RESULTS

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PHYSICO-CHEMICAL PARAMETERS

During present study the physico-chemical parameters such as temperature, turbidity, total solids, pH, dissolved oxygen, free carbondioxide, hardness chlorinity, alkalinity, acidity, phosphates and nitrates etc. from textile mill, electroplating and tannery effluents were studied during September 1999 to August 2000.

Temperature :

The temperature ranged from 23^0C-36^0C for these effluents. The range of temperature for textile mill effluent was 26.0^0C-36^0C and average temperature was 29.9^0C, for electroplating effluent the range was 23.0^0C-32^0C with an average of 25.9^0C and range for tannery effluent was $24.^0$C-34^0C with an average of 28.6^0C during present study. Results are presented in table 1.

The temperature of all the three effluents was more in the month of September, while it was low in January for textile mill and electroplating effluent and for tannery effluent it was low in the month of October (Fig. 1) and high in September.

Turbidity :

Turbidity of the effluent ranges from 26.2 to 560 NTU for all the three effluents. For textile mill effluent the range was 5.2 – 15.6 NTU with an average of 10.9 NTU, for electroplating effluent the range was 2.0 to 84.0 NTU with an average of 44.43 NTU and

Table No. 1

Monthly variation in Temperature (^{0} C) of three different industrial effluents (A,B & C) from Kolhapur.

Month	A	B	C
September 1999	36 ^{0}C	32^{0}C	34^{0}C
October	31^{0}C	27^{0}C	24^{0}C
November	29.6^{0}C	28.1^{0}C	32^{0}C
December	32^{0}C	33^{0}C	28^{0}C
January 2000	26^{0}C	23^{0}C	28^{0}C
February	27^{0}C	24^{0}C	31^{0}C
March	32^{0}C	28^{0}C	25^{0}C
April	28.7^{0}C	31.5^{0}C	29.3^{0}C
May	27.8^{0}C	30.2^{0}C	26.4^{0}C
June	31^{0}C	24.8^{0}C	29.5^{0}C
July	28.8^{0}C	27.1^{0}C	29.2^{0}C
August	29.3^{0}C	28.9^{0}C	26.8^{0}C
Average	29.9	25.9	28.6

A = Textile mill effluent
B = Electroplating effluent
C = Tannery effluent

Table No.2

Monthly variation in Turbidity in (NTU) of three different industrial effluents (A,B & C) from Kolhapur.

Month	A	B	C
September 1999	8	44	420
October	6.8	36	560
November	13.6	8	288
December	13.6	2	288
January 2000	15.6	20.4	30
February	5.2	44	480
March	12.8	84	440
April	12	86	168
May	14	92	490
June	15.6	24.8	100
July	13.6	8	7.2
August	12	84	30
Average	10.9	44.43	275.1

A = Textile mill effluent
B = Electroplating effluent
C = Tannery effluent

Fig. 1 : Monthly variation in Temperature (^{0}C) of three different industrial effluents (A, B & C) (Sept. 1999 to Aug. 2000) from Kolhapur

