to bicarbonates throughout the year, similar observations have also been reported by Holden and Green, 1960 and Venkateshwarlu and Jayanti, 1968.

On the basis of the data obtained from the water sampling, conductivity range in month of March was 573.33 µmhos/cm^2 and in month of August was 437 µmhos/cm^2. The dissolved oxygen and free carbon dioxide are usually inversely related to one another because of the photosynthetic and respiratory activities of the biota (Hynes, 1970). Dissolved oxygen is one of the important parameter in water quality assessment. The DO was found to be maximum 7.1 mg/l in month of August at site S_3 and minimum 3.8 mg/l in month of March at site S_1. The high temperature and low dissolved oxygen during summer, was also reported by Badola & Singh (1981) in the river Alaknanda.

The free carbondioxide is released during the decomposition of certain substances and metabolic activities of living organism, since high temperature accelerate the decomposition of organic substances as well as respiratory activity of the biota. The carbondioxide maximum value recorded in month of March was 12.1 mg/l at site S_3 and minimum value recorded in month of August at site S_1 was 5.21 mg/l. This phenomenon was also reported by Quadri and Shah, 1984. BOD determination is a most useful technique to assess the level of organic pollution in water. The maximum BOD was observed 17.89 mg/l at site S_3 in month of August and minimum 12.24 mg/l in the month of March at site S_1, the same trend was reported by Raina *et al.*, 1984. Chemical oxygen demand is the amount of oxygen required to oxidize all the organic material. It was noted maximum in month of March i.e. 11.89 mg/l at site S_3 and minimum 8.20 mg/l in month of August at site S_1. Total Dissolved solids cause ecological imbalance in the aquatic ecosystem by mechanical abrasive action. In present study, it was noted that TDS was maximum 632.00 mg/l in month of August at site S_3 and minimum 290.00 mg/l in month of March at site S_1. Similar condition was also reported by Verma

and Shukla, 1969; Zingde *et al.*, 1980. Chloride is one of the important chemical indicator of pollution in present study. The maximum value 36. 22 mg/l noted in month of August at site S_3 and minimum value 21.22 mg/l in month of March at site S_1. The similar result was also reported by Raina *et al.*, 1984.

The major sources of phosphates are domestic sewage, agricultural run off and detergents and phosphate are normal constituent of human excreta. Phosphates in large quantity indicates pollution through sewage. In the present study maximum phosphate concentration is 5.8 mg/l in month of March at site S_3 & minimum concentration recorded 3.20 mg/l in month of August at site S_1 which is due to dilution by rain. Sulphate is an important component in protein metabolism and plays important role in growth of plants. Maximum sulphate concentration recorded in present study is 3.7 mg/l in month of March at site S_3 & minimum sulphate concentration recorded 2.00 mg/l in month of August at site S_1, which is due to dilution.

In the present study values of physico-chemical parameters BOD & COD show excess values. Also phosphate and sulphate are noted to be high and it indicates that water is polluted. Pollution of water due to various agencies is one of the important cause to increase a number of blue green algae. These conditions promote eutrophication of water at a rapid rate due to which water is unsuitable for drinking, washing and bathing purpose (Wilhm and Dorris, 1968). From the present study it is noted that there is a definite impact on the water quality of Neri nala due to adjoining slums and their household discharges. Also there is a dilution effect due to rain in monsoon.

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Folk remedies against several human disorders by *Eclipta alba* (L.) Mant.

Manjulla Srivastava and S.C.Tripathi
Department of Post Graduate Studies and Research in Botany
Kisan P.G. College, Bahraich, U.P.

Abstract

The communication deals with the traditional knowledge of *Eclipta alba* (L.) Mant. used by tribal people of our study area i.e. Mihinpurwa block of tehsil Nanpara of Bahraich, a terai district of U.P. This area is very rich in ethnic as well as floristic diversity. The inhabitants of the area have inherited a rich traditional knowledge of the use of this herbaceous flora for cure and care of various human ailments. Important ethnomedicinal uses of flora, parts utilized, local name and mode of treatment has been included in this paper.

Keywords: *Eclipta alba (L.) Mant., Ethnic, Herbaceous flora, Tribals*

Introduction

Study of ethnobotany in itself is a very intricate or convoluted process. India represents one of the most important center of knowledge with special reference to knowledge of plant species for various ailments, examples are the Ayurveda, Unani and Siddha system of medicinal care. To lesser the burden on both human and environment and to make our mother earth safe for future generations indigenous or inherent technical knowledge should be given more emphasis and prominence. The geological area of Bahraich is 5026.6 Km^2 and it is located at 27° 04' to 28° 24' N latitude and between 81° 03' to 83° 13' E longitude. The surveyed villages of Mihinpurwa block i.e. Phakeerpur, Aama, Lohari, Sahoni and Baligaon of Nanpara tehsil is having good population of tribal people i.e. mainly "Tharus". These villages are situated near forest and they are original settlers (Jain, 1987). It is also important to quote here that the knowledge of tribals regarding plants has descended from one generation to another, as a domestic practice (Brahmam, 2000).

Materials and Method

The study is based on field survey which was carried during July 2006 to July 2007 of Nishangada forest of Kakraha range of district Bahraich. Out of 50 collected floras, this potent medicinal flora locally called as "Bhangaria" by tribal people was collected. The tribal ladies named as Phool Kumari, Pooja Chaudhary and Man kumari Chaudhary were working as labours in the forest. They informed us about the use of different remedial properties regarding various human disorders. The collected plant were identified correctly with the help of available literature, *i.e.* Maheswari, 1986; Jain, 1987; Duthie, 1994; Cooke, 1998; Singh *et al.*, 2000 and Joshi, 2000. The herbarium of plant species was prepared scientifically following the method described by Jain and Rao,1976 and maintained in department for record and reference. A questionnaire was prepared containing the information about the tribal people, their living style, source of income and mode of disease treatment.

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Results and Discussion

The study was based on indigenous knowledge of herbaceous flora. The tribal people of the study area told that plant is used for treatment of hair, eye and skin diseases. Fresh juice of leaves is rubbed on head scale for healthy and black hairs. The mixture of Triphala powder and Bhangaria juice is mixed and dried in shade, 1.5 gm of this paste is daily applied on hair in morning for black hairs, it also controls whitening of hairs in young generation which is a frequent problem. The tribal people told that this wild flora is very effective in certain skin problems, fresh juice of leaves is rubbed on burning symptoms of hand and legs. It is also useful in itching and swelling on body. The mixture of 10 gm leaves of bhangaraia, 10 gm Javasa, 60 gm chiraita and 60 gm sarfoka are made paste in 100 gm of water, it is filtered and mixed with 20 gm honey. This mixture is applied three times in a day for curing eye problems. 10 gm of dried powder of leaves is mixed in 3 gm honey and 3 gm Ghee of cow milk, it is applied in night for 40 days at sleeping time, it cures every problems related to eyes. The present ethnobotanical study provided information regarding *Eclipta alba* (L.) Mant. (Asteraceae). The plant is very commonly growing as wild on moist waste places and near drainage. Stern is herbaceous aerial, erect, cylindrical, branched and light brown in colour. Leaves are opposite, simple, sessile and inflorescence is head or capitulum. Flowers are small and white. It may be mentioned here that the treatment given by these tribal people is found very effective as per their information during field survey.

Hence there is need to raise awareness among the people about the flora and to assist for cultivation of the plant to local people of the area to meet their own need. There is also need for conservation of such flora and also maintenance and assessment of germplasm for future use of researchers. The present study was done through structured questionnaire is consultation with tribal people and has resulted the documentation of ethnomedicinal importance of this herbaceous flora. The studied area has long tradition of using herbal products for health care, hence there is an increasing awareness of significance of ethnic and traditional knowledge in the field of therapeutics.

The indigenous knowledge system of herbal practice is still very rich and available among tribal, rural community of Bahraich, north western terai region of U.P. The establishment of modern medical health centers is in progress in many rural areas and that may gradually change the existing pattern of indigenous knowledge system of healthcare. Hence it is necessary to document the traditional knowledge of useful plant and their therapeutic use before being lost forever the community.

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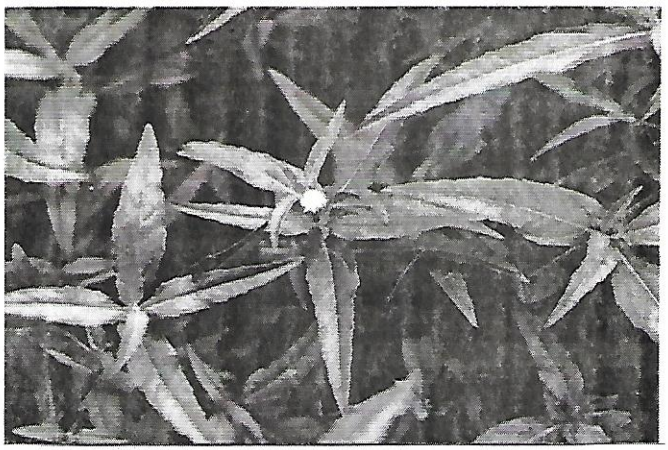

Plate 1:

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Medicinal plant biodiversity in India: Resource utilization and conservational aspects

Abdul Rashid and V.K. Anand
Department of Botany, University of Jammu, Jammu

Abstract

India is among the world's richest countries in terms of plant biodiversity. Besides the abundant flora, containing some 17,500 taxa of vascular plants (Angiosperms, Gymnosperms & Pteridophytes), there is extraordinary ecosystem diversity as well as large pools of both wild and cultivated germplasms. India is also considered as one of the main centers of origin and diversification for plant diversity on Earth. The great British Botanist, Sir J.D.Hooker (1904) remarked that the flora of India is more varied than any other country of the equal area in the eastern hemisphere, if not on the globe. The medicinal plant biodiversity in India both, indigenous and introduced has been put at about 7,500 species. Out of these 1100 plants are frequently used in the Indian system of medicines and 500 plants are commonly used in the preparation of Ayurvedic, Unani and Homeopathic drugs. A tremendous increase in the production of herbal medicines and other products based on Ayurvedic, Unani and other traditional systems of medicines has also been witnessed in India. India has a well established natural drug and pharmaceutical industry making her a major exporter of the plant based products and raw materials. This has put a great pressure on the plant biodiversity of the country. There has been a gross depletion of the natural population of many medicinal plants. Quite few of these have become vulnerable while at least 20 are endangered. Although in recent years, efforts were done to conserve the plant biodiversity in India by various organizations at various levels but much work remains to be done. Past success in augmenting the resource through large scale cultivation of *Sassurea costus, Rauwolfia serpentine, Gloriosa superba* and many others and introduction of some valuable exotic/substitutive species are the inspiring steps in the stride for conservation of medicinal plant biodiversity in India. Various features of medicinal plant biodiversity of India, an account of resource utilization, prospects, concerns and conservational aspects are discussed in the present communication.

Keywords: *Indian Flora, Ayurvedic medicine, Unani medicines, Endangered, Exotic species*

Introduction

India is a treasure chest of biodiversity which hosts a large variety of plants and has been identified as one of the eight important Vavilorian centers of origin and crop diversity. Although its total land area is only 2.4% of the total geographical area of the world, the country accounts for 8% of the total global biodiversity with an estimated 49,000 species of plants of which 4,900 are endemic (Kumar and Asija, 2000). Medicinal plants which constitute a major segment of the flora provide raw materials for use in all the indigenous systems of medicine in India namely Ayurveda, Unani, Siddha and Tibetan medicine. According to the World Health Organization (WHO), 80% of the population in developing countries relies on traditional medicine, mostly in the form of plant drugs for their health care needs. Additionally, modern medicines contain plant derivatives to the extent of about 25%. On account of the fact that the derivatives of medicinal plants are non-narcotic having no side effects, the demand for these plants is on the increase in both developing and developed countries. There are estimated to be around 2500 effective plant based formulations available in Indian medicine. Over 1.5m practitioners of the Indian system of medicine in the oral and codified streams use medicinal plants in preventive, promotional and curative applications. It is estimated that there are over 7800 medicinal drug manufacturing units in India, which consume about 2000 tons of herbs annually (Singh, 2001).

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The number of medicinal plants in India, both indigenous and introduced, has been put at 7,500 by the Ministry of Environment and Forests, Government of India, through an All-India coordinated project on Ethno-biology in 1982 (Ahuja, 2001). Sixteen medicinal plants of exotic origin, introduced in India from time to time are under cultivation and are now considered as a part of the Indian medicinal plant resources. Notable among these are Senna, Psyllium, Belladonna, Cinchona, Eucalyptus, Ipecac, Digitalis and Mexican Dioscorea. In India the number of plants having confirmed therapeutic properties or yielding a clinically useful chemical compound, lies around 700 species. Out of these the plants providing largely and/or regularly used raw materials by Indian drug and pharmaceutical Industry restricts to 300. India is also a major exporter of medicinal plant raw materials and their extracts. These include Senna leaf and pod, Psyllium husk and seed, Chebulic, Belleric and Emblic myrobalan and at least 100 other materials. The country exported a total of 42,000 tonnes of medicinal plant raw material to other countries during the year 2000-2001. Of this, Psyllium husk and seed (ex *Plantago ovata*), Senna leaf and pod (ex *Cassia angustifolia*), Vinca herb (ex *Catharanthus roseus*) and a few other sources of phyto-pharmaceuticals accounted for 32,209 tons. The export of materials employed in Indian System of Medicines (ISM) was 9,740 tons during the same period (Anon, 2001). Bulk of the later came from the plants occurring wild. A tremendous increase in the production of herbal medicines and other products based on Ayurvedia, Unani and other traditional systems has been witnessed in India also. The rich biodiversity of the country is yielding plant sources of various therapeutically valuable chemical compounds or their precursors which are in great demand in national as well international drug and pharmaceutical industry. This has put a great pressure on the raw materials, majority of which are obtained from plants growing in the forests or are associated with other forms of natural vegetation. There has been a gross depletion of the natural population of a number of medicinal plants. Quite a few of these have become vulnerable while at least 20 are endangered and are on the verge of extinction. Some note worthy previous works on the similar aspects of medicinal plants in India are by Adhikari, 2003; Ahuja, 2001; Jain, 1991; Kala *et al.*, 2006; Prakash, 2001; Said, 1969 and Sarin, 2003. However, there is not even a single publication exclusively giving an overview of different aspects of medicinal plants in India. The present study is thus made so as to bring together the otherwise scattered information on the various aspects of medicinal plants with a special focus on conservation and utilization in India.

Materials and Method

This study was conducted as an attempt to consolidate the scattered information lying with different sources regarding the Indian medicinal plants. The present paper is aimed at serving as an overview document on Indian medicinal plants covering a wide range of aspects like distribution, diversity, utilization, marketing conservation and future prospects.

The following institutes of national importance were used as sources for gathering information - Botanical Survey of India, Dehradun., National Botanical Research Institute, Lucknow., Central Institute of Medicinal and Aromatic Plants, Bangalore., Wild Life Institute of India, Dehradun., Jamia Hamdard University, New Delhi and Indian Institute of Sciences, Bangalore. The first author visited all these Institutes personally from September 2005 to January 2007 and gathered the information about various aspects of Indian medicinal plants biodiversity. The gathered information was compiled and critically analyzed to have an overview of the Medicinal plant biodiversity in India: Resource utilization and conservational aspects.

The Indian region (6° 45' to 37° 6' N and 68° 7' to 97° 25'E) with a total area of about 3029 million hectares is considered to be one of the twelve centers of origin and diversity of several plant species in the world. A significant feature of the Indian flora is the confluence of floras from the surrounding countries like Malaya, Tibet, China, Japan, Europe and even from wide separated continents like America, Africa and Australia. The Phytogeographers after critical analysis of flora have convincibly concluded that India has 5,725 endemic plant species (Ahmedullaha and Nayar, 1987). India's rich vegetational wealth and diversity is undoubtely due to the immense variety of the climatic and altitudinal variations coupled with varied ecological habitats. There are almost rainless areas to the highest rainfall area in the world. The altitude varies from the sea level to the highest mountain ranges of the world. The habitat types vary from the humid tropical Western Ghats to the hot desert of Rajasthan, from cold desert Ladakh and icy mountains of the Himalayas to the long warm coast line stretches of Peninsular India. The extreme diversity of the habitats has resulted in such luxuriance and variety of flora and fauna that almost all types of forests, ranging from scrub forest to the tropical evergreen rain forest, coastal mangroove to the temperate and alpine flora occur in this region.

Results and Discussion

India has ten biogeographic zones namely Trans Himalayas, Himalaya, Desert, Semi Arid, Western Ghats, Deccan Peninsular, Gangetic Plain, North East India, Islands and Costs (Sharma, 2006). An account of some of typical Medicinal Plant representatives in each zone is presented in Table 1; and Table 2; shows the some most widely used plants in Indian Pharmaceuticals and Drug industry. Plant Name, Part used, Availability of resource and IUCN Status is also given there. Table 3; represents some important medicinal and aromatic plants grown as horticultural crops. Table 4; shows some other plants grown exclusively as medicinal crops a result of continuous and relate less extraction during the course of many decades, dozens of valuable species are facing danger to their survival in their natural abode in the absence of management practices for their regulated and scientific exploitation, protection, conservation and multiplication. Unregulated exploitation and disorganized trade practices are responsible for sharp decline in the herbal wealth of India. The study revealed that there are twenty eight medicinal plants species whose trade outside India (Export) has been banned under the minor forest produce category. Some of the prominent of these species are; *Aconitum sp., Aquilaria malaccensis, Ceropegia sp., Coptis teeta, Coscinium fenestratum, Cyathea sp, Cycas beddomei, Nepenthes khasiana, Dioscorea deltoidea, Frerea indica, Gentiana kurroo, Kampferia galangal, Nardostachys grandiflora, Taxus wallichiana, Panax pseudoginseng, Paphiopedilum druryi, Picrrhiza kurooa, Podophyllum hexandrum, Rauvolfia serpentine, Renanthera pulcherrima, Saussurea costus, Swertia chirayta* and *Vanda coerulea.*

Critical analysis of occurrence of medicinal plants providing raw material for Indian pharmaceutical and drug industry reveals that *Ferula narthex* is almost extinct from the area of its natural distribution in Ladakh. Four are critically endangered, 20 are endangered and thirty two are vulnerable. There may be a decline in the supplies of another 30 raw materials within next 15 years if the collections at present rate are continued and no remedial steps are taken in near future (Sarin, 2003). Out of 30 medicinal plants under cultivation, at least 10 are being gradually abandoned or replaced by other crops which are more paying or have a regular market. Notable among these are *Atropa belladonna* in Kashmir, *Saussurea costus* in the Lahaul (H.P.), *Rauwolfia serpentine* in Hazaribagh (Jharkhand), *Coptis teeta* in Arunachal Pradesh, *Gloriosa superba* in Trichuraplli (Tamil Nadu) and *Dioscorea floribunda* in Darjeeling hills and Bangalore.

Table 1: Different biogeographic zones of India with some typical medical plant representative species

Biogeographic region	Names of some typical representative medicinal plant
Trans Himalayas	*Ephedra geradiana* Wall., *Hippophae rhumnoides* L., *Arnebia euchroma* (Royle) John
Himalayan	*Aconitum heterophyllum* Wall. Ex. Royle. *Ferule jaeshkeana* Vatke and *Saussurea costus* (Bale.) Lipsch., *Nardostrachys grandiflora* DC., *Taxus wallichiana* Zucc. and *Rhododendron anthopogon* D. Don.
Desert	*Convolvulus microphyllus* Seib ex. Spreng., *Tecomella undulate* (Sm.) Seem., *Citrullus colocynthis* (L.) Schrader and *Cressa cretica* L.
Semi-Arid	*Commiphora wightii* (Arn.) Bhandari. *Caesalpinia bondue* (L.) Roxb. and *Balanites aegyptiaca* (L.) Delilie.
Western Ghats	*Myristica malabarica* Lam. *Garcinia indica* (Thou.) Choisy. *Utleria salicifolia* Bedd and *Vateria indica* L.
Deccan Peninsula	*Pterocarpus santalinus* I.f.. *Decalepis hamiltonii* Wigh & *Arn, Terminalia pallida* Brandis and *Shorea tumbuggaia* Roxb.
Gangetic Plain	*Holarrhena pubescens* (Buch.-Ham.) Wall. Ex. DC., *Mallotus philippensis* (Lam.) Muell-Arg. and *Pluchea lanceolata* C.B. Clarke
North-East India	*Aquilaria malaccensis* Lam., *Smilax galbra* Roxb., *Abroma augusta* (L.) L.f. and *Hydnocarphus kurzii* (King) Warb.
Islands	*Cladophyllum inophyllum* L., *Adenanthera pavonina* L., *Barringtonia asiatica* (L.) Kurz, and *Aisandra buyracea* (Roxb.) Baehni.
Coasts	*Rhizophora mucronata* Lam., *Acanthus ilicifolius* L., *Avicennia marina* Vierth and *Sonneratia caseolaris* (L.) Engl.

The collection from forest area is usually done by local villagers and tribals staying in the vicinity of forests. They collect the material in small lots in their spare time and store it till sold or bartered at a nearby shop. The local shopkeeper, in majority of cases acts as a middleman between the collectors and drug dealers or sometimes the consumer himself. The material so collected from an area is sent out of forest after payment of a nominal fee. Sometimes large scale collections are organized by crude drug dealers or the drug manufactures themselves. The collection of some selected raw material is also handled by the forest department, forest corporations or co-operative societies. In the process, the collection rules are frequently flouted, the life cycle of plant is broken and the quality of the material so collected gets deteriorated. There is a flourishing market of crude medicinal plant materials in India. The traders at local markets also act as procurement and forwarding agents for regional or central markets. The regional markets, such as Baramulla, Srinagar and Udhampur in J&K state, Chamba and Kulu in Himachal, Bhuj and Rajkot in Gujarat, Varanasi in U.P., Haridwar and Dehradun in Uttrakhand and Mysore in Karnataka procure the produce of a particular region and constitute the main supply line for main markets located at Calcutta, Mumbai, Chennai, Kochi, Tuticorin, Delhi and Amritsar. These markets also handle bulk of exports and imports and pharmaceutical industry. This makes the estimation of requirements a difficult task. Such information emanating from various sources differs widely from each other. Chemical and Pharmaceutical Export Promotion Council has estimated the annual demand of raw materials from 55 species at around 32,000 MT (Prakash, 2001). Ayurvedic Drug Manufacturers Association puts such demand at 30,000 MT from 110 species of plants (Unial, 2002). Out of 160 or so plants listed in Tables 3 to 5 of this paper, 100 are having a large demand in the preparation of medicines, around 18 are processed for isolating various phyto-pharmaceuticals or their precursors and 10 such as Psyllium seed and husk and Chebulic and husk, Sena leaf and pod and Chebulic myrobaian fruit are exported in large quantities. Presumptions based on data collected from accurate data is available regarding annual requirements of the plant raw materials by the Indian drug. A large number of sources, indicate that the present requirements of the raw materials lies between 1, 50,000 and 2, 00,000 MT per annum. This include the materials coming from certain largely cultivated sources, such as Cinchona, Psyllium, Senna, Ashwagandha, Tea, Tobacco