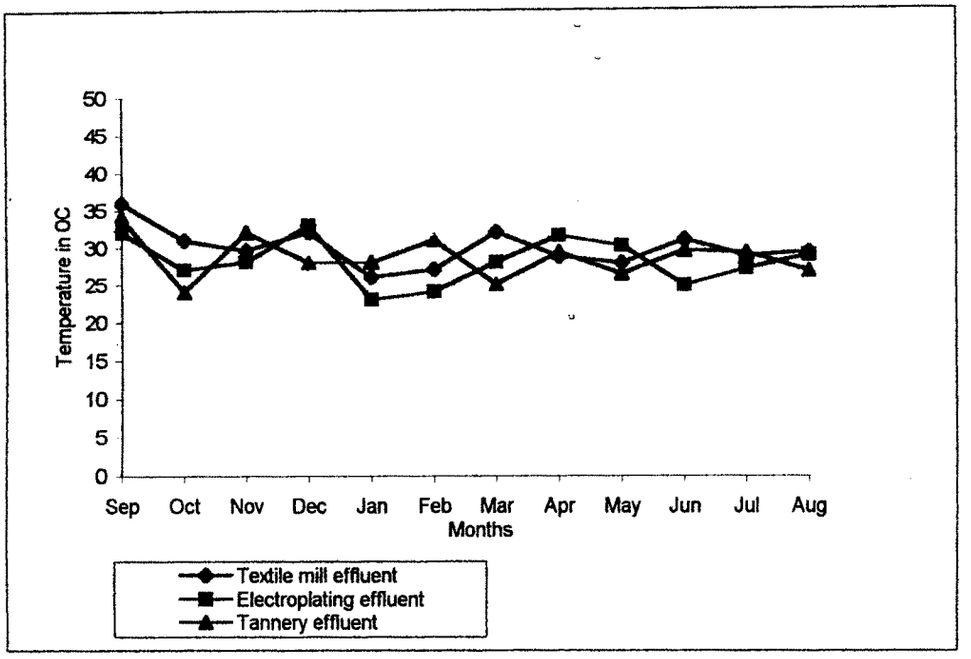
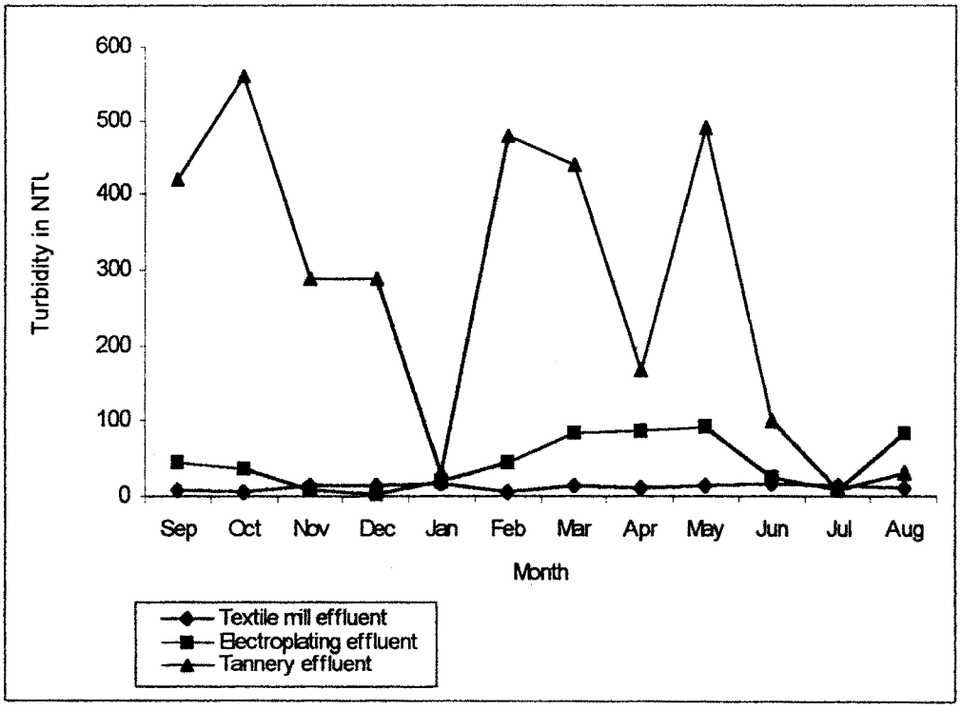


Fig. 2 : Monthly variation in Turbidity (NTU) of three different industrial effluents (A, B & C) (Sept. 1999 to Aug. 2000) from Kolhapur



for tannery effluent the range was 7.2 to 560 NTU with an average of 275.1 NTU (Table No.2). In present study the maximum turbidity was observed in tannery effluent in the month of October and minimum in the month of July. The maximum turbidity for electroplating effluent was in the month of May and minimum in the month of December, while for textile mill effluent it was maximum in the month of January and June, while minimum in the month of February (Fig. 2).

Total Solids :

Total solids for all the three effluents ranged from 2.20-162.00 gm/ l. For textile mill effluent it ranged from 2.20 – 131.60 gm/l. with an average of 44.91 gm/l., for electroplating effluent the range was 2.80-75.60 gm/l. with an average of 29.89 gm/l. and for tannery effluent the range was 2.20–162.00 gm/l. with an average of 63.21 gm/l. The results are presented in table 3.