Table 2: Some widely used medicinal plants of India

Name of the Plant	Part used	Resources availability and IUCN status	Name of the Plant	Part used	Resources availability and IUCN status
Acacia nilotica	STBK/GM	Good	*Aconitum chasmanthum*	RT	Rare (CR)
Aconitum heterophyllum	RT	Rare (CR)	*Adhatoda vasica*	LF	Good
Aegle marmelos	FR-RT	Good	*Albizia lebbek*	STBK	Good
Alstonia scholaris	STBK	Good	*Andrographis paniculata*	HB	Fair (VU)
Aristolochia indica	RT	Fair	*Artemisia maritime*	HB	v.poor
Asparagus racemosus	RT	Poor	*Azadirachta indica*	LS/STBK /SD	Good
Bambusa arundinacea	Manna	v.poor (EN)	*Bauhinia variegate*	STBK	Good
Berberis aristata	RT	Poor (VU)	*Berberis asiatica*	RT	Poor (VU)
Betula utilis	STBK	v.poor (VU)	*Boerhavia diffusa*	RT	Good
Cassia occidentalis	SD	Good	*Catharanthus rosus*	HB/RT	Fair
Centella asiatica	WP	Good	*Cinnamomum tamala*	LS/BK	Good
Colchicum luteum	Corm	Poor (VU)	*Commiphora wightii*	GM	v.poor (EN)
Convolvulus microphyllus	HD	Good	*Coptis teeta*	RT	Poor (VN)
Cosciniumfenestratum	ST	Poor (VN)	*Curculigo orchioides*	RT	Fair (VU)
Curcuma aromatica	Corm	Good	*Cyperus rotundus*	Turer	Good
Dactylorhiza hatagirea	RT	Rare(CR)	*Datura stramonium*	LS/SD	Good
Dioscorea deltoidea	RH	V.poor (EN)	*Eclipta prostrate*	WP	Good
Embelia ribes	FR	Fair (VU)	*Embelia tsjeriumcottam*	FR	Good
Emblica officinalis	FR	Good	*Ephedra gerardiana*	ST	Fair(VU)
Erythrina variegate	STBK	Good	*Ferula narthex*	GM	Extinct
Ficus racemose	STBK	Good	*Gaultheria fragrantissima*	LS	Poor(VU)
Gloriosa superba	RT/SD	Good	*Gynocardia odorata*	SD	Good
Hedychiumspicatum	RH	Good	*Helicteres isora*	FR	Good
Holarrhena anudysenterica	STBK	Good	*Hydnocarpus pentendra*	SD	Good
Ipomoea hederacea	SD	Good	*Lepidiumsativum*	SD	Good
Leptoderia reticulate	RT	Fair	*Madhuca longifolia*	FR, SD	Good
Mallotus philippinensis	FR rind	Good	*Mimosa pudica*	SD	Fair
Mutuna pruriens	SD	Fair	*Nardostachys grandiflora*	RT	Poor(VU)
Nymphaea Stellata	FL	Poor (VU)	*Ocimum basilicum*	HB	Fair
Ocimum canum	SD	Good	*Operadina turpethum*	RT	Fair
Phyllanthus amarus	HB	Good	*Picrorhiza kurroo*	RT	Poor (VU)
Piper longum	FR/RT	Fair	*Pistacea integerrima*	Gall	Poor (VU)
Plumbago zeylanica	RT	Good	*Podophyllum hexandrum*	RT	Poor (VU)
Prunella vulgaris	WP	Fair	*Prunus cerasoides*	STBK	Fair
Psoralea crylifolia	SD	Fair	*Pterocarpus santalinus*	WD	V. poor (EN)
Punica granatum	SD	Good	*Rauvolfia serpentina*	RT	Fair
Santalum album	WD	Fair	*Sapindus mukrossi*	FR	Good
Saussurea costus	RT	Poor	*Sida cordifolia*	SD	Fair
Solanum nigrum	WP	Good	*Solanum surattense*	WP, RT	Good
Swertia chirata	WP	v.poor (EN)	*Symplocos racemosa*	STBK	Good
Tamarix gallica	Galls	Fair	*Taxus wallichiana*	STBK	Fair (VU)
Terminalia arjuna	LS, STBK	Fair	*Terminalia chebula*	Fp	Good
Thespesia populnea	FL, FR	Fair	*Tinospora cordifolia*	ST	Good
Tribulus terrestris	FR,RT	Good	*Valeriana jatamansi*	RT	Good (VU)
Viola pilosa & others	FL	Fair (VU)	*Vitex negundo*	LS/FR	Good

Table 3: Some medicinal and aromatic plants of India grown as horticulture crops

Plant	Crop	Medical Part	Demand
Allium sativum	Garlic (Lahsoon)	Bulb/Oil	V.High
Ammomum sabulatum	Large cardamoms	Fruit, Seed	Med
Amorphophalus campanulatus	Sooran	Corm	Mar
Anethum sousa	Indian Dill (Sowa)	Seed, Seed oil	V. High
Apium graveolense	Calery	Seed, seed Oil	Med
Areca catechu	Betelnut (Supari)	Seed	Med
Cinnamomum verum	Cinnamon (Dalchini)	Stem bark	Med
Coriandrum sativum	Coriander (Dhania)	Fruit	Med
Crocus sativus	Saffron (Kesar)	Pistil	Mar
Cuminum cyminium	Cumin (Zira)	Fruit	High
Curcuma Longa	Turmeric (Haldi)	Root	High
Elettoria cardamomum	Cardamom	Fruit, Seed	High
Foeniculum vulgare	Fennel (Saunf)	Fruit	Med
Lausonia inermis	Mehndi (Henna)	Leaf	High
Linum usitatissimum	Alsi (Linseed)	Seed; Oil	Med
Memordica charantia	Karels	Leaf, Seed	Low
Myristica fragrans	Jaiphal, Javitri	Seed and Aril	Med
Nigella sativa	Kalsunji	Seed	Low
Papavar Somniferum	Opium poppy	Opium	V.High
Piper nigrum	Black pepper	Fruit	V.High
Prunus amygdalus	Badam (Almond)	Kernel/Oil	Med.
Ricinus communis	Eranda (Castor)	Root/Oil	High
Sesamum indicum	Sesamum (Til)	Seed, Oil	High
Syzygium aromaticum	Cloves (Lavanga)	Flower bud	High
Trachyspermum ammi	Ajawain	Seed	High
Trichosanthes dioica	Patol, Parval	Leaf/Fruit	Low
Trigonella foenum-graceum	Fenugreek (Methi)	Seed	Low
Zingiber officinalis	Ginger (Soonth)	Rhizome	V. High

Table 4: Some widely cultivated medicinal plants of India

Plant	Part Used	Demand	Plant	Part Used	Demand
Acorus calamus	RH	High	*Dioscorea floribunda*	RH	High
Alpinia galanga	RH	Med	*Emblica officinalis*	FR	V. High
Aloe vera	LF	V. High	*Eucalyptus globules*	LF.Oil	High
Ammi majus	FR	Med	*Gloriosa superba*	RT/S	Med
Asparagus racemosus	RT	High	*Inula racemosa*	RT	Low
Atropa belladonna	RT/LF	Low	*Kaempferia galangal*	RH	Low
Carum carvi	FR	High	*Piper longum*	FR/RT	High
Cassia angustifolia	LF:FR	High	*Plantago ovata*	SD/Husk	V. high
Catharanthus roseus	RT; HB	V. High	*Rauvolfia serpentina*	RT	High
Cinchona sps.	STBK	High	*Saussurea costus*	RT	High
Digitalis lanata	LF.OIL	High	*Withania somnifera*	RT	High

Abbreviations and legends to Tables 2-4.
Vegetative parts used : RT- Root; RTBK-Root bark; ST-Stem; STBK-Stem bark; LF-Leaf; FL-Flower; FR-Fruit; SD-Seed; GM-Gum, oleoresin; WP-Whole plant; HB-Herb (aerial parts).
Resources: Good-No declines foreseen; Fair-May decline if there is increase in current rate of collection; Poor-Already declining; V. Poor-Declining sharply and may exhaust shortly; Rare-Almost exhausted in the wild; Threat categories (IUCN): CR-Critically Endangered; EN-Endangered; VU-Vulnerable

and Poppy. The demand of the raw material may increase substantially in coming years due to enhanced production of medicines, phyto-pharmaceuticals, extracts and over the counter products by the Indian drug and pharmaceutical industry.

Conclusion

The observations made in the foregoing discussion indicate that medicinal plant raw material resource in India though facing problems, there is enough scope for its development to meet the requirements of drug and pharmaceutical industry. Concerted multi-disciplinary efforts are required to execute large scale production of materials from both wild and cultivated sources. The augmentation and supplies of raw materials obtained from the plants growing in forests, especially those originating from trees and shrubs may better be left with the foresters who may undertake in-situ conservation, restocking and forestation with desirable species. Steps for systematic census of medicinal plants associated with different types of forest vegetation and quantitative evaluation of the raw material available will also have to be undertaken by the forest department.

Large scale cultivation of medicinal plants, both indigenous and exotics will be a desirable solution for ensuring unrestricted supply of the raw material in required quantities. Research and development studies on domestication of wild plants and introduction of certain exotics have been going on at a number of government, non government and academic agencies since long, but the success in large scale cultivation could be obtained in only few cases. The causes of failures need critical investigation in the light of the fact that India is blessed with a wide spectrum of agro-climatic conditions, a chain or research institutions with competent workers in the field of biology, biotechnology and agricultural sciences and a hard working and enterprising farmer. There appears to be a lack of coordination among various workers and between organizations engaged in the development of medicinal plant resources. Cultivation of medicinal plants is inversely linked to prevalence of easy and cheap collection of medicinal raw materials from the wild, cornering of the profits by a vast network of traders and middlemen and absence of industry's interest in providing buyback guarantee to the grower. These problems require immediate solutions to ensure the involvement of the farmers in this task. A lot of work has been done in various fields of development of medicinal plant resources of India. Valuable data on botany, distribution pattern, occurrence, chemistry, pharmacology and agro-technologies has been lying accumulated with various research institutions, universities and non-government organization. Such data retrieved and consolidated at one place, critically examined and documented will greatly help in devising strategies for proper development and conservation of medicinal plant raw material resources of the country. A collaborative work involving scientist, government, institutions, NGO's and forest dwellers is suggested for preserving the traditional indigenous knowledge and practices and conservation of medicinal plants and upliftment of rural economy of the country.

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Remedial measures of human ailments by *Oxalis corniculata* (Linn.)

Manjulla Srivastava and S.C. Tripathi
Department of Post Graduate Studies and Research in Botany
Kisan P.G. College, Bahraich

Abstract

The communication deals with the traditional knowledge of khath metthi *(Oxalis corniculata)* (Linn.) used by tribal people of our study area i.e. Mihinpurwa block of tehsil Nanpara of Bahraich, a terai district of U.P. This tehsil is very rich in ethnic as well as floristic diversity. The inhabitants of the area have inherited a rich traditional knowledge of the use of this herbaceous flora for cure and care of various human ailments. Important ethnomedicinal uses of herbs, parts utilized, local name and mode of treatmcnt has been included in this paper.

Keywords: *Herbaceous flora, Oxalis corniculata (Linn.), Tribals*

Introduction

Study of ethnobotany is in itself a very intricate or convoluted process. Our country represents one of the most important center of knowledge with special reference to use of plant species for various ailments. Examples are the Ayurveda, Unani and Siddha system of medicinal care. To lessen the burden on both human and environment and to make our mother earth safe for future generations, indigenous or inherent technical knowledge should be given more emphasis and prominence. The geological area of Bahraich is 5026.6 km^2 and it is located at 27°04' to 28° 24' N latitude and between 81°03' to 83°13' E longitude. The surveyed villages of Mihinpurwa block *i.e.* Phakeerpur, Aama, Lohari, Sahoni and Baligaon of Nanpara tehsil is having good population of tribal people i. *e.* mainly "Tharus". These villages are situated very near to Katernia forest and the tribal are original settlers (Jain, 1987). It is also important to quote here that the knowledge of tribals regarding plants has descended from one generation to another, as a domestic practice (Brahmam, 2000).

Materials and Method

The study is based on field survey which was conducted during July 2006 to July 2007. During survey out of 60 collected plants, a wild herbaceous flora locally called as "Khath metthi" by tribal people was collected. The tribals helped us a lot in telling local name and folk remedial properties of flora regarding various human ailments. The conversations and discussion with tribal and local elder people regarding these herbaceous flora used in their daily life for disease treatment were also noted in field diary. The collected plant was identified correctly with the help of available literatures *i.e.* Cooke (1908), Maheswari (1986), Jain (1987), Singh (1991), Duthie (1994), Singh *et al.* (2000), Joshi (2000), Jain (2003). The herbarium of plant species was prepared scientifically following the method described by Jain and Rao (1976). The collected plant specimens were deposited in the P.G. Department of Botany, Kisan P.G. College, Bahraich of U.P. for record and reference.

Results and Discussion

Oxalis corniculata Linn. is a small, perennial herb frequently growing as a weed and belongs to family Oxalidaceae. The leaves are eaten, they are good source of vitamin C. The herb possess astringent, vermifuge and antiseptic properties. Fresh leaves are boiled in butter milk and two teaspoons of it is taken twice in a day

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i.e. in morning and evening it is a good remedy for piles, anaemia, dyspepsia and tympanitis. An infusion of leaves is used to remove opacity of cornea. Leaves are used in fever, dysentery, scurvey and biliousness and for removing corns, warts and other excrescences of the skin. An infusion of leaves is used to remove opacities of cornea. The extracts of leaves are used for mouth wash and it is helpful in diseases of gums. Two to three leaves if chewed twice or thrice in a day *i.*e. in morning, noon and evening it relieves the foul smell of mouth.Dried powder of leaves is recommended for cleaning the teeth. The vegetable is locally called as sag, whole plant is made in ghee and it help in curing piles. 2-5 gm extract of whole plant, if taken twice in a day helps in curing diarrhoea and dysentery. 10-15 leaves are grinded with water and its poultice, if bandaged the swelling and burning sensation is reduced. The poultice of leaves is helpful in curing skin eruption, carbuncle, pimples, giddiness and insanity. The indigenous knowledge system of herbal practice is still very rich and available among tribal/rural community of north western terai region of U.P. *i.e.* Bahraich. The establishment of modern medicinal health centers is in progress in many rural areas and that may gradually change the existing pattern of indigenous knowledge system of health care. Hence, it is necessary to document the traditional knowledge of useful plants and their therapeutic uses before being lost forever from the community.

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Study of physico-chemical characteristics of treated effluent of Sugar Industry

A. Polestya, S. Sharma and D.R. Khanna
Deptt. of Zoology and Environmental Science, Gurukula Kangri University, Hardwar (U.K.)

Abstract

An attempt has been made to study the characteristics of the treated effluent of Saraswati Sugar Mill in Yamunanagar, by analyzing various physico-chemical parameters (pH, temperature, TS, TDS, TSS, DO, BOD, COD and oil and grease). Saraswati Sugar Mill is India's second largest sugar industry having well equipped effluent treatment plant. The duration of study was from January 2001 to March 2001. Almost all the monitored parameters were within the prescribed limits. Thus this industry does not possess any threat to water quality.

Keywords: *Sugar industry, Physico-chemical characteristics*

Introduction

All over the world, industrial development has caused indiscriminate exploitation of natural resources, without any regard to conservation aspect. Sugar industry is one of the major industries in India. On one hand sugar industry is playing a vital role in the economy of country on other hand it is a potent and problematic source of environmental pollution. Effluent treatment plant (E.T.P.) of Saraswati sugar mill was designed by Hindustan Dor Oliver. It contains equalization tank, primary clarifier, aeration tank, secondary clarifier and sludge drying beds. Process adopted for the treatment of effluent is activated sludge method, which involves primary treatment, secondary treatment and dewatering of sludge on sludge drying beds.

The main purpose of water analysis is to evaluate methods of treatment of wastewater; with to reuse or dispose, ascertain quality of water and aim at recovery of valuable products from waste effluents. In order to ascertain the above objectives, it is necessary to analyze various parameters, which would throw light on quality of water (Lokhande *et al.*, 2005). Several workers have carried out studies on water of different sources in respect of physico-chemical parameters (Khanna, 1993 and Khanna *et al.*, 2003). Considering the present conditions a quantitative study of physico-chemical conditions of treated effluent of Saraswati Sugar Mill was done.

Materials and Method

Sampling

Water samples were collected from the outlet of the treatment plant.

Analytical methods

The physico-chemical analysis was carried out according to standard methods given by APHA (1998) and Trivedi and Goel (1986). The analytical methods for various parameters are given in Table-1.

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Table 1: Various analytical methods used for analysis

S.No.	Parameters	Analytical method
1	pH	pH metery
2	Temperature	Thermometry
3	Dissolved oxygen (DO)	Winkler's Iodometric with azide modification method
4	Biochemical oxygen demand (BOD)	5 days incubation method
5	Chemical oxygen demand (COD)	Dichromate reflux method
6	Total solids (TS)	Gravimetric method
7	Total dissolved solids (TDS)	Gravimetric method
8	Total suspended solids (TSS)	Difference of TS and TDS
9	Oil and grease	Petroleum ether method

Results and Discussion

The results for the various physico-chemical parameters determined in the treated effluent sample are presented in Table-2. It summarizes the maximum, minimum, mean values and standard deviations of the parameters monitored. The graphical representations are given in Fig. 1.

Table 2:Various physico-chemical parameters at the outlet of effluent treatment plant

S.No.	Parameters	Maximum	Minimum	Average	Standard deviation
1	pH	7.50	7.33	7.43	0.07
2	Temp.(°C)	16.0	7.50	12.9	3.15
3	TS (mg/l)	261.0	214.0	227.0	19.12
4	TDS (mg/l)	250.0	204.0	215.2	19.59
5	TSS (mg/l)	14.0	10.0	12.0	1.58
6	DO (mg/l)	4.1	2.0	3.02	0.99
7	BOD (mg/l)	10.0	5.0	6.8	2.17
8	COD (mg/l)	50.0	20.0	32.0	10.95
9	Oil and grease (mg/l)	0.2	0.0	0.06	0.09

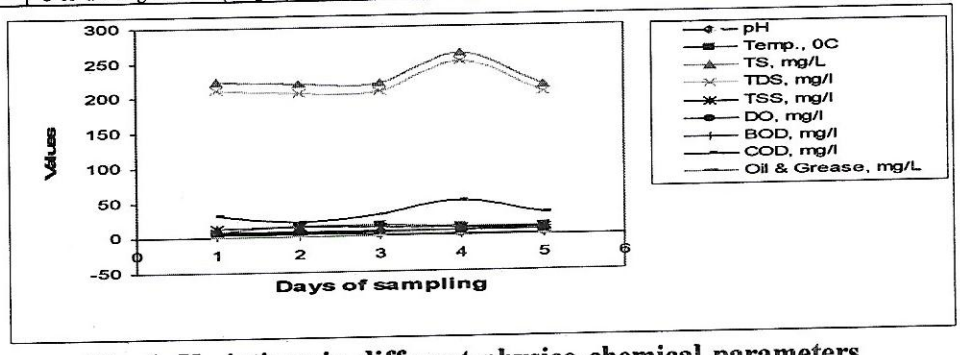

Fig. 1. Variations in different physico-chemical parameters

The pH values were in the range of 7.33 to 7.50 (Table-2). The pH range for the discharge of treated effluent is 5.5 to 9.0. pH of the samples were found to be in the safe range. The values obtained were similar as observed by Manjappa and Naik (2007) for Malaprabha river. It is apparent from results that temperature values ranged between 7.50 to 16.0 °C. and these values were within the prescribed limits (<45 °C). The range of temperature of water samples was similar as observed by Muduli and Dhal (2006) in river Baitarani at Anandpur.

The total solids (TS) values ranged from 214 to 261 mg/l. TDS values ranged between 204 to 250 mg/l. The suspended solids (SS) represent the floating material (bacteria, algae) and undissolved particles, which ranged from 10 to 14 mg/l. All types of solids were found within tolerable limits.

The concentration of dissolved oxygen in water depends on temperature, pressure and the concentration of various ions. Due to pollution load the concentration of DO depletes and possess thrust on the aquatic life. Low oxygen in water can be detrimental to fishes and many other organisms in the aquatic system. The DO values ranged between 2.0 to 4.10 mg/l. BOD is the empirical test to determine the relative oxygen requirement of water mostly due to organic ingredients. Its application is to calculate the pollution load. The BOD values ranged from 5 to 10 mg/l. Maximum permissible limit for the discharge of effluent for BOD is 30 mg/l. Therefore, BOD is not possessing any threat to water quality.

COD is the amount of oxygen required for oxidation of organic constituents with strong oxidizing agent and it is also an important parameter for stream and industrial wastewater pollution studies. In the present study the COD ranges from 20 to 50 mg/l. Maximum permissible limit for the discharge of effluent for COD is 250 mg/l. Oil and grease values were from 0 to 0.2 mg/l. Permissible limits for oil and grease is 10 mg/l.

Conclusion

Saraswati sugar mill follows advanced process technology and system to achieve the environment management and performance. Therefore this industry is conscious of its responsibility and has invested heavily in reducing pollution. All the monitored parameters (pH, temperature, TS, TDS, TSS, DO, BOD, COD and Oil and grease) were within the prescribed limits and this industry is not possessing any threat to water quality.

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A study of plankton population in the Moghat reservoir at Khandwa District (M.P.)

Vivek Keshre, L.K. Mudgal#, D.R. Khanna*, Gagan Matta*, Dheeraj Kumar* and Vikas Singh***
#Department of Zology, Govt. Girl's P.G. College, Indore (M.P.)
*Deptt. of Zoology & Environmental Science, Gurukula Kangri University, Hardwar (UK)
**Deptt. of Zoology, Govt. M.L.C. Girls P.G. College, Khandwa (M.P.)

Abstract

Khandwa District is situated in the south west part of the Madhya Pradesh, along the border of state Maharashtra. With increasing water demand in 1897, Moghat reservoir was constructed specially to store the rain water so that water requirement of the near by area can be fulfilled. This reservoir is very important for local people but no much information on quality of water is available. This study was carried out with the purpose to know the planktonic characteristics of the reservoir.

Keywords: *Khandwa, Reservoir, Planktonic, Rain water*

Introduction

With the technological advancement man made several new things which either had multiple uses or specific use; one of such example is of reservoir, which have multiple uses. Reservoir construction needs very high techniques and technological knowledge. They are used to store water to solve the water problem, control flood, generate electricity, pisci-culture and sometimes for recreational activity and to conserve endangered fresh water organisms. Water quality and productivity of any aquatic (reservior) ecosystem and its health can be evaluated by studying the planktonic status of that water body. Plankton in an aquatic system is an essential link in the food chain, capable in affecting the entire aquatic biota. Freshwater sources are degrading fastly due to men's increased activity (Rao and Durve, 1989) and ignorance towards the health of water source, Moghat reservoir of Khandwa is one of such example. Indian fresh water planktonic information was given by Chakraborty *et al.* (1959), Rao *et al.* (1988), Kumar (1995), Khanna *et al.* (1999), Khanna *et al.* (2000). District Khandwa is situated in the south west part of the Madhya Pradesh. The studied Moghat reservoir was constructed in the year of 1897 on a small river near village named Moghat. Moghat village is 3 km. away from the Khandwa Township. Catchment area of the reservoir was 23.30 sq. km. and storage area was 2.02 sq. km. This water reservoir is situated at a height of 324.54 meter above the sea mean level, height of the band is 12 meter and depth is 8.78 meter. To increase the water supply to the reservoir, a 6.4 km long canal was constructed. The studied reservoir has a long history but till now no much information on its planktonic ecology is available. This study was carried out with the purpose to develop planktonic abundance data and to study and understand their ecological characteristics.

Materials and Method

Study site

Moghat reservoir is located at a distance of 3 km from the Khandwa city in northwest. Location of this reservoir is 21°49' N, 76°20' E and is stuated 1017 ft. above the sea level.

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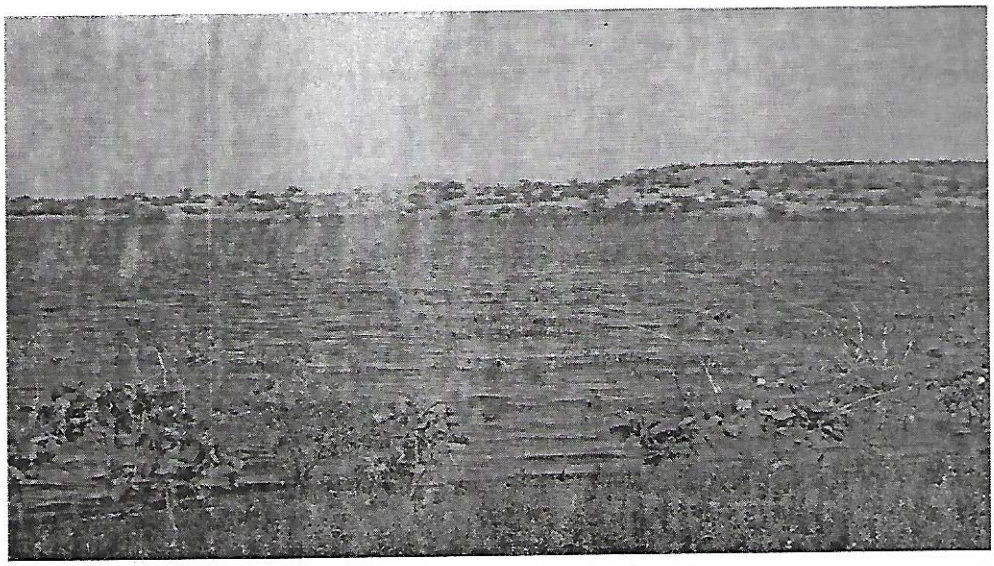


Fig. 1: Moghat reservoir at Khandwa

Sampling

Monthly sampling was done for two years (2005-2007). Samples were collected between 7.00 am. to 11.00 am on first Monday of every month. Plankton were studied following the standard methods of Welch (1948), Khanna (1993) and APHA-AWWA-WPCF (1998).