In present study, maximum total solids in textile mill effluent were in the month of March and minimum in the month of May. In electroplating effluent they were maximum in February and minimum in May and in tannery effluent the maximum values were in the month of March and minimum in July (Fig. 3). Thus maximum total solids were in the month of March in textile mill and tannery effluents. It was minimum in the month of May in textile mill and electroplating effluents (Fig. 3).

Table No. 3

Monthly variation in Total Solids in (mg/lit) of three different industrial effluents (A,B & C) from Kolhapur.

Month	A	B	C
September 1999	70.2 ± 1.235	18.62 ± 1.202	77.84 ± 2.532
October	34.70 ± 1.800	26.90 ± 1.413	62.20 ± 1.711
November	58.80 ± 1.234	9.70 ± 1.942	162.00 ± 1.382
December	50.00 ± 1.453	50.00 ± 1.314	40.00 ± 1.782
January 2000	70.00 ± 1.413	50.00 ± 1.472	60.00 ± 2.332
February	73.00 ± 1.434	75.60 ± 1.782	67.30 ± 2.031
March	131.60 ± 1.831	46.60 ± 1.562	144.20 ± 1.700
April	3.60 ± 1.236	5.60 ± 1.314	18.00 ± 1.342
May	2.20 ± 1.936	2.80 ± 1.342	16.40 ± 2.131
June	38.00 ± 2.532	36.00 ± 1.442	46.20 ± 1.272
July	3.40 ± 1.432	10.00 ± 1.672	2.20 ± 1.817
August	3.47 ± 1.641	26.90 ± 1.632	62.20 ± 1.712
Average	44.91	29.89	63.21

A = Textile mill effluent
B = Electroplating effluent
C = Tannery effluent

Table No. 4

Monthly variation in pH (Hydrogen ion concentration) of three different industrial effluents (A,B & C) from Kolhapur.

Month	A	B	C
September 1999	8.4	4.6	8.9
October	7.9	3.4	8.5
November	8.5	5.2	10.1
December	8.3	5.6	9.4
January 2000	9.6	4.3	8.6
February	8	4	8.5
March	8.5	4.3	9.0
April	8.3	4.4	8.1
May	6.3	4.3	8.2
June	9.5	4.4	8.8
July	8.4	3	8.5
August	8.5	4.2	8.9
Average	8.5	4.3	8.7

A = Textile mill effluent
B = Electroplating effluent
C = Tannery effluent

Fig. 3 : Monthly variation in total solids (gm/ lit) of three different industrial effluents (A, B & C) (Sept. 1999 to Aug. 2000) from Kolhapur