Results and Discussion

During the course of study of plankton of the Moghat reservoir it was observed that the average number of total plankton in the reservoir decreases from October to April and then started increasing from April to September. The maximum number of total plankton was observed in the month of October (3535.13 unit/l ±854.55) and minimum in month of April (661.25 unit/l±99.51). The similar trend of planktonic number was also observed by Eddy (1934) and Khanna (1993). The maximum value of zooplankton was observed (398.75 unit/l ±113.95) in October and minimum number (48.50 unit/l ±29.36) in the month of April. As the total plankton is the sum of phytoplankton and zooplankton, both showed the same trend in their number similar to the total plankton.

The maximum value of phytoplankton (3135.88 unit/l ±823.38) in October and minimum (602.25 unit/l ±98.97) in April. Roy (1955) reported similar results. The study showed a dominance of phytoplankton as also reported by Pahwa and Mehrotra (1966), Dobriyal and Singh (1987), Khanna and Singh (2000). The variation in the number of phytoplankton and zooplankton can be observed in the Table. 1 and in Fig. 1. Phytoplankton observed in the Moghat reservoir belongs to the the classes diatoms, green algae and blue green algae. Variation in their number is tabulated in Table. 2 and graphically represented in Fig. 2. During the study maximum number (1429.87 unit/l ±775.66) of plankton observed belongs to the class diatoms and minimum number (39.42 unit/l ±28.61) of plankton belongs to the class blue green algae. Singh and Ahmed (1990), Khanna *et al.* (1999) reported the same trend. Diatoms observed to be more and

blue green algae minimum in comparison to other class of phytoplankton in every month during the study. Maximum number of diatoms were found in November (2662.75 unit/l ±1217.01) and minimum (590.63 unitl ±178.48) in April and its number showed a continuous increasing trend from April to November and they started decreasing from December to April. Khanna and Bhutiani (2003) worked on limnological status of Satikund pond at Hardwar and they observed the same phenomenon in relation to diatoms. The maximum number (363.13 unit/l ±59.15) of green algae was found in October and minimum number (39.88 unit/l ±26.02) in May.

The green algae showed increasing trend from May to October and then decreasing trend from November to May. Blue green algae are also known as cyanobacteria and during the study of Moghat reservoir the maximum number (90.00 unit/l ±30.47) in the month of October and minimum number (5.00 unit/l ±2.73) in the month of April. The blue green algae showed an increasing trend from August to March. Similar trend was observed by Prasad and Singh (2003) during their study of tropical water body.

In this study five different classes protozoa, rotifera, cladocera, copepod and ostracods of zooplankton were identified and out of all the five class maximum average number (60.55 unit/l ±39.34) was found for rotifers and minimum (42.40 unit/l ±29.00) for ostracods. Results are tabulated in Table. 3 and graphically presented in Fig. 3.

Protozoa found maximum (137.63 unit/l ±37.19) and minimum (12.75 unit/l ±6.65) during October and April respectively. Protozoa showed an increasing trend from May to October and started decreasing from November to April. Maximum and minimum number of rotifera observed was (132.00 unit/l ±115.56) in January and (14.38 unit/l ±9.29) in April respectively. Rotifera showed regular increase in number from April to October. Das and Srivastava (1956), Das and Upaddhyaya (1979) found the same trend in the number of protozoa and rotifera. Cladocera didn't showed any specific trend in number, its maximum number was found in the month of January (84.38 unit/l ±59.03) and minimum in the month of April (7.38 unit/l ±4.27). Similar to cladocera, copepod also did not showed any trend in number during the study period. Copepod was found maximum (109.67 unit/l ±22.50) in December and minimum (5.67 unit/l ±2.52) in April. Ostracods found to be maximum in October (90.88 unit/l ±43.34).

Table 1: Planktonic number (unit/l) in Moghat Reservoir during 2005-2007.

Month	Phytoplankton	Zooplankton	Total Plankton
October	3135.88±823.38	398.75±113.95	3535.13±854.55
November	3175.63±1190.54	355.25±52.89	3406.50±1209.62
December	2837.38±1100.69	459.13±195.82	3157.00±1194.49
January	2123.25±824.85	376.38±145.09	2500.13±911.81
February	1685.00±618.47	288.88±109.80	1974.13±601.73
March	894.00±185.83	118.88±59.16	1013.25±188.12
April	602.25±98.97	48.50±29.36	661.25±99.51
May	772.75±80.79	50.00±20.19	848.00±125.02
June	1090.13±362.93	97.88±24.74	1188.38±370.67
July	1185.13±389.29	144.50±36.99	1330.00±400.71
August	1178.13±350.19	181.88±56.18	1360.63±340.51
September	1787.63±749.94	272.00±69.54	2160.63±799.94
Average	1645.29±921.63	225.84±143.97	1858.26±1022.35

Table 2:Number (unit/l) of different Group among the Phytoplankton of the Moghat Reservoir during 2005-2007

Month	Total Diatoms	Total green algae	Total Blue green algae
October	2327.25±878.64	363.13±59.15	90.00±30.47
November	2662.75±1217.01	238.63±87.13	69.38±26.46
December	2567.63±1046.17	229.88±85.87	54.38±18.33
January	1885.25±780.59	182.00±69.52	66.25±41.91
February	1584.25±649.63	124.00±60.71	33.75±11.88
March	882.75±368.26	85.00±17.27	17.00±21.59
April	590.63±178.48	41.75±29.71	5.00±2.73
May	747.88±117.89	39.88±26.02	5.63±1.99
June	939.38±350.34	104.38±51.35	23.75±15.44
July	985.63±369.63	155.50±32.50	37.00±23.79
August	912.50±316.45	240.38±37.69	13.50±11.93
September	1423.75±772.45	275.75±59.80	68.25±9.71
Average	**1429.87±775.66**	**167.68±99.53**	**39.42±28.61**

Table 3: Number (unit/l) of Different Genera among Zooplankton in the Moghat Reservoir during 2005-2007.

Month	*Protozoa*	*Rotifera*	*Cladocera*	*Copepod*	*Ostracods*
October	137.63±37.19	104.00±60.52	76.75±48.73	75.33± 17.62	90.88±43.34
November	100.63±40.17	87.00±59.01	83.00±59.29	85.33±21.01	72.75±35.98
December	112.25±41.97	104.75±46.74	76.63±56.90	109.67±22.50	80.00±36.13
January	91.88±39.49	132.00±115.56	84.38±59.03	83.67±15.04	55.88±30.14
February	63.13±23.17	70.88±14.60	37.75±19.34	55.67±5.51	27.63±13.59
March	32.25±21.39	26.50±12.12	12.63±7.17	12.00±2.00	13.00±5.13
April	12.75±6.65	14.38±9.29	7.38±4.27	5.67±2.52	5.88±1.81
May	16.88±9.09	14.63±7.74	10.13±6.59	9.33±3.79	9.50±5.83
June	23.50±11.01	27.50±7.21	19.63±12.33	15.33±1.53	24.25±10.09
July	31.88±14.34	38.25±14.47	36.25±18.84	22.00±7.21	33.63±13.09
August	47.63±11.94	52.13±12.00	49.00±31.14	32.67±5.77	44.25±13.47
September	75.00±20.11	75.38±17.05	30.88±21.33	62.00±10.00	64.63±17.89
Average	**60.51±41.28**	**60.55±39.34**	**42.62±29.62**	**46.49±35.71**	**42.40±29.00**

Fig. 2: Average monthly variation in plankton number during 2005-2007

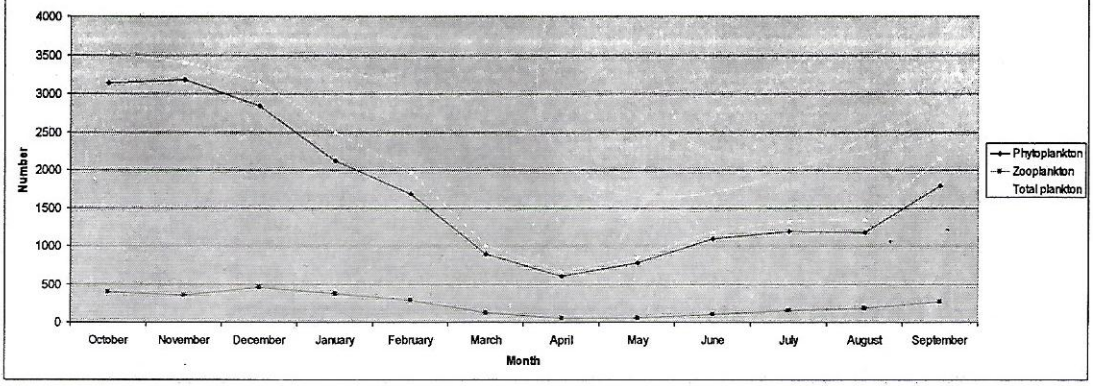


Fig. 3: Average monthly variation in different class of phytoplankton during 2005-2007

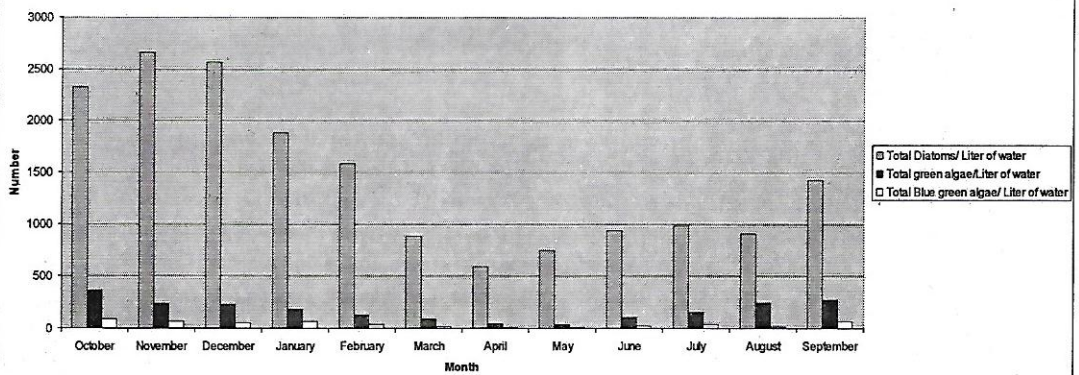
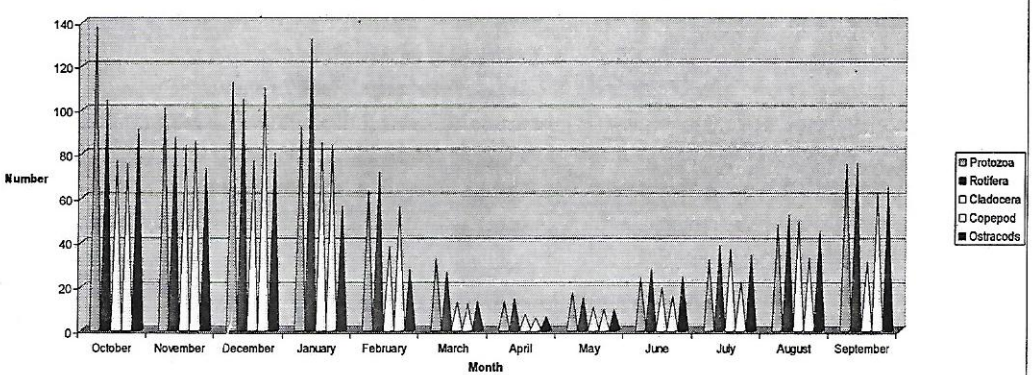


Fig. 4: Average monthly variation in different class of zooplankton during 2005-2007



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Elephantopus scaber L. - A traditional panacea for several ailments

S.C. Tripathi and Manjulla Srivastava
P.G. Department of Botany, Kisan P.G. College, Bahraich

Abstract

The role of natural products, herbal medicines, and traditional medicines is being increasing in the recent years for the prevention and management of human disorders. The present paper deals with ethnomedicinal use of *Elephantopus scaber* L. collected from Nishangada forest (Kakraha range) of Bahraich, a tarai district of eastern U.P. India. During field survey on 5th August 2006 and 2nd January 2007, out of many collected plants we got the information about a herbaceous flora locally called as "Hastipata" by tribal peoples. These tribals are the migrants of Nepal in Nishangada forest (Kakraha range) of Bahraich, working as labour named as Phool Kumari, Pooja Chaudhary and Man Kumari Chaudhary. The botanical name of plant was confirmed by available literature in the department library. The tribals informed us about its use regarding the cure of various human ailments. The gathered informations from them revealed that the decoctions of fresh leaves are used as wash for eczema. Crushed leaves are boiled in the coconut oil and applied to ulcers and eczema. The paste of root is applied in rheumatism and the tribal people apply powder of root with pepper in toothache. The tribals informed that, this traditional knowledge about the plant "Hastipata" has descended from one generation to another as domestic practice and treatment given by them is found very effective.

Keywords: *Herbal medicines, Ethnomedicinal herb, Tribals*

Introduction

Ayurveda, the ancient healing system of India, flourished in the Vedic era in India. According to historic facts, the classical texts of Ayurveda, Charak Samita and Sushruta samita were written around 1000 B.C. The Ayurvedic "Materia Medica" includes 600 medicinal plants along with therapeutics.

During field survey on 5th August 2006 and 2nd January 2007, of Nishangada forest (Kakraha range) of district Bahraich, out of many collected plants we got the informtion about a herbaceous flora locally called as "Hastipata" by tribal peoples. These tribals are the migrants of Nepal in Nishangada forest (Kakraha range) of district, working as labour named Phool Kumari, Pooja Chaudhary and Man Kumari Chaudhary. The tribals used to cure various human disorders by the plants found in this area an important ethnomedicinal herb *Elephantopus scaber* L. (Asteraceae) grows in grasslands preferring wasteland. The tribal told that, this herbaceous flora have been used in the traditional health care system from time immemorial. Particularly among the tribal communities and their knowledge of plant has descended from one generation to another as a domestic practice.

Materials and Method

During the field survey for collection of plants, the local tribal people were contacted and interviewed, questionnaire method was adopted for this purpose. The botanical name of plant was confirmed by available literature in the departmental library by Duthie, 1994 and Joshi, 2000. It was observed that *Elephantopus scaber* L. (Asteraceae) grows in grasslands preferring wasteland. It has a dichotomously branched, deeply stout penetrating root and tuberous root that regenerates, when the shoot is removed. The stem is smaller, leaves alternate, lies flat on the ground. Flowering heads born in clusters at the end of

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the branches and are usually enclosed by three leaflike bracts. The herbarium of plant species was prepared scientifically following the method described by Sass, 1985. The plant specimen was mounted on herbaruim sheet and herbarium sheet was submitted in the department for record. The tribals told that decoction of fresh leaves is used as wash for eczema. Crushed leaves boiled in coconut oil are applied to ulcers and eczema. Crushed leaves are also applied to cure for snakebite and furuncle swelling. Juice of leaves is applied to scalp and powder of root with pepper is applied to toothache. The tribals told that this traditional knowledge regarding plant has descended from one generation to another as a domestic practice (Brahmam, 2000).

Results and Discussion

The study was based on indigenous knowledge of medicinal plant *Elephantopus scaber* L. (Asteraceae) which was collected during survey and the medicinal importance was told by tribal people of area. This medicinal plant of the area is indirectly linked with the traditional and culture of local people and due to the same reason, the survey yielded interesting results. During the study, it was also found that, aforesaid plant species is over harvested due to their extensive uses and has reached at the brink of extinction. It is used to cure various skin diseases such as eczema, ulcer and eruption. The plant is also used in toothache, vomiting and in bronchitis. It is evident from gathered information that the young generation is not fully aware of the significance of this medicinal flora as compared to old generation. Hence, it is essential that this awareness should be created among people in conserving this medicinal plant.

Acknowledgement

The authors express their deep sense of gratitude to Prof. S.K. Singh, Retd. Prof. and Head of Botany Department, DDU, University, Gorakhpur and Dr. T.P. Mall, Head of Botany Department, Kisan P.G. College, Bahraich for their encouragement and suggestions.

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Wound healing activity of *Achyranthes aspera* (Linn.) in experimental rats

Dinisha Malviya, P.N. Shrivastava, Shailendra Rajput and R.C. Saxena*
S.S.L. Jain P.G. College, Vidisha M.P.
*Pest Control and Ayurvedic Drug Research Lab

Abstract

***Achyranthes aspera* Linn. which is commonly known as chirchita is a herb used in indigenous system of medicine in India. Looking to the wide application of this plant, it was proposed to investigate the anti-inflammatory activity leading to the wound healing and repairing of the damaged tissue activity in the plant extract. The aerial part of *Achyranthes aspera* collected from Hathidhal or Udaipura tehsil in Raisen district of M.P. during flowering season was extracted in Soxhlet apparatus with 90% alcohol. Healthy wistar rats (20) weighing between 150-200 gm were used for experimental work.. The study revealed that when maximum dose 8 mg/mm² of *Achyranthes aspera* suspension was applied to wound model, a significant increase was observed in the skin tensile strength for 15 days.**

Keywords: *Achyranthes aspera Linn., Wound healing, Rats*

Introduction

Naturally occurring biologically active compounds are wide spread in plants. *Achyranthes aspera* Linn. which is commonly known as chirchita is a herb used in indigenous system of medicine in India for the cure of heart diseases, asthma (Saxena, 2003) as well as antimicrobial agent (Sharma *et al.* 2006). Looking to the wide application of this plant it was proposed to investigate the anti-inflammatory activity leading to the wound healing and repairing of the damaged tissue activity in the plant extract.

Materials and Method

Plant material

The aerial part of *Achyranthes aspera* was collected and extracted in Soxhlet apparatus with 90% alcohol from Hathidhal or Udaipura tehsil in Raisen district of M.P. in India during flowering season. The crude was concentrated in reduce pressure and low temperature that gave 30 gm gummy material which was further made to a suspension with gum accacia. This suspension was used in wound healing of Albino rat and the crude extract was taken for detailed phytochemical analysis using chromatographic and spectral technique.

Animal material

Healthy wistar rats (20) weighing between 150-200 gm were used for experimental work. Before wounding animals were housed in wire topped cages with husk bedding. During the experimental period the animals were housed individually and resuscitation was done with Ringer locke (0.1 ml/100mg) daily.

Wounding Procedure

Rats were anaesthetised with pentobarbitone (30 mg/kg) and the hair on the back was clipped with electric clippers. Burn wounds were created by pouring hot molten wax at 80 °C into metal cylinder placed on the back of the rat.

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The metal cylinder was having 300 mm area of circular openings and capacity to hold 4.6 gm of wax. On solidification of wax (8min.) the metal cylinder with wax adhered to skin was removed which left distinctly demarked circular wounds of 300 mm^2, after this each animal was placed in a separate cage for full recovery from anaesthesia before being returned to holding rooms. No local or systemic chemotherapeutic agents were given. Animals showing signs of infection were excludcd from the study. Actual amount of heat by molten wax to create burn wound was collected by the following formula.

$$\frac{\Delta H}{\Delta A} = \frac{MS\,(T_2 - T_1)}{\text{Area of skin exposed to molten wax (300 mm}^2\text{)}}$$

$\Delta H/\Delta A$ = Amount of heat delivered by molten wax to mm^2 of exposed skin
M = Mass of molten
T_1 = Initial temperature
T_2 = Room temperature
S = Specific heat

The following parameters were studied:

(a) Epithelization period

It was monitored by noting the number of days required for eschar to fall away and leaving no raw wound behind.

(b) Wound contraction

To monitor this progressive changes, wound area were followed planimetrically, leaving the wounding day, wounds were traced, on a transparent paper on alternate days the animal was restrained in proper position during tracing, They were then transferred to 1 mm^2 graph sheet from this wound area and the percent of wound contraction was calculated taking the initial size of the wound (300mm.^{2}) as 100%.

Results and Discussion

The results of the study are shown in Table 1-3. Ethenolic extract and its suspension was used for the healing of wound. It was observed that the breaking strength was much significant than that of the control animal. Therefore it shows that the different concentration of *Achyranthes aspera* may help in wound healing.Chemisty of the biologically active compound in purified fraction of *Achyranthes aspera* showed the presence of Saponin like compound which caused epithelization of the damage tissue.

Table-1: Percentage yield of *Achyranthes aspera* by Soxhlet extraction at 40 °C

Solvent used	Wt. Of powder (gm)	Wt. Of extract (gm)	Yield of crude drug %
n-Hexane	260	5.62	2.620
Chloroform	700	6.42	3.210
Ethyl acetate	200	2.85	1.425
70% Methanol	200	5.30	2.650
Water	200	15.43	7.660

*Both the solutions gave polar compound

Table-2: TLC of crude drug of *Achyranthes aspera*

Solvent system	Fraction	Behavior			RF value of each spot
		Spot No.	Visible	UV light	
$CHCl_3$:MeOH:H_2O (2:2:1)	A1	Spot 1	Dark green	Dark green	0.31
$CHCl_3$:CCl_4:H_2O (2:2:1)	A2	Spot1 Spot 2 Spot 3	Light green Light yellow Dark green	Yellow Brown green	0.42
$CHCl_3$:MeOH:H_2O	A3	Spot 1 Spot 2	Light brown Yellow brown	Dark brown brown	0.56

Table-3: MIC value of the different fraction of Saponin of *Achyranthes aspera* against *Staphylococcus aureus.*

Saponin Fraction	Microorganism minimum inhibitory concentration
Fraction 1	0.63
Fraction 2	0.31
Fraction 3	0.15

The study revealed that when maximum dose 8 mg/mm^2 of *Achyranthes aspera* suspension was applied to wound model, a significant increase was observed in the skin tensile strength for 15 days. Diffcrent dose's of the plant extract was applied and showed good results. The drug treated animal of dead space wound model showed significant increase in dry granulosa weight. Granulosa breaking strength was found to be improved. The collegen fibres were found to be deposited in the drug treated animals more fastly as compared to the control, Varshney *et al.* (1997) have reported the wound healing activity in Bovine saliva. Similarly, Shriwaikar *et al.* (2003) have also reported the wound haeling property of ethenolic extract of leaves of Hyptis sceaveloerrs with supportive role of antioxidant enzymes.

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Effectiveness of coagulation for removal of turbidity and biological growth in experimental salt gradient solar pond

A.K. Saxena*, S. Sugandhi**, M. Husain*** and S.K. Mahajan****
*Samrat Ashok Technological Institute, Vidisha (M.P.)
**Jawaharlal Institute of Technology, Borawan, Khargone (M.P.)
***SSBT's College of Engineering and Technology, Bambhori, Jalgaon (M.S.)
****31, Jain Mandir Path, Khargone (M.P.)

Abstract

The present paper deals with effectiveness of coagulation for removal of turbidity and biological growth in experimental salt gradient solar pond. The result obtained indicated that coagulation is not able to bring down the turbidity below 1 NTU, while at 10 NTU starting turbidity, the optimum alum dose comes out to be 75 mg/l and it is 60 and 45 mg/l for 5 and 3 NTU respectively. This acquired level of turbidity is within acceptable limits for solar ponds, hence the experimentation with higher dose was not continued.

Keywords: *Coagulation, Non convective zone, Salinity, Salt gradient solar pond, Stratified layer, Turbidity*

Introduction

Energy crises are the principal barrier for the development of modern society. Fossil fuel has played the key role in scientific advancement followed by industrialization and modernization in the past century. At the dawn of new millennium, fossil fuel is alarmingly depleting leading to severe energy crises. Apart from this, fossil fuel has left behind the rigorous environmental havocs including global warming and climatic changes. The rapidly degrading environment has become the prevalent threat to the very existence of human civilization (Pachauri *et al.,* 1998). The solution to both the crises i.e. environmental degradation and energy crises lies in the use of alternative energy sources. Solar energy is the obvious foremost choice due to its plentifulness and environmental friendliness. There are various methods of harnessing solar energy. Salt gradient solar ponds are the most significant amongst various solar energy harnessing methods owing to their reliability, economy and large-scale long-term storage capacity. They store solar energy in the form of heat of water, which finds several direct and indirect applications (Sukhatme, 1994; Duffie *et al.,* 1981). The hot water can also be used to run Rankin's cycle generators and to produce electricity (Amnon, 2004). The technology is globally accepted. Israel is doing pioneer work in the field of solar ponds with a target of switching over to complete dependence on solar ponds for their energy requirements by 2025. Large size solar ponds are working successfully all over the world e.g. (Sukhatme, 1994) 2000 m^2 at Miamisburg (Australia), 3500 m^2 at El Paso, Texas (USA), 225000 m^2 at Bet Ha Arava in Israel is the largest of world at the Dead Sea in Israel has been used to generate 5MW of electrical power. India stepped in to the field of solar ponds with a 1200 m^2 at Bhavnagar in 1973.

Other ponds in India are 100 m^2 at Pondicherry, 240 m^2 at IISc Banglore and 1600 m^2 again at Bhavnagar in 1980, 400 m^2 at Masur, 300 m^2 at Hubli .The largest pond built in India is at Bhuj of 6000 m^2 areas. Presently all over the world scientists are working on various aspects of SGSP; the references cited below highlight few significant recent contributions in this field (Punyasena,2003; Angeli *et al.,* 2004; Jaefarzadeh, 2004; Angeli *et al.,* 2005; Agha *et al.,* 2004; Ouni *et al.,* 2003 and Huseyin *et al.,* 2006). Huanmin *et al.* (2004) has given a glossary of major works in the maintenance of pond.

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Salt gradient solar ponds are large body of saline water as shown in the Fig. 1. It has three zones namely upper convective zone, non-convective zone and storage zone. The UCZ is designed to preclude wind born turbulences. It has a minimum salinity of around 2%. The STZ is for storage of hot water. While NCZ has gradient of salinity increasing up to 26% at STZ interface. This prevent convection in the zone hence acts as a lid over STZ. STZ maintains a constant salinity of 26% (Sukhatme, 1994).

The solar radiation penetrates into the depth of pond and warms it up. For the higher efficiency of the pond, good penetration of radiation is required. This insists for transparency (clarity) of the water. However, pond is exposed to atmosphere and continuously receives wind born dust. This adds turbidity to the water. Turbidity has a very drastic effect on radiation penetration and consequently on thermal efficiency (Wang and Yagoobi, 1994,1995 and Husain *et al.*, 2004). Hence a real pond always requires removal of turbidity by coagulation (Kumar *et al.*, 1999). In the present work, an experimental pond is created and salt is dissolved for salinity which imparts to turbidity of water This turbidity is removed by alum dose. Optimum alum dose is worked out to remove turbidity. Optimum time required for removal is also estimated. The experimentation is done for varying levels of starting turbidity.

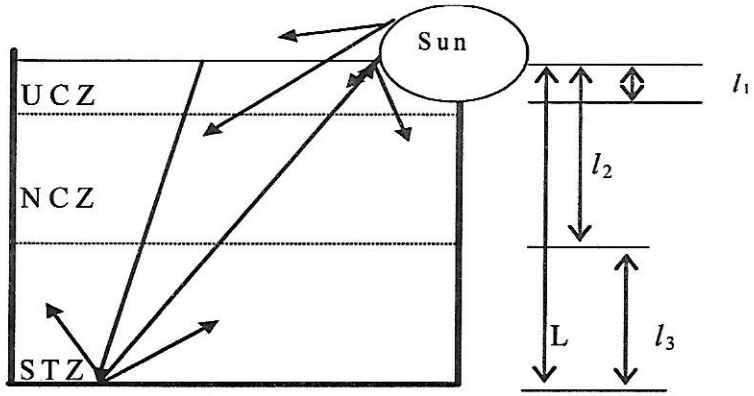


Fig. 1: Schematic diagram of a salt gradient solar pond showing the radiation pathway

Theory

Coagulation of water is a four-stage phenomenon (Sawyer *et al.*, 1978) as described below:

Addition of coagulant $\rightarrow$ *Rapid mixing* $\rightarrow$ *Slow mixing* $\rightarrow$ *Sedimentation*

The rapid and slow mixing is generally done for 30 seconds and 30 minutes respectively. The rapid mixing lead to the uniform mixing of coagulant with water and $Al(OH)_3$ formation. Slow mixing leads to adhesion of $Al(OH)_3$ and colloidal particles to form flocs. Hence it is called as flocculation. Finally sedimentation removes the floc. Sedimentation requires 60 to 90 minutes time. Working of alum is described in following equation (Birdie *et al.*, 1998 and Weber, 1972).

$$Al_2(SO_4)_3.18H_2O + 3CaSO_4 \rightarrow 2Al(OH)_3 + 3CaSO_4 + 18\,H_2O \qquad (1)$$

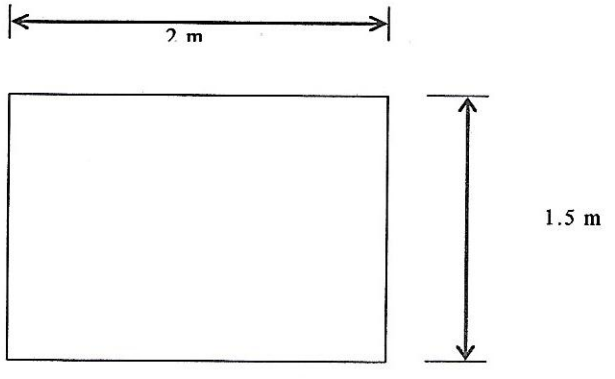
In case of salt gradient solar pond, salinity layers are quite delicate. They are provided to inhibit mixing in the NCZ. Hence rapid and slow mixing in coagulation of pond cannot be carried out. The coagulation is done in two steps only as shown below:

Addition of coagulant in solution form $\rightarrow$ *Sedimentation.*

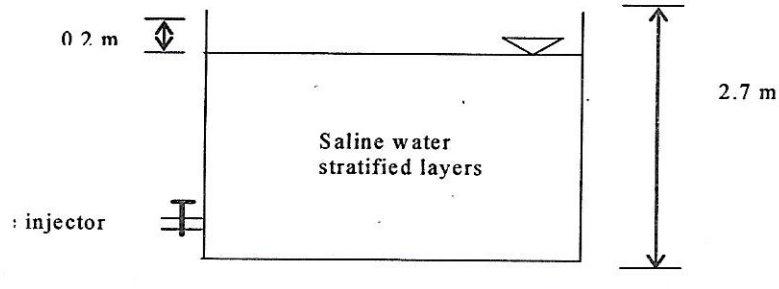
This obviously suggests that the required optimum alum dose shall be unusually higher. Such coagulation is typically termed as still coagulation. Alum is used as a coagulant for present study due to its efficiency, low cost, easy availability and common application by field ponds (Kumar *et al.*, 1999).

Experimentation methodology

A. An experimental laboratory scale pond is created at the laboratory of SATI, Vidisha, MP. Schematic diagram of the pond is shown in Fig 2. It has lateral dimensions 2m x 1.5 m. depth is taken as 2.7 m. freeboard is 0.2 m out of this depth. Hence available effective depth of water is 2.5 m. The tank is made of steel. In a master tank, salt solution (Brine) is prepared and allowed to settle for removal of high turbidity. After a settlement of 24 hours, the supernatant is used in experimental tank. The bottom depth is 1.3 m filled with 26% sodium chloride solution. Then it is filled up to a depth of 2.5 m. with fresh water. Then it is left still for 8 days. The salt slowly diffuses upwards and creates a gradient of salt (Sukhatme, 1994). Meanwhile the bottom zone of experimental tank is fed again with concentrated brine obtained from master tank, to compensate the loss of salt diffused up wards. The feeding is done on 3rd, 5th and 8th day of the start.



Plan of tank used for still coagulation studies



Elevation of tank used for still coagulation studies

Fig 2: Schematic diagram of experimental set up used for coagulation studies.

B. On 9th day, the liquid of experimental tank had a turbidity level of 10 NTU. The tank was ready with salinity layers as shown in Fig 2. Now, tank is dosed with alum solution 15 mg/l. The solution is sprinkled gently over the surface. Then it is allowed to work for 30 minutes. Samples from each 20 cm depth of the NCZ zone of the tank were collected with the help of a long graduated glass tube. The samples were analyzed for residual turbidity in laboratory using Nephelo-Turbidity Meter. Samples were again collected at 60 and 120 minutes and turbidity was measured. The experiment was repeated with higher dose of alum with an interval of 15 mg/l up to 75 mg/l. A dose of 75 mg/l has yielded a residual turbidity of 1 NTU, which is in permissible limits. Hence further increment in the dose is not done.

C. The experimental tank was cleaned and washed. Again in master tank salt solution was prepared. It was dosed and mixed with alum 2 mg/l to reduce the turbidity to 5 NTU. The turbidity was reduced to 8 NTU. Again alum solution was added and turbidity was measured. By hit and try we have obtained a turbidity level of 5 NTU. The steps described in **A** and **B** were performed again. Again experimental tank was prepared with layers (**A**) and alum dosing was done gradually (**B**). At a dose of 60 mg/l, residual turbidity of 1 NTU is obtained.

D. Steps described in **C** were repeated such that starting turbidity of the master tank was kept as 3 NTU. The required dose for obtaining 1 NTU turbidity in experimental pond was 45 mg/l for this case. Normally field ponds are having low turbidity (< 10 NTU). Higher turbidity is uncommon in ponds because of regular maintenance. Hence in the present work, experiment was done with low turbid water.

Results and Discussion

The results are presented in table from Table. 1 to 12. Following salient observations can be made out of these results:

a. The required alum dose for removal of turbidity is very high compared to the case of traditional coagulation (Birdie *et al.,* 1998). The required dose is in the range of 50 to 75 mg/l, while the initial turbidity is quite low, in the range of 3 to 10 NTU.

b. The time required for removal of turbidity is also significantly high. This may also be attributed to the same reason as described above.

c. The reason behind higher dose of coagulant may be attributed to the fact that in the present case, complete coagulation process has not been carried out. The coagulation is done for still water in which flocculation has not been enhanced by mixing.

d. The minimum turbidity achieved is around 1 NTU. Within the observation range, the coagulation has not been able to bring down the turbidity below 1 NTU. With 10 NTU starting turbidity, the optimum alum does comes out to be 75 mg/l. The same for 5 and 3 NTU respectively is 60 and 45 mg/l. This acquired level of turbidity is within acceptable limits for solar ponds. Hence the experimentation with still higher dosing is not continued.

e. The turbidity has formed a downward increasing profile after alum dosing. This is obviously because settlement of colloidal mass is sluggish. The changes in turbidity are relatively faster in the beginning and get slow down after two hours. This is in confirmation to the first order sedimentation kinetics (Sawyer *et al.,* 1978).

f. The higher turbidity has required higher alum dose to yield final minimum turbidity.

Table 1. Removal of turbidity with respect to alum dose in experimental salt gradient solar pond.

Alum dose: 15 mg/l **Initial turbidity: 10 NTU**

Depth of NCZ in m	Residual turbidity after 30 minute in NTU	Residual turbidity after 60 minute in NTU	Residual turbidity after 120 minute in NTU
0.2	8	7	7
0.4	8	7.5	7
0.6	8.5	7.5	7.5
0.8	9	8.5	8
1.0	9.5	9	8

Table 2.Removal of turbidity with respect to alum dose in experimental salt gradient solar pond.

Alum dose: 30 mg/l **Initial turbidity: 10 NTU**

Depth of NCZ in m	Residual turbidity after 30 minute in NTU	Residual turbidity after 60 minute in NTU	Residual turbidity after 120 minute in NTU
0.2	6	5	4.5
0.4	6.5	5.5	4.5
0.6	7	6	5
0.8	7.5	6.5	5
1.0	8	6.5	5.5

Table 3.Removal of turbidity with respect to alum dose in experimental saltgradient solar pond.

Alum dose: 45 mg/l **Initial turbidity: 10 NTU**

Depth of NCZ in m	Residual turbidity after 30 minute in NTU	Residual turbidity after 60 minute in NTU	Residual turbidity after 120 minute in NTU
0.2	4	3	2.5
0.4	4.5	3.5	2.5
0.6	5	3.5	2.5
0.8	5.5	3.5	3
1.0	6	4	3

Table 4.Removal of turbidity with respect to alum dose in experimental salt gradient solar pond.

Alum dose: 60 mg/l **Initial turbidity: 10 NTU**

Depth of NCZ in m	Residual turbidity after 30 minute in NTU	Residual turbidity after 60 minute in NTU	Residual turbidity after 120 minute in NTU
0.2	2.5	2	1.8
0.4	3	2.5	1.8
0.6	3.5	2.5	1.9
0.8	3.5	2.5	2
1.0	4	2.5	2

Table 5.Removal of turbidity with respect to alum dose in experimental salt gradient solar pond.

Alum dose: 75 mg/l **Initial turbidity: 10 NTU**

Depth of NCZ in m	Residual turbidity after 30 minute in NTU	Residual turbidity after 60 minute in NTU	Residual turbidity after 120 minute NTU
0.2	1.5	1.2	1.0
0.4	1.6	1.3	1.0
0.6	1.7	1.35	1.1
0.8	1.8	1.4	1.1
1.0	1.8	1.5	1.2

Table 6.Removal of turbidity with respect to alum dose in experimental salt gradient solar pond.

Alum dose: 15 mg/l **Initial turbidity: 5 NTU**

Depth of NCZ in m	Residual turbidity after 30 minute in NTU	Residual turbidity after 60 minute in NTU	Residual turbidity after 120 minute in NTU
0.2	4	3.5	3.2
0.4	4.5	3.6	3.3
0.6	4.6	3.8	3.3
0.8	4.7	3.8	3.3
1.0	4.8	3.9	3.4

Table 7.Removal of turbidity with respect to alum dose in experimental salt gradient solar pond.

Alum dose: 30 mg/l **Initial turbidity: 5 NTU**

Depth of NCZ in m	Residual turbidity after 30 minute in NTU	Residual turbidity after 60 minute in NTU	Residual turbidity after 120 minute in NTU
0.2	3.5	3	2.6
0.4	3.7	3.1	2.6
0.6	3.8	3.1	2.6
0.8	3.8	3.1	2.7
1.0	4	3.2	2.7

Table 8.Removal of turbidity with respect to alum dose in experimental salt gradient solar pond.

Alum dose: 45 mg/l **Initial turbidity: 5 NTU**

Depth of NCZ in m	Residual turbidity after 30 minute in NTU	Residual turbidity after 60 minute in NTU	Residual turbidity after 120 minute in NTU
0.2	2.5	1.9	1.6
0.4	2.7	2	1.6
0.6	2.8	2	1.7
0.8	2.9	2.1	1.7
1.0	3	2.1	1.8

Table 9.Removal of turbidity with respect to alum dose in experimental salt gradient solar pond.

Alum dose: 60 mg/l **Initial turbidity: 5 NTU**

Depth of NCZ in m	Residual turbidity after 30 minute in NTU	Residual turbidity after 60 minute in NTU	Residual turbidity after 120 minute in NTU
0.2	1.2	1.1	1
0.4	1.2	1	1
0.6	1.4	1	1
0.8	1.4	1.1	1.1
1.0	1.5	1.1	1.1

Table 10.Removal of turbidity with respect to alum dose in experimental salt gradient solar pond.

Alum dose: 15 mg/l **Initial turbidity: 3NTU**

Depth of NCZ in m	Residual turbidity after 30 minute in NTU	Residual turbidity after 60 minute in NTU	Residual turbidity after 120 minute in NTU
0.2	2.4	1.9	1.8
0.4	2.6	2	1.8
0.6	2.8	2	1.8
0.8	2.9	2	1.9
1.0	3	2.1	1.9

Table 11. Removal of turbidity with respect to alum dose in experimental salt gradient solar pond.

Alum dose: 30 mg/l **Initial turbidity: 3 NTU**

Depth of NCZ in m	Residual turbidity after 30 minute in NTU	Residual turbidity after 60 minute in NTU	Residual turbidity after 120 minute in NTU
0.2	1.8	1.6	1.4
0.4	2	1.7	1.4
0.6	2.1	1.7	1.4
0.8	2.1	1.7	1.5
1.0	2.2	1.8	1.5

Table 12. Removal of turbidity with respect to alum dose in experimental salt gradient solar pond.

Alum dose: 45 mg/l **Initial turbidity: 3 NTU**

Depth of NCZ in m	Residual turbidity after 30 minute in NTU	Residual turbidity after 60 minute in NTU	Residual turbidity after 120 minute in NTU
0.2	1.2	1	0.9
0.4	1.3	1.1	0.9
0.6	1.3	1.1	1
0.8	1.4	1.1	1
1.0	1.5	1.2	1

Conclusion

Turbidity in real solar pond is unavoidable. It has a very drastic effect on the thermal performance of pond. Still coagulation as described above has been found to be successful in removing the turbidity. The experimental methodology described above had been successful in bringing down the turbidity to 1 NTU, which is an acceptable value. Of course, the required alum dose is significantly high. While extrapolating these results for a real pond, some additional care is required. The present study is done for a confined tank of water, which is small in dimensions. A real pond is having very large dimensions and it is very difficult to maintain uniformity throughout. Further a real pond is exposed to atmosphere and continuously receives air born turbidity. Hence a real pond may either require an even higher alum dose or may not yield turbidity as low as 1 NTU.

Nomenclature

l_1	Thickness of UCZ (m)
l_2	Depth from surface to the interface of NCZ-STZ (m)
l_3	Thickness of STZ (m)
L	Depth of pond (m)
NCZ	Non-convective zone
STZ	Storage zone
UCZ	Upper convective zone
SGSP	Salt gradient solar pond

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Larval feeding and gallery pattern of a single larva of *Hoplocerambyx spinicornis*, a major pest of Sal, *Shorea robusta*

S. Negi and V.D. Joshi
Department of Zoology, Govt. P.G. College, Kotdwar, Uttarakhand

Abstract

The present study deals with the quantification of larval feeding and gallery pattern of a single larva of *Hoplocerambyx spinicornis*, a severe pest of Sal, *Shorea robusta*. The larva is the destructive stage. They bore into the bark and then slowly moves inwards and upwards through bast and sapwood. Consumption and digestion of wood by a single larva showed that the third instar larva do the maximum damage to the Sal tree as indicated by the size of frass ejected from the tree. During its life time one larva can eject 30.19g (dry wt.) of frass and fecal matter. In view of damage, the bark, bast and heartwood region are of major importance as the attacks is more intense in these region while sapwood region is only a passage way where the larva do not stay for too long. Thus, the size of the fecal matter is the true indicator of larval instars.

Keywords: *Quantification, Single larva, Gallery pattern, Fecal matter*

Introduction

H. spinicornis is a major pest of Sal which causes economic damage to the Sal tree. During the past, several outbreaks have been reported from various parts of the country (Beeson, 1941). The larva of *H. spinicornis* completes its development from 1st instars to final instar inside the bole of the tree. During its development the larva makes galleries while feeding into the sapwood and bore into the heartwood. The duration of larval period is influenced by the climatic condition mainly rainfall, humidity and temperature. The duration of larval instars varies from 150-152 days depending upon climatic conditions (Bhandari, 2001). The amount of dust ejected from the ejection hole by one larva during its life cycle was also quantified. By separating the dust and fecal matter ejected through the hole by sieve size of 1m, 1.5m etc. of different dimensions. It is concluded from the above findings that the third instar larvae do the maximum damage to the tree. In case of Sal heartwood borer or stem borers the larvae works inside the wood and molting also takes place inside therefore it is difficult to ascertain the duration and size of the larval instars. The examination of frass or fecal matter is the true indicator of larval instars in such cases.

Materials and Method

To study the feeding behavior of larval instars freshly cut healthy logs of ½ m long (10 nos.) were kept in rearing cages. Freshly hatched larvae were released into the logs and were reared for one generation. Following the emergence after one year, the size of the emergence hole, larval gallery in wood and bark gallery, pupal chamber size were measured. The amount of frass ejected from the log was also recorded during the period. By considering the mean value of each parameter, standard deviation was also calculated.

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Results and Discussion

The insect exhibits enormous size variation in all the life stages (i.e. adults, larvae and pupae). Thus, according to Roonwal (1977), this is probably due to varying degree of woody nutrition available to the developing larvae inside the host tree. The larva of *H. spinicornis* on hatching is about *ca* 4mm in length and before pupation the length of final instar is *ca* 85 mm in length. The larva complete its development from 1st instars to final instar inside the bole of the tree. During its development the larva makes galleries while feeding on the sapwood and bore into the heartwood. The length of the larva is generally 33-61mm, but a well-fed larva may reach up to 90 mm (Muir, 1929). The shape of larval gallery and that of the bark gallery is zigzag (Plate-1). The length of larva depends upon the amount of nutrition available. Nutrients play an important role in maintaining the healthy stand of Sal because nutrients are constantly being added or removed from the ecosystem by artificial or natural process. The shape of larval gallery and that of the bark gallery is zigzag. The size of the larval gallery was 35.15±8.75 cm and that of the bark gallery was 30.1± 9.76 cm. The size of the pupal chamber was 5.38±0.76 cm and width was 1.32± 0.24 cm the mouth of which is guarded by calcareous operculum (Table. 1). According to Beeson (1919), this calcareous substance is produced by two of the six malphigian tubules; this regurgitated calcareous substance is moulded into a helmet-shaped cap named as operculum, which blocks the mouth of the prepupal chamber. The rest of the larval stage is passed here in quiescent stage and is called the prepupal chamber and which on pupation becomes the 'pupal chamber'. Pupation usually takes place in the month of Feb.-April and the pharate beetle is formed in the month of April-June.

Table:1 Larval food and gallery pattern in *H. spinicornis*

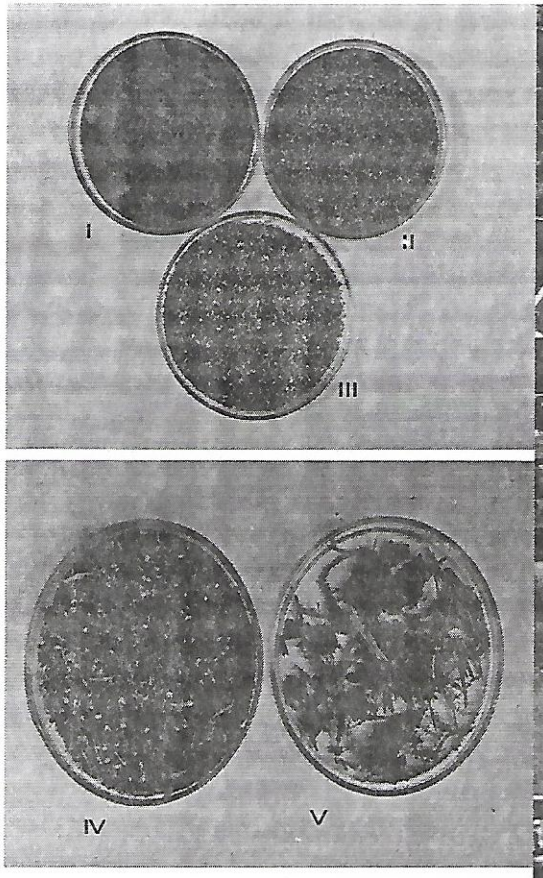
Parameters	Mean
Circumference of log (in cm)	53.67±2.28
Emergence hole size (in cm)	Length 2.39±0.23 Width =1.33±0.15
Pupal chamber size (in cm)	Length=5.38±0.76 Width=1.32±0.24
Larval gallery (in cm)	35.15±8.74
Bark Gallery (cm)	30.10±9.76
Weight of dust ejected by one larva in one year (g)	30.19±3.99

Table:2 Frass size of different instars

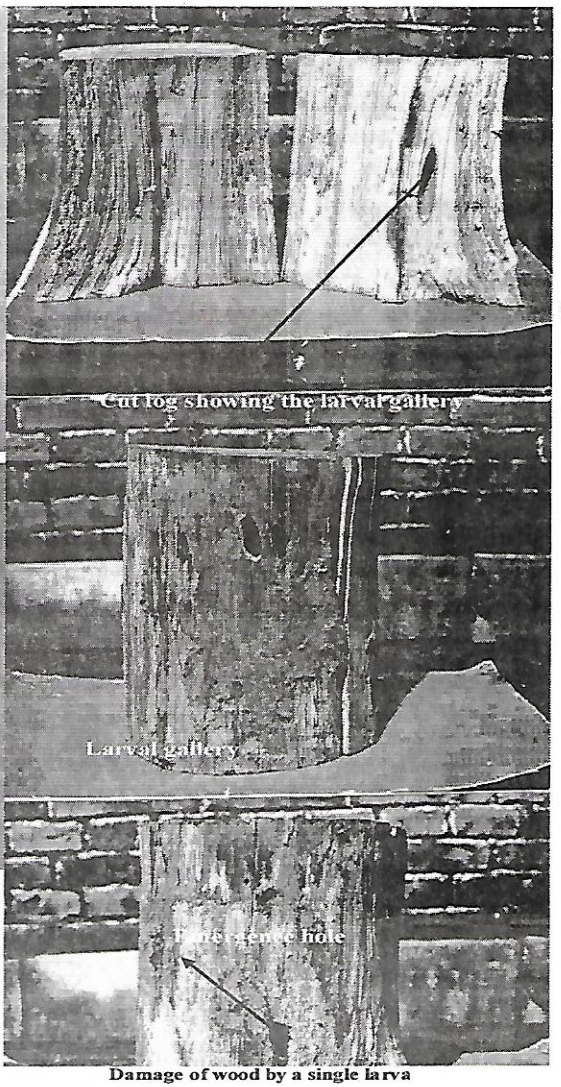
Instar size	Frass (gms)
I	1.131
II	10.287
III	10.970
IV	4.084
V	3.698

Emergence hole is nearly excavated entirely by the adult. The size of the emergence hole depends upon the size of the adult. The length and width of the emergence hole is 2.39±0.23 cm and 1.33±0.15 cm. The shape of the emergence hole is somewhat elliptical. The knowledge on consumption and assimilation of bark and wood by an insect is significant to understand its bioecological behavior in formulating suitable advance control measures. Thus, the damage caused by a single larva was quantified. On an average one larva ejects 30.19 gm of dust and fecal matter in one year. The contribution of different instars was 1.13 gm, 10.28 gm, 10.97 gm, 4.08 gm and 3.69 gm for the Ist, IInd, IIIrd, IVth and Vth instar larva respectively (Table. 2). Third instar larva contributes maximum damage, which proves third instar larva as the most destructive larval stage (Plate-1). By collecting the dust thrown at the base of the tree the number of larvae present inside the tree can be quantified. Eckstein (1938) also concluded frass size as a reliable indicator of larval instars than the width of the head capsule; as in saw fly *Diprion hercyniae* (Morris, 1949) and the

armyworm (*Pseudetida unipunctata*). Pond (1961) also suggested the pellet size as the indicator of larval instar. Quantity and quality of food also plays an important role in increasing or decreasing the development period and also on the size of the insect. In case of sal heartwood borer and or stem borers and root borers the larvae works inside the wood and molting also takes place inside therefore it is difficult to ascertain the duration and size of the larval instars. The examination of frass or fecal matter (Gusain, 2004) is the true indicator of larval instars.



Frass size of different instars. Fig.I: Ist instar, II: IInd instar, : IIIrd i nstar, IVth instar, V: Vth instar.



Damage of wood by a single larva

Plate I :-Laboratory studies showing larval feeding and gallery pattern of a single larva of *H. spinicornis* causing damage to the *Shorea robusta*

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Suitability of ground water for irrigation in Lakhanpur block of Jharsuguda District, Orissa

Atish Kumar Pattanaik
Department of Earth Sciences, Sambalpur University, Jyoti Vihar, Sambalpur

Abstract

Lakhanpur block of Jharsuguda district rests predominantly on crystalline and sedimentary rocks of Precambrian and Permo-carbonifeous age. In most of the part of the study area cultivation sustain on groundwater. The area is characterized by shallow to moderate deep phreatic aquifers system. The present study has been carried out to evaluate the suitability of ground water for irrigation. On the basis of various criteria like salinity, magnesium hazard, RSC etc. The majority of water samples are found suitable for irrigation.

Keywords: *Ground water quality, SAR, Percent sodium, Magnesium hazard*

Introduction

Ground water is a valuable as well as a dependable source to meet both the domestic and agricultural need. In ground water evaluation quality is as important as quantity. The quality of ground water depends on the various chemical constituents and their concentration, which decides its suitability for any particular use. Water used for irrigation can vary greatly in quality depending upon type and quantity of dissolved solid present. The soil problems most commonly encountered and used as the basis of evaluation of water quality are those related to salinity, water infiltration etc. Water used for irrigation should therefore meet the demands of both soil as well as crops for better results.

Lakhanpur block comprises 602.71 sq.km. The livelihood of this area largely depends upon agriculture. The study area rests on crystalline and sedimentary rock of precambrian and permo-carboniferrous age. Geomorphologically it is pedeplain with nos scattered structural and denudation hill. The drainage of the area is controlled by the Mahanadi River. Loamy soil is the most common soil and is of medium depth. The study area enjoys a humid tropical climate with hot summer (maximum 43 °C) and chilled winter (minimum 12 °C). The average rainfall is 1300 mm. The irrigated area with respect to Khariff and Rabi crops are 3376 hectares and 1648 hectares respectively. The total ground water resources available in the block are 3297 ham, out of which utilizable ground water for irrigation purpose is 1929 ham. The purpose of this paper is the evaluation of ground water quality of shallow aquifer and finds its suitability for irrigation purposes. Use of ground water for irrigation if not judged from angle of suitabiiity, may cause serious problems.

Materials and Method

A total of 20 water sample, representing shallow ground water of the study area were collected as per standard procedures laid down by Brown *et al.* (1974). Environmental sensitive parameters such as pH, electrical conductivity (EC) and temperature were measured on the spot at the time of sampling with water analysis kit (CK711 of Century make). For chemical analysis, the ground water samples were collected in precleaned, dried one liter polyethylene bottles after rinsing. The chemical analysis for major cations

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(Na^+, K^+, Ca^{+2}, Mg^{+2}) and anions (HCO^{-3}, Cl^-, $SO4^{-2}$, F^-) of water samples were done at the laboratory, according to standard procedure (APHA, 1989; Jain *et al.*, 1987). The sodium adsorption ratio (SAR), residual sodium carbonate (RSC), percent sodium (% Na), magnesium hazard were calculated, which are used to evaluate water quality for irrigation use. The results of chemical analysis are given in Table.1.

Results

Water quality evaluation for irrigation

Ground water quality depends largely on both, type and quantity of dissolved solids. The important characteristic properties of ground water used for determine its suitability for irrigation in present study area are:

Salinity: Salinity of irrigation water is of major importance. The evaluation of salinity within the root zone is the controlling factor for plant growth and crop yield. The total salt concentration is usually measured as EC in irrigation work. Out of 20 ground waters, no water falls under salinity hazard. Most of the water samples fall in good to permissible zone.

Sodium Hazard: Owing to its effect on both soil and plant, sodium is one of the governing specific ion. A number of indices have been proposed to assess sodium effects and the equilibrium between soil chemistry and soil water chemistry. Percent sodium (%Na) is calculated as

$$\% Na = (Na^+ + K^+) * 100 / (Ca^{+2} + Mg^{+2} + Na^+ + K^+)$$

where,

all values are in epm.

According to the classification depending on % Na as proposed by Wilcox (1967), the ground water of the study area is of good quality.

Sodium adsorption ratio (SAR) is an important parameter for determination of suitability irrigation water and is calculated as

$$SAR = Na^+ / \{(Ca^{+2} + Mg^{+2})/2\}^{1/2}$$

where,

all the values are in epm.

The SAR values in ground water of study area ranges from 0.62 to 2.4 which implies that no alkali hazard is anticipated in the study area. According to classification for irrigation based on SAR the water is of excellent quality (Raghunath, 1987).

Fig. 1. U. S. Salinity Diagram for classification of Irrigational water (After Richards,1954)

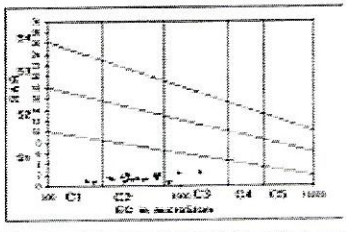

Table.1. Chemical quality of ground water samples of Lakhanpur Block

Sl. No	Location	pH	EC	Na	K	Ca	Mg	HCO3	Cl	SO4	SAR	%NA	RSC	Mg Hazard
1	Charpali	7.6	402	43	12	27	6	150	50	17	1.94	54.06	0.61	27.03
2	Kanaktura	7.9	546	36	22	34	20	137	75	16	1.21	38.74	-1.12	49.50
3	Kandijharan	8.2	401	30	16	24	14	120	60	12	1.20	42.01	-0.40	49.30
4	bikampali	7.1	460	43	8	42	18	200	46	30	1.39	36.56	-0.32	41.67
5	Rengali	7.5	289	29	5	20	7	50	53	27	1.42	46.73	-0.76	36.84
6	Machida	8.3	951	90	65	60	30	315	195	56	2.36	50.36	-0.34	45.45
7	Jamgaon	7.3	640	60	25	52	9	150	110	38	2.02	49.24	-0.89	22.39
8	Kuremal	7.1	1390	118	4	114	41	330	305	15	2.40	36.47	-3.71	37.48
9	Kodapada	8	680	68	5	40	22	260	85	30	2.14	44.59	0.43	47.83
10	Durga	8.4	378	19	14	34	12	150	32	16	0.71	30.50	-0.24	37.04
11	Bagmunda	8.8	812	20	11	26	32	215	113	8	0.62	22.50	-0.44	67.23
12	Pandra	7.3	360	34	6	20	8	120	30	18	1.62	49.48	0.30	40.00
13	Lakhanpur	8.4	300	25	6	21	10	200	25	5	1.12	39.72	1.40	44.25
14	Kudloi	7.9	515	29	3	34	14	165	64	18	1.05	31.82	-0.16	40.70
15	Ubda	8.1	390	43	16	20	8	110	35	30	2.05	57.77	0.14	40.00
16	Kursoloi	8.6	195	16	4	28	1	100	23	4	0.81	34.99	0.16	5.62
17	Kumarbandha	7.5	220	14	6	20	6	90	25	9	0.70	33.70	-0.02	33.33
18	Piplikani	8	425	30	3	38	12	200	30	7	1.08	32.26	0.38	34.48
19	Sarandamal	7.1	656	47	10	50	22	225	45	12	1.39	34.67	-0.64	42.31
20	Karpabahal	7.2	467	36	6	45	8	120	30	30	1.30	37.08	-0.95	22.86

***All concentration are in mg/l, except pH, EC(µS/cm), SAR and RSC (meq/l**

Magnesium Hazard: a ratio of (Mg X 100)/ (Ca + Mg), is used as magnesium hazard of irrigational water. When this ratio is less than 50, no magnesium hazard is found. According to this scheme all of the ground water samples except one are found to be within 50.

Alkalinity Hazard: when the sum of CO_3^{-2} and HCO_3^{-1} is in excess of Ca and Mg there occurs a complete precipitation of the later. It is judged by the RSC value (Eaton, 1950).

$RSC = (HCO_3^{-1} + CO_3^{-2}) - (Ca^{+2} + Mg^{+2})$, all values area in epm.

The water of low RSC values (<1.25) is safe for irrigation where RSC value above 2.5 is unsuitable and may cause hardening of soil which may lead to infertile soil. Except one (1.6), all the water samples are found to be within safe limit.

Integrated effect of Electrical conductance and SAR: The SAR (Sodium Hazard) and EC (Salinity Hazard) values of the ground water of the study area were plotted in the graphical diagram of irrigational water (Richards, 1954) (Fig.1). Most of the samples (16) fall in the category of good quality with low alkali hazard and moderate salinity hazard (C_2S_1). Only 3 sample fall under class C_3S_1, show medium to high salinity hazard.

Toxicity: Certain ions like sodium and chloride in the soil and water are taken up by plant and accumulate to concentration high enough to cause crop damage or reduce yield. The degree of damage depends upon the exposure time, concentration, sensitivity of the crop and volume of water transpired by crop. Sodium and chloride can also cause toxicity by absorbing through wetted leaves by over head sprinklers. No sodium, chloride and bicarbonate toxicity have been encountered in the water samples of the study area.

Conclusion

On the basis of various criteria and guidelines the ground water quality of the phreatic aquifers of Lakhanpur block of Jharsuguda Dsistrict is found suitable for agricultural purpose. There is no harm in using ground water as source of irrigation in present soil condition.

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Wastes encountered by green chemistry

Pankaj Srivastava, Rajeev Rajput, Mukesh Ruhela, Munendra Varshney* and Dheeraj Kumar#
Dept.of Applied Sciences, Vishveshwarya Institute of Engi. & Tech., Dadri (G.B. Nagar)
* Department of Pharmacy, Vishveshwarya Institute of Medical Sciences, Dadri (G.B. Nagar)
# Department of Chemistry, Aligarh College of Engi. & Tech., Aligarh

Abstract

Green chemistry involves an economically sustainable view of chemical research, development and manufacture and is dedicated to chemistry to benefit society. Now a days green chemistry is universally accepted term to reveal the movement towards more environmentally accepted chemical processes and products.

Keywords: *Green chemistry, HAZMAT, Twelve principles of Green Chemistry*

Introduction

Man has always inhabited two worlds. One is the natural world of plants, animals, air, water and soil, of which man himself is a part; while the other is the built world of social institutions and artifacts, which he created for himself by using science and technology. Since man inhabits both the worlds, so they constitute an important part of the environment (Deswal and Deswal, 2005). Throughout the history, mankind has adapted to the natural variations of the earth's system and its climate. Until very recently in the history of the earth, humans and their activities have not featured as a significant force in the dynamics of the earth system. But today, mankind has begun to match and even surpass the forces of nature in changing key earth's system process (Joseph, 2006).

Primitive humans used natural resources to satisfy their basic needs of air, water, food and shelter. These natural and unprocessed resources were readily available in the biosphere and the residues produced by the use of these resources were generally compatible with or easily assimilated by the environment. With the dawn of the industrial revolution, humans were better able to satisfy their needs. So, humans turned their attention to other needs beyond those associated with survival. These acquired needs are usually met by items that must be processed or manufactured or refined; and the production, distribution and use of such items usually results in more complex residuals or wastes, many of which are not readily assimilated by the environment.

Wastes are broadly classified as domestic, trade and industrial. Domestic wastes are originated from homes. Trade wastes originate from retail, commercial and business premises. Industrial wastes originate from all mineral manufacturing and processing establishments. Different types of industries produce large quantities of solid wastes. During last 50 years, about six million chemicals have been synthesized at the rate of 10,000 new ones every month. Some 60,000 to 70,000 chemicals are used extensively in millions of different commercial products. A chemical that causes certain hazard or risk is known as hazardous material (HAZMAT). HAZMAT is waste that poses substantial or potential threats to public health or the environment and generally exhibits any one or more of these characteristics:

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(1) **Ignitability-** Ignitable wastes spontaneously combustible or have flash point less than 60 °C. e.g. waste oils and used solvents.

(2) **Corrosivity-** Corrosive wastes are acid and bass that are capable of corroding metal (12.5dHpH dH 2). e.g. battery acid.

(3) **Reactivity-** Reactive wastes are unstable under normal conditions. They can cause explosion, toxic fumes, gases or vapors when heated, compressed or mixed with water. e.g. Li-S batteries and explosives.

(4) **Toxicity-** Toxic wastes are harmful or fatal when ingested or absorbed. These wastes when land disposed, contaminated liquid may leach from the waste and pollute ground water. e.g. wastes containing mercury or lead.

These wastes not only degrade the quality of environment but also affect human life. So, there is an urgent need of some alternatives that provide better products that are not harmful to our environment. The term green chemistry (Morgenstern *et al.*, 1996) describes an area of research arising from scientific discoveries about pollution and from public perception, in much the same way as the identification and understanding of a deadly disease stimulating the call for a cure. Green chemistry, an approach to the synthesis, processing and use of chemicals that reduce risks to humans and the environment, covers the following areas (Sanghi, 2000) :

- Application of innovative technology to establishe industrial processes.
- Development of environmentally improved routes to important products.
- Design of new green chemicals and materials.
- Use of sustainable resources.
- Use of biotechnology alternatives.
- Methodologies and tools for evaluating environmental impact.

The term 'Green Chemistry' was coined at the Environmental Protection Agency (EPA) established in 1970. Green chemistry or environmental benign chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances (*http://center.acs.org/applications/greenchem*). In late sixties and seventies great attention has been taken in the field of environment. Several laws were developed during this period in order to protect our environment; twelve major laws among them are:

(A) 1970 clean Air Act. Regulates air emissions.

(B) 1972 National Environmental Policy Act. Requires in part that EPA review environmental impact statements of proposed major federal projects.

(C) 1972 Clean water Act. Establishes the sewage treatment construction grant program and a regulatory and enforcement program for discharges of pollutants into US waters.

(D) 1972 Federal Insecticide, Fungicides and Rodenticides Act. Governs distribution, sale and use of pesticides products. All pesticides must be registered by EPA.

(E) 1972 Ocean Dumping Act. Regulates the international disposal of materials into ocean waters.

(F) 1974 Safe Drinking Water Act. Establishes primary drinking water standards.

(G) 1976 Toxic Substances Control Act. Requires the testing, regulating and screening of all chemical produced or imported in the U.S.

(H) 1976 Resource Conservation & Recovery Act. Regulates solid and hazardous waste form "cradle to grave".

(I) 1976 Environmental research & development demonstration Act. authorizes all EPA research programs.

(J) 1980 Comprehensive environmental response, Compensation and Liability Act, better known as Superfund. Provides for a federal "superfund" to clean up abandoned hazardous waste sites, accidental spills and other emergency releases of pollutants in the environment.

(K) Emergency planning and Community right-to-know act. Requires that industries report toxic releases and encourages planning by local communities to respond to chemical emergencies.

(L) 1990 Pollution Prevention Act. Seeks to prevent pollution by encouraging companies to reduce the generation of pollutants through cost-effective changes in production, operation and raw material use.

Green chemistry is the utilization of a set of principles that reduces or eliminates the use of generation of hazardous substances in the design, manufacture and application of chemical products associated with a particular synthesis or process. Thus chemists can greatly reduce risk to human health and the environment. Consequently, there have been efforts to achieve environmentally benign synthesis (Tundo, 1998) and various acts have been passed to control and treat pollution, in an endeavour to encourage industries and academics to devise novel technologies, processes and educational materials, discouraging the formation or use of hazardous substances. This revolution is rather recent and started in the real sense in the 1990s, especially in the developed nations like the US, Germany and UK, for instance. Eventually, it is appreciated that while it is necessary to proclaim enactments and legislations, what is perhaps more important is the realization of detriments not only by the chemists/technologists, the academia and policy makers but also by the common mass in good proportion, to enable create a sense of resistance (Bora *et. al.*, 2002).

Twelve principles of green chemistry (Anastus, 1998)

(1) It is better to prevent waste than to treat or clean it up after it is formed.

(2) Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.

(3) Wherever practicable, synthetic methodologies should be designed to use and generate substances that possess little or no toxicity to human health and the environment.

(4) Use of auxiliary substances (solvents, separation agents, etc.) should be avoided whenever possible and, innocuous when used.

(5) Chemical products should be designed to preserve efficacy of function while reducing toxicity.

(6) Energy requirements should be recognized for their environmental and economic impacts and should be minimized. Synthetic methods should be conducted at ambient temperature and pressure.

(7) A raw material feedstock should be renewable rather than depleting, whenever technically and economically practical.

(8) Unnecessary derivatization (blocking group, protection/deprotection, and temporary modification of physical/chemical processes) should be avoided whenever possible.

(9) Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.

(10) Chemical products should be designed so that at the end of their function, they do not persist in the environment and break down into innocuous degradation product.

(11) Analytical methodologies need to be further developed to allow for real-time in-process monitoring and control prior to the formation of hazardous substances.

(12) Substances and the form of a substance used in a chemical process should be chosen so as to minimize the potential for chemical accidents, including releases, explosions and fires.

Green chemistry aims towards the design of environmental friendly products and processes using environmental friendly materials and solvents, with no or minimal amount of waste generation. Complete conversion of the reactant molecules to useful products, called atom economy, is the first step in Green chemistry. The Green chemistry approach 'benign by design', when applied at the design stage, help assure the sustainability of new products across their full life cycle and minimize the number of mistakes. Thus we can say Green chemistry deals ideal synthesis, which covers safety, renewable materials, 100% yield in one step, no waste, simple separation and atom efficiency.

Conclusion

Though it is true that many industries and research organizations are yet to implement the principles of green chemistry, nevertheless some of them have begun to realize that the 'think green' culture is more than just a fashion. In fact, the winds of changes have already started blowing and the more successful chemistry researchers and chemical technologists will like to appreciate and apply the values of green chemistry in innovation, application and teaching.

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Corynespora sp.- An ethnomedicinal plant from north western Tarai forest of Uttar Pradesh - A new report

D.P. Singh, Nishat Asif and T.P. Mall
P.G.Department of Botany, Kisan P.G. College, Bahraich U.P., India

Abstract

During survey of medicinal plants of Dudwa Tiger reserve, Kheri Lakhimpur, the hot spot of plant diversity in north western tarai forest region of Uttar Pradesh, on November 25, 2006 the authors collected two important ethnomedicinal plants i.e. *Terminalia tomentosa* and *Mallotus phillipinsis* suffering from foliar blight disease. On detailed examination of fungus it was identified as corynespors sp. infected leaves having irregular, greyish white spots on lower surface, brown on upper surface. Microscopic examination of the infected part revealed the presence of solitary, 1-s distoseptate, obclavate, dark, brown, paler towards the apex, smooth, 16-30*6-8 millimicron conidia.

Keywords: *Corynespora sp., Terminalia tomentosa, Mallotus phillipinsis*

Introduction

The north western belt of U.P. is the hot spot showing great plant diversity as well as fungal diversity. A survey trip was organized for Dudwa Tiger Reserve, Kheri Lakhimpur on 25th November, 2006 for collection of ethnomedicinal plants and foliar fungi infecting the medicinal plants. During the disease survey we collected two important ethnomedicinal plants i.e. *Terminalia tomentosa* and *Mallotus phillipinsis* suffering from foliar blight disease. The infected leaves showed irregular, greyish white spots on lower surface, brown on upper surface. Both the ethnomedicinal plants have great therapeutics as their bark possess diuretic, cardiotonic properties and given in spleen enlargement.

Materials and Method

The collected specimens were pressed and dried by routine herbarium technique as described by Jain and Rao (1978). Infected leaves were collected, hand cut section and scrap mount were prepared of infected parts in lactophenol and cotton blue as described by Jamal *et al.* (2003).

Results and Discussion

The slide were examined and fungus was identified. Microscopic examination of the infected part revealed the presence of solitary, 1-5 distoseptate, obclavate, dark brown, paler towards the apex, smooth, 16-30* 6-8 millimicron conidia. The fungus was later confirmed as *Corynespora* sp. by Prof. Kamal, Emeretus Professor in Botany, D.D.U. University of Gorakhpur, Gorakhpur (U.P.).

Corynespora sp. was recorded on *Terminalia tomentosa* and *Mallotus phillipinsis*. The fungus causes foliar blight disease on the plants in which leaves are badly damaged. The leaves provide a suitable habitat for the growth and development of fungal pathogens by providing ample surface area and nutrient supply. The fungal pathogen damage the photosynthetic elements of living leaves. Leaf spot reduces the photosynthetic area of leaf and productivity of host, leaf inhabiting fungi interfere with the physiology of the host and host as well as pathogen both produce toxins which may cause degradation in the quality of

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bark which is ethnomedicinally important. When leaf is damaged, the ethnomedicinal properties are lost so attention must be paid towards the conservation of *Terminalia tomentosa* and *Mallotus phillipinsis*.

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Recent progress in Aflatoxin analysis and their inactivation

Harish Chandra*, Parul Bishnoi, Jatin Srivastava***, A.R. Nautiyal# and S.V.S. Chauhan****

*Deptt. of Microbiology, Gayatri College of Biomedical Sciences, Dehradun (Uttarakhand)
**Institute of Life Science, Dr. Bhim Rao Ambedkar University, Agra (U.P)
***Deptt.of Env.Sciences,Institute of Biological Science and Biotechnology, C.S.J.M.University, Kanpur
#High Altitude Plant Physiology Research Centre, H.N.B. Garhwal Univesity, Srinagar, Garhwal

Abstract

Aflatoxin is the secondary metabolite of low molecular weight produced by naturally occurring fungi mainly *Aspergillus flavus* and *Aspergillus parasiticus*. Rapid progress in the area of aflatoxin analysis and detoxification method has been made during the last few years. Simplified method, cleanup protocol and chromatographic methods have been continuously developing to make these methods more sensitive and reliable. In this review we are discussing different aflatoxin analysis methods as well as different methods of aflatoxin detoxification.

Keywords : *Aflatoxin, Aspergillus flavus, Aspergillus parasiticus*

Introduction

Cereals, especially maize and groundnut are the major sources of carbohydrates and proteins in Asia and are important as export products in some Asian countries. Grain quality is critically monitored to meet international standards in export. Aflatoxin development in many stored cereal grains has constantly hampered the availability of good quality grains in Asian countries. The most important group of toxigenic Aspergilli are the Aflatoxigenic molds, *Aspergillus flavus, Aspergillus parasiticus* and the recently described but much less common species *Aspergillus nomius* all of which are classified in Aspergillus section Flavi (Gams *et al.*, 1985). Although these three species are closely related and share many similarities, a number of characteristics may be used in their differentiation. *A. flavus* is widely distributed in nature but *A. parasiticus* is less wide spread, the actual extent of its occurrence being complicated by the tendency for both the species reported indiscriminately as *A. flavus*.

A. flavus Link ex Fries and *A. parasiticus* Speare have been identified as the major pests that produce aflatoxin and deter the quality of grain when stored. They especially affect oilseed. Edible nuts and cereals in subtropical regions throughout the world are spoiled due to inadequate storage conditions. The main cause of disease in the human is their secondary metabolite i.e. Aflatoxins which are carcinogenic and result in liver cancer. Liver cancer takes time to develop but the aflatoxin acts as an immunosuppressant so that affected individuals become susceptible to wide range of diseases. In the last decade, aflatoxin levels on product were found to exceed an acceptable level limit of 20 ppb stipulated in most export specifications. Aflatoxin contamination has affected maize, groundnuts, peanuts and cottonseeds in several countries including Thailand and India; and coconut in the Philippines, Sri Lanka and other Pacific countries. Aflatoxicosis, both in humans and animals, has been more prevalent in areas where maize and groundnut constitute a major part of the diet. Many private and government organizations have embarked on aflatoxin research. However, aflatoxin control is still an intricate problem.

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Aflatoxins have been widely detected in cereals, oilseeds, fermented beverages and milk which form basic human diet (Bilgrami *et al.*, 1983; Bullerman, 1986). Maize has been reported to be the most susceptible followed by groundnut to aflatoxin contamination. Bhat *et al.* (1997) reported that about 26% maize and 21% of groundnut samples collected from 11 states exceed the permissible limit of 30ppb aflatoxin per kg of material. Prevention of Food adulteration act (1954), amended in 1986, U.S. Food and Drug Administration (FDA) and the Codex Alimentarius Commission (1989) have recommended a permissible limit of aflatoxin of 30ppb/kg, 20ppb/kg and 5ppb/kg respectively.

A survey from thirty countries concluded that aflatoxins are the leading toxins present in agricultural commodities, compared to the presence of other mycotoxins (Hesseltine, 1986). Aflatoxin in animal feed presents two problems; first deleterious effect on the health of the animal ingesting the contaminated feed and on the health of humans consuming aflatoxin residue in foods derived from such animals. There is great variation among strains of *A. flavus* in the quantity of aflatoxins produced (Cotty, 1989), this quantity is independent of a strain's ability to infect and colonize developing cottonseed. Simultaneous inoculation of wounded 28-to-32-day-old cotton bolls with toxigenic and aflatoxigenic strains of *A. flavus* led to lower levels of aflatoxin B_1 in the cottonseed at maturity than in bolls inoculated with the toxigenic strain alone. Less B_1 was detected when the aflatoxigenic strain was introduced into the wound 1 day before inoculation with a toxigenic strain than when atoxigenic and toxigenic strains were co-inoculated (Cotty, 1990). In this review we are discussing some important methods for analyzing aflatoxin and methods of inactivation by physical, chemical as well as biological means.

1.0 Sampling and sample preparation for aflatoxin analysis

Sampling is important and usually the largest source of error. This is because a small percentage of the kernels and contaminated kernels have high level of Aflatoxin and other fungal toxin (Whitakar and Wiser, 1969). With small samples, it is difficult to get contaminated kernel in the sample. Studies have shown that less than 1 kernel per 1000 (0.1%) is contaminated in a lot or raw shelled peanuts. The sample has to be selected in such a way that every kernel in the lot has an equal chance of being chosen. The sample should be the accumulation of many small incremental portions taken at many different locations throughout the lot (Whitaker, 2000). The sample is ground in mill. The kernels are broken into many small pieces. Then a small sub sample of ground product is removed from the sample. The aflatoxin and other fungal toxin in replicated subsample will also vary about the sample concentration. Sample error is reduced by increasing sub-sample size and grinding the sample into finer particles.

1.1 Detection of Aflatoxin in food commodities

There are various methods for determination of aflatoxin in food commodities. Some of the important methods are:

A. Thin Layer Chromatography (TLC)

Aflatoxin has fluorescent properties i.e. Aflatoxin B_1 and B_2 give blue and Aflatoxin G_1 and G_2 give green fluorescence under U.V. light at 360 nm. This property of fluorescence has been utilized for the detection of different types of aflatoxin by TLC. The first thin layer chromatographic (TLC) separations of aflatoxins were proposed simultaneously by Coomes and Sanders (1963). They used paper chromatography and reported that the system did not resolve aflatoxins B_1 and B_2, the least detectable amount of B ($B_1 + B_2$)

was about 0.2 µg. Broadbent *et al.* (1963) used glass plates coated with neutral alumina and reported that B_1 and B_2 were not resolved but as little as 6×10^{-3} µg of B could be detected, about a 30 fold increase in sensitivity over that attainable with paper chromatography for development. The two dimensional thin layer chromatography was proposed by Peterson and Ciegler (1967) to yield improved separation of aflatoxins from impurities in plant extract and for better separation of aflatoxin B_2 from G_2. Neshiem (1968) has investigated the effect of variations in developing solvents, commercial silica gels, calcium sulfate binders, gel thickness, humidity and vapor phase composition, all of which influence the separation of aflatoxins in thin layer chromatography. TLC method has detection limit of 50-100 ppb. In TLC method compare the fluorescence intensities of the spots at the Rf of B_1 in the sample with those of the B_1 standard spots and determine which of the sample spots matches one of the standards and record the corresponding aliquot volumes. If the sample spot intensity lies between two adjacent standard spots the average liquor volume of the standard spots is recorded. If the spots of the smallest volume of sample are too intense to match the standards the sample extract should be diluted and re-chromatographed. Stroka and Anklam (2000) developed miniaturized and low power consuming detector cell for the densitometeric measurement of aflatoxin on TLC plates. A UV-light emitting diode (UV-LED) with a peak emission wavelength of 370nm was used for the fluorescence excitation, while photo diode with peak sensitivity of 440 nm in combination with a 418 nm cut off filter was applied for detecting the fluorescence intensity. The resulting signal was further amplified by means of commonly used operational amplifier integrated circuit (OA) and directly converted into digital signal with simple analogue-digital converter (ADC). This signal was recorded at the serial (RS232) port of a portable PC and processed with spreadsheet program.

HPTLC-ELISA involves the separation of Mycotoxins in HPTLC, followed by blotting the chromatogram to nitrocellulose membrane coated with antibody, incubation with mycotoxin enzyme conjugate and finally incubation with substrate to develop the color. The only disadvantage of this technique is use of large amount of antibody.

B. High Performance Liquid Chromatography (HPLC)

The development of highly automated HPLC systems has afforded very precise, selective and sensitive quantification techniques for aflatoxin analysis. HPLC methods have been developed using both normal and reverse phase systems in conjunction with UV adsorption and fluorescence detection techniques. Reverse phase HPLC separations of aflatoxins are more widely used than normal-phase separations. Aflatoxin analysis using HPLC for separation and detection is quite similar to TLC because similar sampling and extraction procedures are used. The major advantages of HPLC over TLC are speed, automation, improved accuracy and precision. Both normal-phase and reverse-phase HPLC separations have been developed for aflatoxin analysis. Early experimental work by Seitz (1975) on HPLC separations revealed that aflatoxins could be separated on normal-phase columns and detected with either a UV detector or a fluorescence detector. Seitz (1975) noted that the fluorescence detector had limited usefulness for aflatoxin B_1 and B_2 with normal phase separations. Panalaks and Scott (1977) developed a silica-gel packed flow cell for fluorometric detection of B_1, B_2, G_1, and G_2 with normal phase aflatoxin separations. A silica-gel packed cell was used by Pons (1979) and Thean *et al.* (1980) in two different HPLC methods for determination of aflatoxins. The major disadvantage of the packed cell is lack of stability. The cell needs to be repacked often and the detector signal weakens with time. The advantages of a packed cell

method are that no derivative is necessary for detection and the mobile phase can be recycled. Reverse-phase HPLC separations of aflatoxins are more widely used than normal-phase HPLC separations. However, the fluorescence intensities of B_1 and G_1 are diminished in reverse-phase solvent mixtures so the derivatives B and G are diminished in reverse-phase solvent mixtures so the derivatives B and G are generally prepared before injection. Analysts should be aware that derivatives B and G are not stable in methanol, which should be used with caution, especially in the injection solvent. Acetonitrile-water mixtures do not degrade B and G rapidly and are preferred to methanol-water mobile phases. Several reverse-phase methods have been published (Stubblefield and Shotwell, 1977; Hutchins and Hagler, 1983 and Tarter *et al.*, 1984). Stubblefield and Shotwell (1977) found that M_1 and M_2 as well as B_1, B_2, G_1 and G_2 could be resolved and detected with a UV detector at 350 nm using reverse-phase chromatography. The methods developed by Hutchins and Hagler (1983) and Tarter *et al.* (1984) all use TFA derivatization and apparently compare favorably with other methods

According to the procedure described by Sharma and Marquez (2001) a 50gm sample was extracted with 100 ml of methanol-water (60:40 v/v) for 1 minute and then filtered on Whattman Filter paper no. 4. The sample extract was concentrated to a volume of 30ml and was then diluted with 40ml PBS (pH 7.4). It was cleaned up on an immunoaffinity column by gentle syringe pressure at flow rate of 5ml/min and then the column was washed with distilled water (20 ml). Elute from each column containing the analytes were evaporated to dryness under nitrogen in 2 ml vials, the residue were derivatised with hexane/trifluoroacetic acid (300µl each) mixed and incubated for 10 min at 40°C. The solvent were evaporated and finally the residues were dissolved in Acetonitrile and distilled water (60 and 180 µl respectively). Aflatoxins were separated isocratically on Perkin-Elmer HPLC chromatograph, connected to reverse phase C18 column particle size 5 µm, LC-10 flourescence detector (Perkin Elmer) and LCI-100 computing integrator. Measurements were made by peak area. The mobile phase was 60% water, 22% acetonitrile and 18% methanol (filtered through 0.2 µm Millipore filter) at flow rate of 1 ml/min and detection was observed by fluorescence with excitation at 370 nm (λ_{em}) and emission cut off at 418 nm(λ_{em}). Quantification of each toxin was performed by measuring peak areas at their retention time and comparing with their relevant standard calibration curve. The identity of each toxin was confirmed in all the analyzed samples by injecting sequentially sample extract and comparing the peak area ratio with their corresponding standard. HPLC has partly superceded TLC in the analysis of food for mycotoxin. Separation is usually much better than those obtained with one dimensional TLC. HPLC methods generally provide good quantitative information and the equipment employed in HPLC systems is generally automated rather easily.

Otta *et al.* (2000) developed rapid, reproducible and cost effective Over Pressure Layer Chromatography (OPLC) method for quantitative determination of Aflatoxin B_1, B_2, G_1 and G_2 in different foods. Using OPLC one can analyse ten samples simultaneously. Chiavaro *et al.* (2001) studied the effect of succinyl-β-cyclodextrin (β-CD-Su), Dimethyl-β-cyclodextrin (DINEB) and β-cylodextrin (β-Cd) on the fluorescence of B_1, B_2, G_1, G_2 and M_1. β-CD-Su promoted the largest fluorescence enhancement for AFB_1 and AFM_1 while DIMEB showed better result for AFG_1. On the basis of the Fluorescence enhancement, a RP-HPLC method for detecting aflatoxin B_1, B_2, G_1, G_2 and M_1 was developed using cyclodextrins directly dissolved in the LC elutent. Aflatoxin B_1, B_2, G_1 and G_2 were resolved using methanol: water as mobile phase to which β-CD-Su or β-Cd was added. Chromatographic response of AFB_1 and AFG_1 achieved using β-CD dissolved in the mobile phase were enhanced respectively, 8 and 12 times and 10 to 15 times with β-CD-Su. Blesa *et al.* (2003), developed method based on solid-solid phase dispersion (MSPD) extraction to determine

aflatoxin B_1, B_2, G_1 and G_2 from peanut. The method used 2 gm of peanut sample, 2 gm of C18 bonded silica as MSPD sorbent and Acetonitrile as eluting solvent. The limit of quantification ranges from 0.125 to 2.5 ng/g for the four studied aflatoxin using Liquid Chromatography. Calleri *et al.* (2007) developed fully automated HPLC method with fluorescence detection for the determination of AFB_1 in aqueous solution by using anti-aflatoxin B_1 immunoaffinity monolithic disk. Polyclonal anti AFB_1 is covalently immobilized in batch on an epoxy activated monolithic Convective Interaction Media (CIM) disk (12mm x 3mm i.d) by a one step reaction. 0.96 mg of antibody were immobilized. The CIM disk was coupled through a switching valve to reverse-phase column Chromolith Performance RP-18e. The total analysis time with integrated system is 46 min and the retention time of AFB_1 is approx. 29 min.

C. Radio Immuno Assay (RIA)

The RIA involves the incubation of specific antibody simultaneously with unknown sample or known standard and constant amount of labeled toxin. After separation of the free and bound toxin, the radioactivity in those fraction is then determined. The toxin concentration of the unknown sample is determined by compairing the results to a standard curve, which is established by plotting the ratio of radioactivities in the bound fraction and free fraction with log concentration of unlabeled standard toxin. RIA can detect 0.25 to 0.5 ng of purified mycotoxin. The sensitivity of RIA can be improved by a simple cleanup procedure after extraction or by using radioactive markers of high specific activity (^{125}I-labeled mycotoxin) (Chu, 1991).

D. Enzyme Linked Immunosorbent Assay

There are two methods of ELISA used in the analysis of Aflatoxin. One type, direct ELISA involves the use of an aflatoxin-enzyme conjugate and other system, indirect ELISA involves the use of a protein-aflatoxin conjugate and a secondary antibody to which an enzyme has been conjugated (Chu, 1986). In the direct competitive assay specific antibodies are first coated to a solid phase, including polystyrene microtiter plate (Chu, 1991). The sample solution or standard toxin is generally incubated simultaneously with enzyme conjugate or incubated separately in two steps. After washing, the amount of enzyme bound to the plate is then determined by incubation with a substrate solution containing hydrogen peroxide and appropriate oxidizable chromogen. The resulting color is measured spectrophotometrically or by visual comparison with the standard. In this assay, toxin in the sample and toxin-enzyme conjugate compete for the same binding site with the antibody coated to the solid-phase. Because the toxin-enzyme and antibody concentration are constant, the color intensity as a function of enzyme is inversely proportional to the toxin concentration in the testing sample. In the indirect ELISA, an aflatoxin protein conjugate is first prepared and then coated to the microtiter plate before assay. The plate is then incubated with specific rabbit antibody in the presence or absence of the homologous aflatoxin. The amount of antibody bound to the plate coated with aflatoxin conjugated protein is then determined by reaction with goat anti-rabbit IgG enzyme. Thus toxin in the sample and toxin in the solid-phase compete for the same binding site with the specific antibody in the solution. The indirect ELISA has been used for the analysis of a number of mycotoxins (Chu, 1991). Degan *et al.* (1989) developed method to analyse Aflatoxin involving the use of Europium ion (Eu) labeled antibody. Kolosovo *et al.* (2006), developed direct competitive ELISA for detection of Aflatoxin B_1 and an ELISA kit has been designed. This immunoassay was highly specific, sensitive, rapid, simple and suitable for aflatoxin monitoring. AFB_1 concentration determinable by ELISA ranged from 0.1 to 10 µg/l.

E. Immunochromatographic technique

A rapid diagnostic method has been developed by Xiulan *et al.* (2005) in which they prepared an antibody-colloidal probe (conjugate) specific to aflatoxin B_1 (AFB_1). Nanogold – labeled probe was used to develop an immunochromatographic (IC) method for Aflatoxin B_1 analysis. With this method analysis can be completed within 10 min. reducing the detection time 6-10 times comparative with ELISA. Shim *et al.* (2007) developed an Immunochromatography (ICG) strip test using a nanocolloidal gold-antibody probe and optimized for the rapid detection of aflatoxin B_1. A monoclonal antibody specific to AFB_1 was produced from the cloned hybridoma cell (AF78), coupled with nanocolloidal gold and distributed on the conjugated pad of the ICG strip test. The visual detection limit of the ICG strip was 0.5 ng/ml. They analyzed 172 grain sample by ICG and compared with HPLC and showed good agreement with those obtained by HPLC. These strips are a potential screening tool for the detection of AFB_1 in samples and could be applied to the preliminary screening of mycotoxin in food and agricultural products, generating result within 15 minutes.

F. Polymerase Chain Reaction

Manonmani *et al.* (2006) developed rapid method for assessment of aflatoxigenic fungi in food using an indigenously designed primer pair for the aflatoxin regulatory gene *aflR* in Polymerase Chain Reaction. They extracted DNA from 28 different fungal strains on PCR template. Positive amplification was achieved only with DNA from Aflatoxigenic *A. flavus* and *A. parasiticus.* The detection limit for mycelium was determined as 0.05 g and $\geq$ 100 cfu respectively. Some of the genes coding for enzymes involved in aflatoxin biosynthesis have been cloned and sequenced which aided in the characterization of the aflatoxigenic molds. It is estimated that at least 16 enzymes are involved in the bioconversion of norsolorinic acid to aflatoxin (Chang *et al.*, 1995, Yu *et al.*, 1995). Among these genes, the nor-1 gene codes for reductase that convert norsolorinic acid to averantin (Trail *et al.*, 1994). The ver-1 gene is involved in the conversion of versicolorin A to Sterigmatocystin and omt-1 gene codes for O-methyltransferase that converts sterigmatocystin (Skory *et al.*, 1992). In addition to these structural genes, a regulatory gene, aflR, codes for regulatory protein that activates the pathway genes. On the basis of cloned and sequenced gene involved in the aflatoxin biosynthesis, specific primer had been designed for Polymerase Chain Reaction or Multiplex PCR method for detection of aflatoxigenic fungi (Farber *et al.*, 1997). Yang *et al.* (2004) applied multiplex PCR for the detection of potential aflatoxin-producing molds in Korean fermented foods and grains. Three genes, avfA, omtA, and ver-1, coding for key enzymes in aflatoxin biosynthesis were used as aflatoxin-detecting target genes in multiplex PCR. DNA extracted from *Aspergillus flavus, Aspergillus parasiticus, Aspergillus oryzae, Aspergillus niger, Aspergillus terreus, Penicillium expansum* and *Fusarium verticillioides* were used as PCR template to test specificity of the multiplex PCR assay. Positive results were achieved only with DNA that was extracted from the aflatoxigenic molds *A. flavus* and *A. parasiticus* in all three primer pairs. This result was supported by aflatoxin detection with direct competitive enzyme-linked immunosorbent assay (DC-ELISA).

G. Tandem Mass Spectrometry

The tandem MS method (Plattner, 1986) has been used extensively in the last few years. This method involves one stage of mass separation to select the compound of interest from the sample matrix (molecular ion, protonated molecular ion or molecular anion) and a second stage of analysis after colloisionally

activated dissociation (CAD) by collision with a target gas such as argon. Thus both the parent ion and the activated dissociated ion (daughter ions, or secondary ions) are analyzed. In contrast to selection ion mode (SIM), the monitoring system of tandem mass spectrometry is called "multiple reaction monitoring" (Plasencia *et al.*, 1990). This method has also been used in conjunction with Gas Chromatography (GC) (Plattner, 1986). Fast atom bombardment/tandem MS has been used for the detection of aflatoxin (Uyakual *et al.*, 1989). Lattanzio *et al.* (2007) developed liquid chromatography/tandem mass spectrometry method for simultaneous determination of aflatoxin B_1, B_2, G_1, G_2, Fumonisin, ochratoxin A, deoxynivalenol, zearalenone, T-2 and HT-2 toxins in maize.

2.0 Inactivation Method to Control Aflatoxin

Decontamination process must be technically and economically feasible. The FAO requirement for acceptable decontamination process is that the process must destroy, inactivate or remove aflatoxins, not produce, nor leave toxic (carcinogenic and mutagenic) residue in the food commodities and should destroy fungal spores and mycelium that could proliferate and produce new toxins under favorable conditions. Many detoxification methods of aflatoxin have been recommended and include: mechanical separation of contaminated seed, heat treatment, extraction using solvents, detoxification using solvent, detoxification using chemical agents and added sorbents. Some physical, chemical and biological methods to detoxify aflatoxin in feedstuffs are reviewed here.

Botanicals

Krishnamurthy and Shashikala (2006) studied the effect of *Withania somnifera, Hyptis suaveolens, Eucalyptus cimodora,* peel powder of *Citrus sinensis, Citrus medica* and *Punica granatum*, neem cake and Pongamia cake on Aflatoxin B_1 production by *A. flavus.* All tested plant material was significantly effective in inhibiting aflatoxin B_1. Neem cake showed maximum inhibition (98.22% at 10% and 87.07% at 5%) followed by *H. suaveolens* (84.38% at 5% and 78.85% at 10%), Pongamia cake (81.35% at 5% and 75.17% at 10%), *Withania somnifera* (78.11% at 10%), *C. sinensis* (70.84% at 10%) and *C. medica* (73.65% at 5%).

Leaf powder of *Ocimum* has been successfully used in inhibiting mould development and aflatoxin production on stored soyabean (Awuah, 1996). Neem leaf extracts were found to be very effective in controlling growth of mould and aflatoxin production (Bankole, 1997). Ghorbaman *et al.* (2007) studied the effect of neem (*Azadiracta indica* A. juss) leaf extract on the growth of *A. parasiticus* and production of aflatoxin. They found maximum inhibition i.e. 80-90% at 50% concentration. Similar finding was also reported by Bhatnagar and McCormic (1988) and Allameh *et al.* (2001). In 1977, Bullerman *et al.* established that Cinnamon and clove oil and their principle components, cinnamic aldehyde and Eugenol, inhibited the growth and toxin of *A. parasiticus.*

Chandra *et al.* (2007) studied the synergistic effect of *Pongamia pinnata* (Bark) and *Tamarindus indica* (fruit) against *A. flavus* and found significant reduction in growth *i.e.* 62%. Sanchez *et al.* (2005) studied the effect of ethanolic, methanolic and aqueous extract of *Agave asperrima* and *Agave striata* on growth and production of aflatoxin and observed remarkable reduction in aflatoxin synthesis. Hazare *et al.* (2005) reported that aqueous extract of Ajowan (*Trachyspermum ammi*) has aflatoxin Inactivation Factor (IF). Essential oil of *Thymus eriocalyx* and *Thymus x. porlock* showed

inhibitory effect when exposed to *A. parasiticus*. The oil from above plants was found to be strongly fungicidal and inhibitory to aflatoxin production (Rasooli and Abyaneh, 2004). Chloroform extracts of *Garcinia indica* rinds was tested for the inhibition of *A. flavus* and Aflatoxin production using peanut powder as model food system. Aflatoxin was estimated by spectroflurophotometric and Thin Layer Chromatographic methods. At lower concentration i.e. 500-1000 ppm, the aflatoxin inhibition was much higher than the growth inhibition. At 3000 ppm the Aflatoxin production was completely inhibited (Tamil Selve *et al*, 2003). As evident from the above account, the Botanicals have immense potential to control fungal growth and toxin and thus there is need of more research on purification of active fraction for commercialization as an alternate to chemicals.

Heat

Normal home cooking such as boiling and frying (approx. 150°C) failed to destroy AFB_1 and AFG1 in the solid state (Kamimura, 1989). Aflatoxins have high decomposition temperature ranging from 237°C to 306°C. Solid AFB_1 is quite stable to dry heating at temperature of 267°C (Behna, 1989). Degradation of aflatoxin by heat is also governed by the moisture content, ionic strength and pH of the food. The moisture content is a critical factor; contaminated food that contains more moisture can more easily be inactivated by heat. Mann *et al.* (1967) observed that heating a cottonseed meal containing 30% moisture at 100°C for 1h degraded 74.8% of aflatoxins ($B_1 + B_2$) present in meal, whereas only 32.7% of the toxins were destroyed after heating a similar meal containing 6.6 % moisture under the same condition.

Farah *et al.* (1983) cooked raw unshelled peanuts in 5% NaCl solution in an autoclave at 116°C, 0.7 bar for 30 min. This treatment reduced the total content of aflatoxins ($B_1 + G_1 + B_2 + G_2$) by 80-100%. Rustom *et al.* (1993) studied the effect of pH (5.0, 8.0, 10.2), temperature (121°C, 130°C, 140°C) and heating time (5s, 20s, 15 min). Heat treatment at pH 8.0 was not effective in reducing mutagenic activity. On the other hand, the treatment pH 10.2, 130°C, 20s and pH 10.2, 121°C, 15 min reduced the mutagenic activity by 78% and 88% respectively. Harish *et al.* (2002) studied the effect of roasting at different moisture levels on the inactivation of Aflatoxin B_1 of food grains. The initial content of AFB_1 in inoculated groundnut kernel sample was 2836.4 ppb. Roasting at 150°C for 10 min at 10% moisture level reduced AFB_1 by 48%; whereas at the same temperature and time and 20% and 30% moisture AFB_1 was significantly reduced by 53.03% and 56.02% respectively.

Antagonistic microorganism

Ciegler *et al.* (1966) have screened approximately 1000 microorganisms representing yeasts, molds, mold spores, actinomycetes, bacteria and algae for their ability either to destroy or to transform aflatoxin B_1 andG_1. Some molds and mold spores partially transformed aflatoxin B_1 to new fluorescing compounds. Only one of the bacteria *Flavobacterium aurantiacum*, NRRL B-184 removed aflatoxin from solution. Detoxification by cells of this microorganism was tested on milk, corn oil, peanut butter, corn, soybeans and peanuts. The milk, corn oil, and peanut butter were artificially contaminated by adding 600, 700 and 700 $\mu g\ kg^{-1}$ of aflatoxin B_1 respectively, to 50 ml of milk and corn oil and 50 gm of peanut butter. When 2.0 x 10^{13} viable cells of *F. aurantiacum*, NRRL B-184 were added to each of these food products aflatoxin levels were reduced to 0 and a trace after 3 hours of incubation. Viable cells of *F. aurantiacum* were mixed with soybeans, corn, and peanuts contaminated seeds which were then incubated for 12 hours at 28°C. Aflatoxins were completely removed from corn and peanuts but only 86% were removed from soybeans.

Destruction of aflatoxins in solution by *F. aurantiacum* was confirmed by duckling tests. Aflatoxin contamination by the toxic strains of *A. flavus* inhibited by an atoxigenic strain of *A. flavus* in vivo and in liquid fermentation, and the atoxigenic strain was equally effective when applied at spore concentration either equal to or one-half those of the toxigenic strain (Cotty and Bayman, 1993). Displace toxigenic strains of *A. flavus* from agricultural fields with strains of *A. flavus* that do not produce aflatoxins; strategy is possible because of the great variability of phenotypes of *A. flavus* in agricultural fields and the common occurrence of atoxigenic strains (Cotty, 1989). Several atoxigenic strains of *A. flavus* isolated from agricultural fields in Arizona can reduce the aflatoxin contamination of developing cotton bolls caused by toxigenic strains (Cotty, 1990). *Lactobacillus casei pseudoplantarum* 371 isolated from a silage inoculant was found to inhibit aflatoxin B_1 and G_1 biosynthesis by *A. flavus* sub sp parasiticus NRRL 2999 in liquid medium (Gourama and Bullerman, 1997).

Radiation

Food irradiation is becoming a technique of potential application on commercial scale as it renders the food product sterile (Diehl, 1990).

Gamma rays

The toxicity of Peanut meal contaminated with AFB_1 was reduced by 75% and 100% after irradiation with gamma rays at a dose of 1 and 10 kGy, respectively (Temcharoen and Thilly, 1982). Dose higher than 10kGy inhibited the seed germination and increased the peroxide value of the oil in gamma irradiated peanuts (Chiou *et al.*, 1990). A dose of 10 kGy completely inactivated AFB_1 and 95% of AFG_1 in Dimethylsulphoxide-Water (1:9 v/v) solution (Mutluer & Erkoe, 1987). Addition of 1 ml of 5% hydrogen peroxide to an aqueous AFB1 solution (50 µg/ml) resulted in 37-100% degradation of the toxin at a lower dose (2 kGy). The final degradation products showed no biological activity in Ames mutagenic test. The same treatment reduced the level of AFB_1 in peanut kernel by 73-80% (Patel *et al.*, 1989). El-Bazza *et al.* (2001) exposed the *A. flavus* isolate to gamma radiation dose level from 0.0 to 3.0 kGy. The gradual decrease in the growth occurred by increasing the irradiation dose upto 2.5 kGy. Low doses of gamma radiation did not affect its production upto 0.5 kGy, the mycelial weight markedly increased the total production reaching 3000 µg/L. Thereafter a decrease in its production was observed by increasing the dose. El-Bazza *et al.* (2001) found that increased dose of ionizing radiation for the spore of *A. flavus* led to an increase in the aflatoxin production reaching the maximum at a dose level of 1.0 kGy. No detectable aflatoxin was observed at 3.0 kGy. Aziz and Youssef (2002) showed that application of radiation at 10 kGy significantly detoxify aflatoxin B_1 by 82-88%. Aziz *et al.* (2004) showed that at 4 kGy gamma rays in maize significantly destroyed 60.9%-66.7% of aflatoxin.There is number of reports which suggest that the molds are very sensitive to gamma radiation and the mycotoxin production decreased after irradiation of food (Refai *et al.*, 1996). It appears that the fungal strains, condition of storage, humidity, inoculum size and irradiation dose affect mold growth and toxin production (Mahrous *et al.*, 2002; Aziz *et al.*, 2004).

UV rays

Aflatoxin B_1 absorbs UV light at 222, 265 and 362 nm with maximum absorption occurring at 362 nm, which lead to the formation of 12 photodegradation products (Samarjeeva *et al.*, 1995). The photodegradation products were less toxic to chick embryo than the parent toxins (Andrello *et al.*, 1967). Treatment of

peanut oil with UV light for 2 h destroys 40-45% aflatoxin (Shantha and Murthy, 1977). UV Radiation (30 min) treatment of dried figs artificially contaminated with AFB_1 (250 µg/kg) reduced the aflatoxin level by 45.7% (Altug *et al.*, 1990).

Solar Radiation

Efficacy of solar energy has been studied in different countries. In India, Shantha and Murthy (1981) exposed the peanut cake in sunlight for 6h and found 50% reduction in aflatoxin content. Naturally contaminated peanut flakes were exposed to sunlight for 14h and 50% reduction in aflatoxin content was found (Shantha and Murthy, 1981).

In USA, Mahjabeb & Bullermann (1988) exposed the olive oil for 10 and 40 min and found the 55% and 95% reduction of aflatoxin respectively.

Chemicals

Ghosh *et al.* (1996) studied the effect of propionic acid, sodiumbisulfite and sodium hydroxide on the biosynthesis of aflatoxin on groundcake. The aflatoxin free ground cake were treated with 0.25, 0.50, 0.75 and 1.0% each of propionic acid, sodiumbisulfite or sodium hydroxide at three moisture levels of 10, 15 and 20%. Out of three chemicals, the propionic acid was found to be most effective followed by sodium sulfite and sodium hydroxide. Acetic acid and propionic acid which are used in animal feeding are effective mold inhibitor (Sauer, 1997). Several studies have dealt with the use of propionates to control mold growth and toxin production by *A. flavus, A. parasiticus, A. ochraceus* and *Penicillium viridicatum* in artificially inoculated corn up to 29 weeks of storage (Vandergraft *et al.*, 1975). Propionic acid inhibits aflatoxin formation largely through inhibition of growth of *A. flavus* and *A. parasiticus* (Tsai *et al.*, 1984). Davis and Diener (1967) reported that sulfite inhibits a number of metabolic pathways in fungi. Therefore, it reduces the growth of fungus which leads to less aflatoxin production. Moerck *et al.* (1980) reported that sodium hydroxide at 2% concentration was effective for reducing aflatoxin level. Aflatoxin in the maize grain with an initial concentration of 29 ng/g was completely degraded and 96.7% degradation occurred in maize contaminated with 93 ng/g when treated with citric acid. Aflatoxin fluorescence strength of acidified samples was much weaker than untreated sample when observed in HPLC chromatogram (Mendez-Albores *et al.*, 2005).

Ammonia is one of the most effective reagents proposed for chemical inactivation of aflatoxin in contaminated peanut and cottonseed meals. Masri (1965) treated a toxic meal (Aflatoxin B_1 content about 1 ppm) with ammonium hydroxide solution and biological test of treated meal indicated elimination toxicity. Dollear and Gardner (1966), reported inactivation of aflatoxin in cottonseed and peanut meals with anhydrous ammonia under pressure in the range of 20 to 43 psig. It has been observed that AFB_1 molecular structure is irreversibly altered if exposure to ammonia lasts long enough. The disadvantage of ammonia treatment is mainly related to the need to build special plant as ammonia corrodes metal and becomes explosive in the air at mixture over 15% volume. Some effect on the chemical and qualitative characteristics of the feed i.e. undesirable brown color of the treated feed has also been observed.

Feuell (1966) reported that treatment of peanut meal with chlorine reduced its toxicity to duckling but did not prevent liver lesion. Aly *et al.* (2004) used the commercially hydrated sodium calcium alumino silicate (HSCAS) and Egyptian monmorillonite (EM) and found that it has capability of absorbing AFB_1 and

Fumonisin B_1 in aqueous solution. HSCAS was reported to have high affinity to AFB_1. The HSCAS removed more than 80% of the toxin from solution. In vivo studies demonstrated the role of HSCAS in preventing the mutagenicity and toxicity of AFB_1 (Phillips *et al.*, 1998).

Mckenzie *et al.* (1997) treated aqueous equimolar (32 μM) solution of Aflatoxin B_1, B_2, G_1, G_2, cyclopiazonic acid, Fumonisin B_1, Ochratoxin A, Patulin, Secalonic acid and Zearalenone with 2, 10 and/or 20 weight % Ozone (O_3) over a period of 5 min and analysed by HPLC. AFB_1 and AFG_1 were rapidly degraded using 2% O_3, while AFB_2 and AFG_2 were more resistant to oxidation and required higher dose of O_3 (20%) for rapid degradation. O_3 gas generated by corona discharge has been reported to degrade the aflatoxin in corn and cottonseed meals (Dollear *et al.*, 1968; Dwarkanath *et al.*, 1968) and in aqueous solution. Akacid® plus, a new member of guanidine based polymeric disinfectant was recently introduced for the first time as a potent inhibitor of *A. parasiticus* growth and its aflatoxin productivity (Razzaghi-Abyaneh *et al.*, 2006). Akacid® plus was developed by POC polymer Production GmbH, Vienna, as a new member with enhanced broad antimicrobial activity while significantly less toxicity compared to the former compound of this class. Akacid® plus is water soluble, nonflammable, nonexplosive, colorless and odorless formulation, which is composed of a mixture of two different polymeric guanidine compounds. It was accepted as biocide according to the new EU guidelines and it has in vitro antimicrobial activity against some important pathogenic bacteria and fungi (Kratzer *et al.*, 2006a, b; Buxbaum *et al.*, 2006).

Analysis of aflatoxin is difficult task because only trace amount of toxin are present in the animal feed and other food commodities. However, rapid progress in the development of new aflatoxin analytical methodology has been made during the last few years. Researchers have attempted to simplify and improve the existing analytical methods. New more versatile and sensitive methods have come to the market. After many years of laboratory research, immunoassay technique has gained wide acceptance as analytical method for aflatoxin and other toxins. The mycotoxin problem is serious in developing countries where conditions and agricultural practices are conductive to fungal growth and toxin production. The control of Aflatoxin can be achieved by good farm management and use of effective detoxification process which we have discussed in this review.

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Assessment of water quality of Phagwara drain in Punjab

A. Polestya, S. Sharma and A.S. Reddy
Thapar University, Department of Biotechnology and Environmental Sciences, Patiala

Abstract

An attempt has been made to study the pollution level of the Phagwara drain, by analyzing the physico-chemical and biological parameters. The duration of study was from January 2007 to December 2007. Water samples were collected monthly and analyzed to assess the quality of the drain. It receives wastes mainly from Phagwara and nearby areas. Domestic waste, industrial waste and agricultural runoff from surrounding areas is entering into the drain. The study revealed that the overall daily input of waste let into the drain has resulted in complete deterioration of water quality. Almost all the parameters were beyond the prescribed limits. The water of this drain is not suiatable for any kind of use and it is poisonous in nature.

Keywords: *Water quality monitoring, Phagwara drain, Physico-chemical and biological characteristics*

Introduction

Phagwara drain originated from Phagwara town and ultimately merged into river East Bein near Kangniwal. The main purpose of water analysis is to evaluate methods of treatment of wastewater; to reuse or dispose, ascertain quality of water and aim at recovery of valuable products form waste effluents. In order to ascertain the above objectives, it is necessary to analyze various parameters, which would throw light on quality of water (Lokhande *et al.*, 2004). In comparison to water analysis, the analysis of wastewater is complicated; the reason being one does not encounter in wastewater the kind of impurities and deterious materials, which are dumped by different industries. Further the wastewater of different industries mixes together, before merging into the river or disposal point, to form very complex mixture. The study of water quality of different regions in India by Datar and Vashistha (1992), Athappan *et al.* (1992), Janaki Arunan *et al.* (2004), Ramamurthy *et al.* (2005), Dwivedi *et al.* (2006), Manohar *et al.* (2007) have shown remarkable pollution levels. Considering the present conditions of water quality of Phawara drain, a quantitative study of physico-chemical and biological conditions of this drain was done.

Materials and Method

Samples were collected in precleaned and sterilized polythene or glass containers and preserved according to standard methods (APHA, 1998) at monthly intervals between 9 am to 5 pm from January 2007 to December 2007 and brought to laboratory for various physico-chemical and biological analysis. Temperature and dissolved oxygen (DO) were measured on the spot. The physico-chemical and biological analysis was carried out according to standard methods given by APHA (1998).

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Table 1: Various analytical methods used for analysis

Parameter	Analytical method
pH	pH metery
Temperature	Thermometry
Conductivity	Conductivity meter
Dissolved oxygen (DO)	Winkler's Iodometric with azide modification method
Biochemical oxygen demand (BOD)	5 day incubation method
Chemical oxygen demand (COD)	Dichromate reflux (closed) method
Chloride	Argentometric method
Total solids (TS)	Gravimetric method
Total dissolved solids (TDS)	Gravimetric method
Total suspended solids (TSS)	Difference of TS and TDS
Ammonical and organic nitrogen	Kjeldahl method
Nitrate and nitrite nitrogen	Spectrophometric and Cd-reduction column method
Phosphate	Colorimetric ($SnCl_2$) method
Total coliform	Mac-Conkey broth
Faecal coliform	A-1 broth

Results and Discussion

The results for the various physico-chemical and bacteriological parameters determined in the water samples of the drain are presented in table 2. Table 2 summarizes the maximum, minimum, mean values and standard deviation. The temperature values were lower in winter season as compare to summer and rainy season. The ranges of temperature of water samples were similar as observed by Muduli and Dhal (2006) in case of river Baitarani at Anandpur. Conductivity qualitatively reflects the status of inorganic pollution and is a measure of total dissolved solids and ionized species in the waters. The conductivity values ranged from 1,122 to 2,920 µmho/cm. These values indicate higher quantity of inorganic acid, base and salt in wastewater samples. Ram and Singh (2007) observed the same conditions in Ganga river.

The total solids (TS) values were ranged from 1,220 to 2,050 mg/l. These higher values of total solids indicate higher pollution load in the drain. The total dissolved solids (TDS) values correlated well with the conductivity values. In agreement with the high conductivity values, TDS levels were high. TDS values ranged from 900 to 1,630 mg/l. Ahmad *et al.* (2003) observed same results for river Damodar, where solids come from fly ash and fine coal particles from thermal plants and coal washeries.

The suspended solids represent the floating material (bacteria, algae) and undissolved particles, which ranged from 99 to 504 mg/l. No fix trend was observed in various solids seasonally this may be due to different discharges at different time. The concentration of dissolved oxygen in water depends on temperature, pressure and the concentrations of various ions. Due to pollution load the concentration of DO depletes and possess thrust on the aquatic life. Low oxygen in water can be detrimental to fishes and many other organisms in the aquatic system. The DO values were nil throughout the year showing higher pollution load. A minimum value of 4.0 mg/l of dissolved oxygen in water is essential for the survival of aquatic life. BOD is the empirical test to determine the relative oxygen requirement of water mostly due to organic ingredients. Its application is to calculate the pollution load.

The BOD values were from 62.5 to 238.0 mg/l (Fig. 1). Higher values of BOD were also observed by Rajurkar *et* al. (2003) in case of river Unkhrah at Shillong.The level of BOD depends on temperature, density of plankton, concentration of organic matter and related factors. In the present study it was observed that the BOD in rainy season was lesser than winter and summer seasons, which may be due to dilution of drain water with rain. In this study the COD values ranged from 275 to 575 mg/l (Fig .1). These results were showing higher organic pollution load in the drain. The COD values were also minimum in rainy season; this again may be due to dilution of river water with rain. Higher COD values were also observed by Verghese *et al.* (2005) in the river Yamuna at Agra. Ammonical nitrogen imparts an adverse impact on aquatic life. The values of ammonical nitrogen were very much higher, which ranged from 22.1 to 40.0 mg/l. Ammonical nitrogen values were highest in summer season and lowest in rainy season at all stations. Ammonical nitrogen is extremely soluble and is readily transported by run off from cultivated lands and also a major component of raw sewage. It occurs in water as a break down product of nitrogenous material. Such higher concentrations of ammonical nitrogen were also observed by Rajurkar *et al.* (2003) in case of river Unkhrah at Shillong. The presence of ammonical nitrogen may be perhaps due to frequent flow of sewage into water systems, since sewage has large quantities of nitrogenous matter which tend to increase the ammonia content in water. The values of organic nitrogen were in the range of 1.90 to 2.40 mg/l (Fig. 2). In case of organic nitrogen there was not much difference in different seasons.

Nitrate, the most highly oxidized form of nitrogen compounds is commonly present in surface waters because it is the end product of the aerobic decomposition of organic nitrogenous matter. The values of nitrate and nitrite nitrogen were in the range of 0.02 to 4.17 mg/l (Fig. 2). Similar trend in nitrate and nitrite

Table 2: Various physico-chemical and biological parameters at Phagwara drain

Parameter	MAX	MIN	AVG	STD
pH	9.42	7.12	7.57	0.60
Temp. (°C)	32.40	20.30	26.56	4.56
EC (μ mho/cm)	2920.00	1122.00	1893.92	522.49
TS (mg/l)	2050.00	1220.00	1587.08	283.71
TDS (mg/l)	1630.00	900.00	1312.42	250.24
TSS (mg/l)	504.00	99.00	274.67	114.97
DO (mg/l)	0.00	0.00	0.00	0.00
BOD (mg/l)	237.50	62.50	161.99	54.84
COD (mg/l)	575.00	275.00	410.33	107.24
NH_3-N (mg/l)	40.04	22.12	31.34	5.94
Org-N (mg/l)	2.74	1.90	2.37	0.24
NO_2+NO_3 - N (mg/l)	4.17	0.02	0.61	1.20
Org-N (mg/l)	2.74	1.90	2.37	0.24
Total-P (mg/l)	3.54	0.79	2.60	0.94
Chloride (mg/l)	519.10	195.66	343.58	104.58
Total, MPN/100 ml	460000000	1359779	82500761	139898204
Faecal, MPN/100 ml	75894664	314484	20345803	24585711

nitrogen was observed by Jaji *et al.* (2007) in Ogun river. Phosphate values were in the range of 0.79 to 3.54 mg/l (Fig .2). High levels of phosphorous increase the growth of vegetation in water systems and increase the oxygen demand. Very high phosphate values were observed throughout the year. Photosynthesis and respiration play an important role in the self-purification of natural water. The disturbance of the stationary state between photosynthesis and respiration leads to chemical and biological changes reflecting pollution. High level of phosphate in the drain indicates the wastewater discharges from Phagwara. Fertilizer industries were the most likely source of phosphorous in the waters. The high phosphate values obtained from the samples could be attributed to phosphorous in runoff from domestic, municipal and agricultural wastes (non- point sources) flowing into drain as well as washing along the side with detergents (Correll, 1998).

Chlorides values were in the range of 195.66 to 519.10 mg/l. Higher values of chlorides were also observed by Verghese *et al.* (2005) in the study of river Yamuna at Agra city. High chloride concentrations were due to excess dumping of domestic and industrial effluent into drain water. Coliform bacteria are common indicators of overall water quality and although they are ubiquitous in the environment and are generally not considered harmful to humans, their presence in high concentrations often coincides with more dangerous bacteria (WHO 1996). Higher total coliform values indicate severe microbiological contamination, originated due to the wastewater discharges and sewage contamination. The constant presence of total coliform through all the study period clearly indicates a pathogenic risk caused by the accidental consumption of water during recreation (WHO 1996). The total and faecal coliforms were not following any trend with seasons. Total coliform were ranged from 13,59,779 to 46,00,00,000 MPN/100 ml. Faecal coliform were from 3,14,484 to 7,58,94,664 MPN/100 ml (table 2). From the above study it was concluded that the drain was highly polluted through out the year.

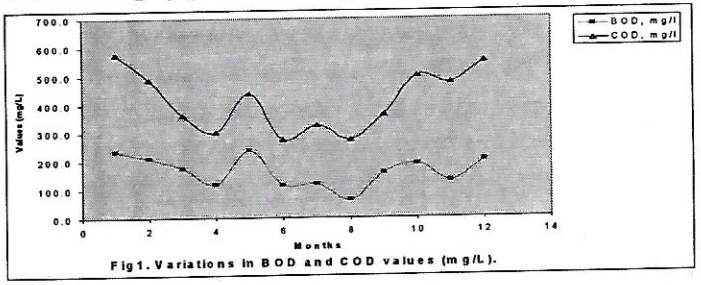

Fig. 1: Variations in BOD and COD values (mg/l)

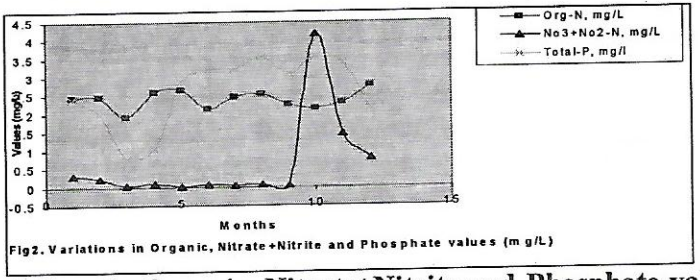

Fig. 2: Variations in Organic, Nitrate+Nitrite and Phosphate values (mg/l)

Conclusion

The parameters analyzed revealed higher pollution load in the drain. The colour of the drain water was black throughout the year. This state result from discharges coming from various industries such as distilleries, leather, fertilizer, textile, sugar industries and sewage discharges from the town Phagwara and nearby areas. Almost all the parameters were found to be beyond permissible limits. The high levels of pollution parameters are definitely harmful to aquatic living beings. Significant pollution was observed at sampling station because of huge quantity of industrial effluents and sewage discharge. A continuous monitoring of the drain water for various parameters is required because it merge into river East Bein.

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Studies on the ecology of River Beas with reference to benthic fauna

Ashok Kumar* and V. K. Saxena**
*AD Hydro Power Ltd. V. and P.O. Prini, Manali, District - Kullu (H.P.)
**Fisheries Research Laboratory, Deptt. of Zoology, Narain College, Shikohabad (U.P.)

Abstract

The paper incorporates the findings on the seasonal abundance and fluctuations of benthic fauna in relation to physico-chemical parameters of water in the selective stretches of river Beas. Considerable variations of benthic fauna in quality and quantity were observed. The population of benthic fauna was high in the month of July (418.0 units/m^2) while minimum in December (38.0 units/m^2).

Keywords : *Ecology, River Beas, Benthic, Physico-Chemical*

Introduction

The river Beas is one of the major rivers of Himachal pradesh. It originates from southern slope of Rohtang pass at an elevation of 4062 mts. The river recieves a number of tributaries both on right and left banks during its downward drift of over 470 kms. Its principal tributaries are Solang, Manalsu, Sujjain, Fojal and Sarvari on the right bank and Alain, Duhagan, Chhaki, Parbati, Tirthan and Sainj on the left bank. The disposition of the river in Kullu valley is shown in Fig. 1.

The water of Beas and its tributaries remains shallow, rapid cool and clear except during the rainy season. The bed comprises of mainly the boulders, stones and rubble. The vegetation along the banks consist mainly of the alnus, willow, rubenia and conifers. The ecology of the river is constantly degrading. Once teeming with large number of trout the catches are declining each year. The major reasons are attributed to fall in catches are ecological erosion, heavy silt deposition and shrinkage of feeding and breeding ground in the river. Observations were therefore made in the river Beas at Kullu District to study the abundance, seasonal fluctuations of benthic fauna.

Materials and Method

The physico-chemical parameters of water of river Beas like water temperature, pH, transparency, dissolved oxygen, total alkalinity were analysed fortnightly following APHA (1998) manual. Due to shallow depth, stony bottom and fast current, the transparency was measured by bright pin head method (Saha *et al.,* 1971). Hydrogen ion concentration of water was determined by pH digital meter. For dissolved oxygen 'Winkler's Method' (Welch, 1948) was adopted and total alkalinity was determined by 'titration' method. The aquatic insects and other bottom fauna were collected monthly from pre-selected sites of the river, by enclosing one square meter of river bed with square-meshed cloth. The bottom stones, gravel and sand were upturned to dislodge the aquatic life. This resulted in collection of all the benthic life in the square-meshed cloth. The organisms were hand-picked and preserved in 5% formaline and were analysed quantitavely and qualitatively (Jhingran *et al.,* 1988). The species composition of benthic life was done group-wise, genera-wise and where ever possible, species wise.

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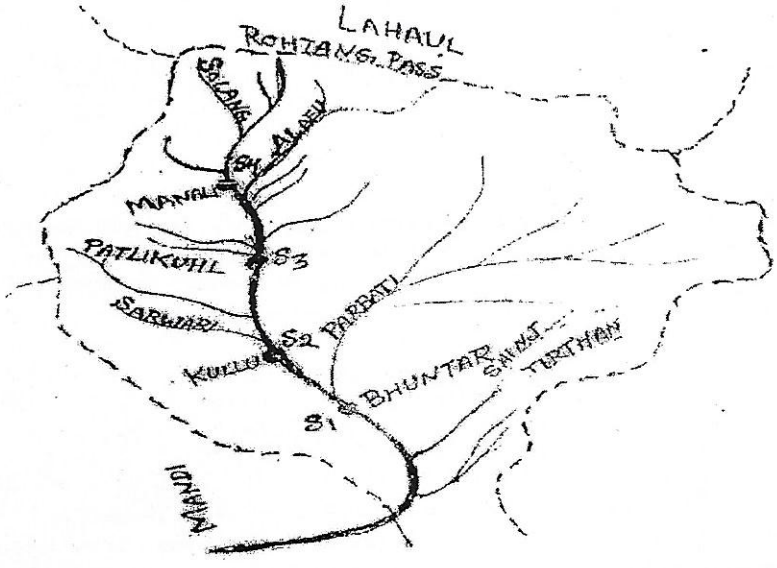


Fig. 1. Disposition of the experimental sites of river Beas in Kullu District.

Results and Discussion

The physico-chemical parameters studied in the river Beas includes water temperature, transparency, pH, dissolved oxygen and total alkalinity. Seasonal variations in physico-chemical parameters of water are shown in Table. 1. Water temperature (average) ranged from 5.2 °C to 17.7 °C . The pH of the river water was always found to be in the alkaline range (7.0-7.7). River water was clear and transparent during winter and turbidity was found during monsoon (6.1 cm) which was due to fast current and greater inflow of muddy rain water. Total alkalinity was high and the value was maximum in the month of February (85.0 ppm) and minimum was (53.7 ppm) in the month of August. Dissolved oxygen was quite high and showed wide fluctuation. Its value was maximum in December (12.8 ppm) and minimum during august (9.2 ppm).

Table. 1. Fluctuations in physico-chemical parameters of river Beas from December, 02 - November, 03.

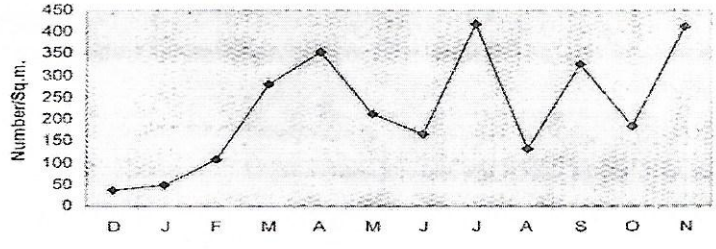
Months	Water Temp. (°C)	Transparency (cm)	pH	D.O. (ppm)	Alkalinity (ppm)
December	6.2	51.5	7.5	12.8	75.6
January	5.2	47.8	7.6	12.0	70.6
February	7.1	43.3	7.4	11.2	85.0
March	9.2	46.1	7.4	11.2	83.1
April	11.3	51.5	7.3	10.0	80.1
May	10.0	29.3	7.1	10.8	61.2
June	12.8	10.2	7.3	10.2	57.5
July	16.0	6.1	7.5	9.7	59.3
August	17.7	7.7	7.7	9.2	53.7
September	17.1	9.9	7.0	9.9	56.2
October	12.9	29.5	7.0	10.9	67.5
November	8.1	53.2	7.4	11.4	75.6

The analysed benthic fauna samples showed that the bulk of benthic organisms in different beats of river Beas comprised nymph, larvae and adults of different orders of class insects. The fluctuation of benthic fauna in the river during different months of the year is shown in Fig. 2. Insects contributed 98% in the selective stretches of Beas River. Their population is constituted by nymph of Ephemeroptera and Plecoptera, larvae of Trichoptera, Diptera, larvae and adults of Coleoptera contributing 79%, 2.6%, 4%, 7% and 5.8% respectively. The remaining was constituted by molluscs, annelids and others. The average numbers of organisms encountered were 223 units/m^2. Throughout the sampling year, the main bulk of benthic fauna was formed by Caenis and Baetis. The other genera viz., Iron, Hexagenia, Ephemerella and Triaenode were also dominated in the collections. Perla, Tabanus and Simulium showed their seasonal dominance while species like Antocha, Psychoda, Gomphus, Maurina, Elimidae, Mollusc and Annelids occurred only sporadically and in considerable small number.

The nymphs of Ephemeroptera were abundant in all the stretches ranging from 26-334 units/m^2. May-flies were available throughout the year in the collections. The maximum number 334 units/m^2 of may-flies were encountered during the November while lowest were encountered during December. The important genera in order of their abundance were Caenis, Baetis, Hexageia, Ephemeralla, Iron and Epeorus. The nymphs of Plecoptera (stone-flies) were less abundant in all the four stretches of the river. Stone-flies were available in the river in an average number of 6 units/m^2. The important genera in order of their abundance were Perla, Peltoperla, Nemoura. The larvae of Trichoptera (caddis-flies) both the cased and caseless were available in the river in an average number of 9 units/m^2. The important genera in order of their abundance were Brachycentrus, Triaenode and Rhyacophila.

The important genera of order Coleoptera in order of their abundance were Elmis, Dytiscus, Hydrogobus and Hydrophilus in the river. The important genera of order Diptera in order of their abundance were Simulium, Tabanus, Altherix, Antocha, Maruina and Psychoda. The order Odonata represented by only one genus viz. Gompohus. The order Gnathobdellida was represented by Hirudinaria genus (Leeches) in the collections. The order Basommatophora was represented by mollusc in the collection. The aquatic insects and other benthic organisms concentration were high in the river. The maximum number 418 units/m^2 of organisms were encountered during the July while minimum were 38 units/m^2 encountered during December. The genera belonging to order Ephemeroptera were recorded as the main biota of the river. The diversity and abundance of insect larvae which constitute the benthos are directly related to the substratum consisting of small sized boulders, cobbles which provide protection to the larvae (Johal, 2001). The insect population is numerically more in the months of higher alkalinity.

Fig. 2. Monthly fluctuation of benthic fauna in the river Beas during Dec, 02 to Nov, 03.



In the present investigation the relative abundance of major insect orders shows correlation with alkalinity and the carbonate alkalinity is more important than the other factor such as temperature, current, speed, volume of flow etc. in influencing the density of benthic fauna. The optimum temperature, high dissolved oxygen, slightly alkaline pH and reasonable high value of alkalinity were observed the main reasons of the high density in glacier-fed rivers (Dobriyal and Singh, 1990).

Acknowledgement

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In vitro antibacterial activity of Sahdevi (*Vernonia cineria* less)

Prabhat, Navneet, Pramod and Chhaya****
Department of Botany and Microbiology, Gurukul Kangri University, Hardwar
**Department of Chemistry, Gurukul Kangri University, Hardwar

Abstract

Sahdevi (*Vernonia cineria* less) were evaluated for antibacterial activity against human pathogenic bacterial strains i.e. *Staphylococcus aureus, Klebsiella pneumoniae, Salmonella typhi* and *Escherichia coli.* The methanolic extracts of the plant parts showed the significant activity followed by water and petroleum ether extracts. The methanolic extract of roots showed maximum activity against *K. pneumoniae*(18mm) minimum activity against *S.typhi*(14mm) by well diffusion method. The use of plant for its antibacterial activity and treatment of fever has been suggested.

Keyword: *Vernonia cineria,* Antibacterial, Fever

Introduction

Microorganisms are closely associated with the health and welfare of human beings. Human cannot escape a dynamic on going association with microbes. In Indian system of medicine, the plants are used as a curative in cough, asthma, dropsy, bronchitis, colic, vomiting, leprosy, cardiac disorders, anemia and vitiated conditions of kappa and vata and general debility (Prabhat *et al.*, 2005). The microorganisms have developed resistance to many antibiotics. This has created immense problem for the treatment of microbial diseases, therefore, there is a need of an alternative to these antibiotics for the treatment of diseases. One of the methods to reduce this resistance is by using medicinal plants. The plants are known to produce a variety of phytoconstituents that have antimicrobial properties (Prabhat and Navneet, 2007). The unripe fruits of *Mimusops elengi* showed antibacterial activity against *Bacillus anthrasis, B. subtilis, Salmonella typhi, Staphylococcus aureus, S. sanguis* and *S. mutans* (Kapoor *et al.*, 1989; Prabhat *et al.*, 2005). In the present study, we have selected different parts i.e.roots, leaves, stem and whole plant of *Vernonia cineria* against *Klebsiella pneumoniae, Salmonella typhi, Staphylococcus aureus* and *E. coli.*

Materials and Method

The plants were collected from the foot hills of Shivalik range in Hardwar, Uttarakhand. The root, stem, leaves were separated by peeling. These were washed by running tap water to remove the adhering unwanted material and cut into small pieces, dried at room temperature and then powdered by using blender. The powered plant materials were loaded in soxlet assembly and extracted in three different solvents i.e. petroleum ether, methanol and water for 72 hrs by successive method. At the end of each extract, it was passed through Whattman filter paper No. 40 and the filtrates were evaporated under reduced pressure. Muller Hinton agar media (Hi media No. 173) was used to test to antimicrobial activity against *Escherichia coli,* gram negative (MTCC 739), *Staphylococcus aureus*, gram positive (MTCC 1144), *Salmonella typhi*, gram negative, (MTCC 109) and *Klebsiella pneumoniae* (MTCC) by agar well cup plate method (Ahmad *et al.*, 1998). 8 mm diameter wells were punched in the agar and filled with

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abstracts of respective solvents for control and standard antibiotic ampicillin (100 mg/ml) was used as positive control. The plates were incubated at 37°C for 24 hours. The antimicrobial activity was evaluated by measuring the diameter of inhibition zone in mm.

Results and Discussion

The plant parts showed broad spectrum antimicrobial activity (Table. 1) i.e. the petroleum ether, methanol and water extracts were active against both gram positive and gram negative bacteria. The *Vernonia cineria* extracts were found to be less effective as compared to ampicillin. The antibacterial activity of plant (*V. cineria*) parts i.e. leaves, roots, stems, whole plant and antibiotic ampicillin in all the three solvents against *Escherichia coli, Salmonella typhi, Staphylococcus aureus* and *Klebsiella pneumoniae* at concentrations of 100 mg/ml is given in Tables. 1-4. The zone of inhibitions obtained in crude extracts of different parts of plants varied against pathogens while it was same in case of ampicillin. The results revealed that antibiotic is more effective as compared to crude extracts. The methanolic extracts showed the highest activity against *Klebsiella pneumoniae* followed by *Escherichia coli, Salmonella typhi* and *Staphylococcus aureus* as compared to other extracts.

The extracts of roots showed maximum activity followed by whole plant, leaves and stem. The antibacterial therapy is going through crises due to the rapidly increasing development of resistance to existing agents. Antibiotic resistance has increased substantially in the recent years and is posing an increasing therapeutic problem. The use of plants as primary health remedies is quite common due to their pharmacological properties. The plant produced a variety of phytoconstituents that have antibacterial activity. These compounds includes flavonoids, phenols, phenolic glycosides and glycerinates etc. the natural antimicrobial compounds in plants can inhibit the growth of bacteria by means of unknown mechanisms other than that of known antibiotics and for this reason the search for new antibiotics must continue. The present study has shown that the plant and its parts are potentially a rich source of antibacterial agents. The plant extracts inhibited the growth of all pathogens. The antibacterial activity of active extracts of parts were observed in decreasing order roots>whole plant> leaves> stem. The crude extracts (100mg/ml) of each part was used for determination of their potency against pathogens and compared with antibiotic (100mg/ml). The extent of antimicrobial activity of the extracts based on inhibition zone diameter has been described as low (10-14), moderate (15-20) and strong (21-26) by Ahmad *et al.* (1999). In our study, root extracts showed moderate activity against all pathogens and followed by whole plant, leaves and stem. The methanolic extracts of each part is highly effective against all pathogens because more phytoconstituents were leached in this solvent. Our findings have validated the use of these medicinal plants for the treatment of microbial infections. It seems important to recommend that further studies using isolated constituents instead of whole extracts must be done in this field. Health foundations have to increase their funding of these studies and research to help saving the lives of many peoples. This will also offer a great help in facing the emergence and spread of antimicrobial resistance.

Table 1: The percentage of potency of plant *Vernonia cineria* roots extract and antibiotic (ampicillin) against pathogens

S.No.	Human Pathogens	Zone of Inhibition (Antibiotic 100 mg/ml)				Zone of Inhibition (Extract 100 mg/ml)				%of Potency
		Pt. Ether	Methanol	Water	Pt. Ether	Methanol	Water	Pt. Ether	Methanol	Water
1	*K pneumoniae*	15	19	18	-	16	14	-	26.32	22.22
2	*S. typhi*	14	18	17	-	14	14	-	22.22	17.64
3	*S. aureus*	14	18	20	11	15	15	21.43	16.67	25.00
4	*E coli*	14	19	20	12	14	15	14.29	26.32	25.00

Table 2: The percentage of potency of plant *Vernonia cineria* stems extract and antibiotic (ampicillin) against pathogens

S.No.	Human Pathogens	Zone of Inhibition (Antibiotic 100 mg/ml)				Zone of Inhibition (Extract 100 mg/ml)				%of Potency
		Pt. Ether	Methanol	Water	Pt. Ether	Methanol	Water	Pt. Ether	Methanol	Water
1	*K pneumoniae*	15	19	18	10	12	1	33.33	36.84	44.44
2	*S. typhi*	14	18	17	9	13	12	35.71	27.78	29.41
3	*S. aureus*	14	18	20	11	14	14	21.42	22.22	30.00
4	*E coli*	14	19	20	10	13	10	28.57	26.32	50.00

Table 3: The percentage of potency of plant *Vernonia cineria* leaves extract and antibiotic (ampicillin) against pathogens

S.No.	Human Pathogens	Zone of Inhibition (Antibiotic 100 mg/ml)			Zone of Inhibition (Extract 100 mg/ml)			% of Potency	
		Pt. Ether	Methanol	Water	Pt. Ether	Methanol	Water	Pt. Ether	Methanol	Water
1	*K pneumonicae*	15	19	18	9	14	13	40.00	26.32	27.78
2	*S typhi*	14	18	17	10	13	10	28.57	27.78	41.18
3	*S aureus*	14	18	20	10	13	12	28.57	27.78	40.00
4	*E coli*	14	19	20	11	11	12	21.43	42.11	40.00

Table 4: The percentage of potency of plant *Vernonia cineria* whole plant extract and antibiotic (ampicil lin) against pathogens

S.No.	Human Pathogens	Zone of Inhibition (Antibiotic 100 mg/ml)			Zone of Inhibition (Extract 100 mg/ml)			% of Potency	
		Pt. Ether	Methanol	Water	Pt. Ether	Methanol	Water	Pt. Ether	Methanol	Water
1	*K pneumonicae*	15	19	18	9	15	13	40.00	21.05	27.78
2	*S typhi*	14	18	17	8	14	10	35.71	22.22	41.18
3	*S aureus*	14	18	20	10	12	14	28.57	27.78	30.00
4	*E coli*	14	19	20	11	13	13	21.42	31.58	35.00

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Water quality of river Ganga in respect of physico-chemical characteristics at Kangri Village, District Haridwar

Unnati Vishnoi*, Jagjit Kaur and S.K. Pathak*****
*Deptt. Of Chemistry, K.L.D.A.V. (P.G.) College, Roorkee (U.K.)
**M.S. College, Saharanpur (U.P.)
***Govt. Girls P.G. College, Mhow (M.P.)

Abstract

This paper deals with the water quality status of river Ganga at Kangri village was studied with respect to physico-chemical characteristics. Parameters studied was pH, Total solids, total dissolved solid, TSS, conductivity, alkalinity, hardness, DO, BOD, COD. With respect to pH the water of river Ganga was found alkaline.

Introduction

Kangri village (District Hadwar) is situated at the east bank of river Ganga where number of people and cattle take bath daily. Kangri village is connected by Hardwar-Najibabad road. Ganga rver passés through the Hardwa at Shyampur and Gendi Khata villages. Number of workers have carried out their investigations on water quality of river Ganga with respect to different physico-chemical characteristics from its origin to merging point (Sngh *et al.*, 1988, Khan *et al.*, 2003). But no study has been coducted to assess the water quality of river Ganga at Kangri village. The present paper include one year study Jan.- Dec. 2005).

Materials and Method

Two sampling stations were selected, upstream Kangri village denoted as sampling station- A and downstream Kangri village denoted as sampling station- B. Water samples of river Ganga were collected in neat and clean two litre white plastic jericanes for physico-chemical parameters. Sample preservation and analytical methods were adopted as per APHA, AWWA, WPCF-(1992), Khanna and Bhutiani (2004). All chemicals, reagents and solvents were used for the analysis of analytical grade. Fine chemicals and glass wares were used of Borsil made.

Results and Discussion

The physico-chemical parameters are given in Table-1 to 3. The values of studied parameters pH, TS, TSS, alkalinity, total hardness, chloride, free CO_2, conductivity, water temperature varied between 7.00-8.50, 119.00-220.9 mg/l, 29.0-51.20 mg/l, 52.0-92.0 mg/l, 64.00-98.00 mg/l, 6.20-27.20 mg/l, 1.40-3.60 mg/l, 0.10-0.58 µmho, 11.2-21.5 °C, at sampling station-A Where at sampling station-B the values of these parameters ranged from 6.80-8.20, 130.00-262.00 mg/l, 30.00-79.00 mg/l, 58.00-102.00 mg/l, 60.00-98.00 mg/l, 6.90-58.10 mg/l, 1.20-3.90 mg/l, 0.12-0.65µmho, 12.4-20.5 °C respectively and of DO, COD and BOD ranged between 9.0-11.5, 10.0-29.0, 0.4-1.5 mg/l at sampling station-A whereas at sampling station-B the values of these parameters ranged from 8.10-11.00, 9.00-27.20, 0.60-3.00 mg/l respectively. The average value of pH, TS, TDS, TSS, conductivity, DO, COD, alkalinity, total hardness and chloride were obtained within the tolerance limit of drinking purpose where as average values of BOD is 0.94 mg/l at sampling station-A and 2.0 mg/l at sampling station-B (Table-3).

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Maximum values of the studied parameters was observed during monsoon season except DO and minimum values of these parameters obtained during winter, lower values of DO was observed during rainy period at both sampling station which may be due to dilution in rainy season and super saturation of oxygen at lower temperature in winter. After winter period as temperature of water rises than the free CO_2, COD, BOD was increased and DO decreased of river Ganga, Khanna *et al.*, 2003 had also found the similar trend. Water quality of river Ganga with respect to pH is alkaline similar trends was also found by Singh, 1988.

Table-1: Variation in physico-chemical characteristics of river Ganga at sampling station-A of Kangri village (Haridwar), during Jan. to Dec. 2005

Month / Parameters	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Water temp. (°C)	11.20	13.00	18.40	18.60	20.30	21.50	18.00	17.70	17.60	17.30	19.00	13.80
TS (mg/l)	122.00	119.00	128.00	157.00	174.10	210.00	221.20	229.00	220.00	221.90	200.00	185.00
TDS (mg/l)	92.00	88.00	89.00	118.00	125.00	158.00	169.00	178.00	175.00	180.00	157.00	145.00
TSS (mg/l)	29.00	28.90	35.00	37.00	48.00	49.00	51.20	51.00	42.00	40.50	38.00	33.00
Conductivity	0.10	0.14	0.19	0.18	0.20	0.28	0.58	0.43	0.45	0.39	0.20	0.21
pH	7.00	7.30	7.20	7.80	7.80	8.00	8.50	8.10	8.40	7.90	7.00	7.50
DO (mg/l)	11.50	10.80	10.00	10.10	10.20	9.00	9.10	9.30	9.50	10.00	10.10	11.00
Free CO_2 (mg/l)	1.40	1.90	2.00	2.20	2.40	2.60	3.60	3.00	2.60	2.40	2.00	1.80
COD (mg/l)	10.00	11.20	11.5	12.00	16.00	20.00	24.00	29.00	23.00	12.20	19.00	14.50
BOD (mg/l)	0.50	0.80	1.10	0.60	0.90	1.40	1.50	1.20	1.20	1.00	0.70	0.40
Alkalinity (mg/l)	52.00	56.00	59.00	61.00	70.00	72.00	74.00	79.00	71.00	92.00	88.00	74.00
Total Hardness (mg/l)	76.00	64.00	69.00	70.00	74.00	84.00	98.00	75.00	80.00	81.00	80.00	73.00
Chloride (mg/l)	6.20	6.90	7.20	11.50	17.00	19.00	27.20	23.00	17.60	9.80	7.20	7.00

Table-2: Variation in physico-chemical characteristics of river Ganga at sampling station-B of Kangri village (Haridwar), during Jan. to Dec. 2005

Month / Parameters	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Water temp. (°C)	12.40	12.60	18.50	19.00	20.00	20.50	20.00	18.60	17.90	19.30	18.10	15.00
TS (mg/l)	130.0	140.00	144.0	170.00	183.00	229.00	259.00	262.00	253.00	230.00	223.00	195.00
TDS (mg/l)	100.00	104.00	92.00	133.00	128.00	173.00	189.00	181.00	179.00	185.00	160.00	135.00
TSS (mg/l)	30.00	33.00	48.00	35.00	54.00	49.00	69.00	79.00	72.00	46.00	63.00	61.00
Conductivity	0.13	0.19	0.20	0.12	0.14	0.34	0.65	0.58	0.59	0.58	0.51	0.37
pH	6.80	6.90	7.00	7.10	7.20	7.30	7.50	7.80	7.50	7.60	8.20	7.60
DO (mg/l)	10.00	9.10	8.10	9.50	8.90	8.40	9.50	10.00	10.10	9.70	10.00	11.00
Free CO_2 (mg/l)	1.20	2.80	2.00	2.90	2.30	3.50	3.90	2.60	207.00	3.30	209.00	2.60
COD (mg/l)	9.00	10.20	10.50	11.00	14.50	19.20	22.50	27.20	22.40	10.20	16.50	13.50
BOD (mg/l)	2.20	0.60	106.00	2.00	2.50	2.90	3.00	1.50	106.00	1.50	2.00	2.60
Alkalinity (mg/l)	58.00	65.00	59.00	78.00	95.00	100.00	102.00	74.00	79.00	94.00	95.00	80.00
Total Hardness (mg/l)	60.00	64.00	76.00	79.00	90.00	96.00	98.00	79.00	93.00	89.00	97.00	89.00
Chloride (mg/l)	6.90	7.50	9.00	12.00	21.00	33.00	58.10	24.50	20.00	16.00	14.00	12.00

Table-3: Average value of physico-chemical parameters at sampling station-A and B at Kangri village during Jan. to Dec. 2005

Parameter	Jan.- Dec. 2005			Jan.- Dec. 2005		
	Sampling-A			Sampling-B		
	Min.	Max.	Average	Min.	Max.	Average
Water temp.	11.20	21.50	17.20	12.40	20.50	31.10
TS	119.00	220.90	182.10	130.00	262.00	201.50
TDS	88.00	180.00	139.50	92.00	189.00	136.90
TSS	29.00	51.20	40.20	30.00	79.00	53.30
Conductivity	0.10	0.58	0.28	0.12	0.65	0.37
pH	7.00	8.50	7.70	6.80	8.20	7.40
DO	9.00	11.50	10.1	8.10	11.00	8.80
Free CO_2	1.40	3.60	2.30	1.20	3.90	2.70
COD	10.00	29.00	15.10	9.00	27.20	13.90
BOD	0.40	1.50	0.94	0.60	3.00	2.00
Alkalinity	52.00	92.00	70.70	58.00	102.00	81.60
Total Hardness	64.00	98.00	77.00	60.00	98.00	84.20
Chloride	6.20	27.20	13.30	6.90	58.10	19.50

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