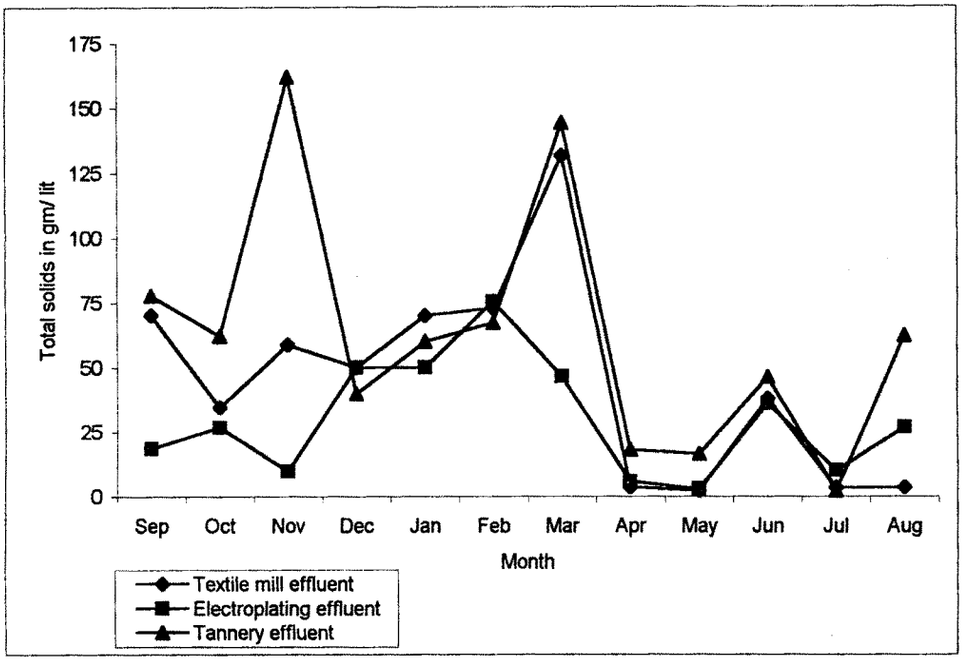
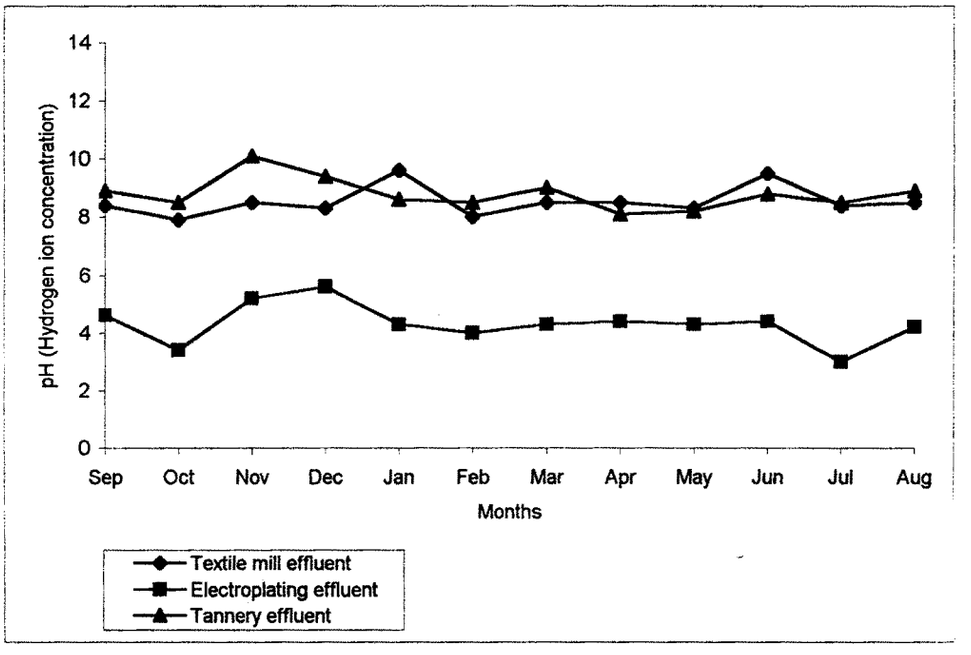


Fig. 4 : Monthly variation in pH (Hydrogen ion concentration) of three different industrial effluents (A, B & C) (Sept. 1999 to Aug. 2000) from Kolhapur



pH :

pH of all the three effluents ranged from 3 to 10.1. For textile mill effluent it ranged from 7.9 to 9.6 with an average of 8.5, for electroplating effluent it ranged from 3 to 5.6 with an average of 4.3 and for tannery effluent the range was between 8.1 to 10.1 with an average of 8.7 (Table 4).

In present study, the pH of textile mill effluent was highly alkaline in January and slightly alkaline in October, that of electroplating effluent, it was highly acidic throughout the year but, varied from month to month. The pH of tannery effluent was found to be highly alkaline in November and slightly alkaline in the month of April (Fig. 4).

Dissolved Oxygen :

The variation in dissolved oxygen was between 0.810 to 5.10 mg/l for all the three effluents. For textile mill effluent it ranges from 1.62 – 4.86 mg/l with an average of 3.10 mg/l, for electroplating effluent it ranges from 3.1 to 4.9 mg/l with an average of 4.3 mg/l and for tannery effluent it ranges from 0.810 to 5.10 mg/l with an average of 3.33 mg/l The results are presented in Table 5.

The dissolved oxygen in textile mill effluent was minimum in the month of April and May while, maximum in the month of June. In electroplating effluent it was minimum in August and maximum

Table No. 5

Monthly variation in Dissolved Oxygen (mg/lit) of three different industrial effluents (A,B & C) from Kolhapur.

Month	A	B	C
September 1999	3.26 ± 4.23	3.87 ± 4.82	4.48 ± 3.34
October	3.64 ± 2.10	4.5 ± 3.42	2.79 ± 4.82
November	2.79 ± 4.32	4.23 ± 3.2	5.10 ± 4.31
December	3.48 ± 3.1	5.1 ± 2.31	3.21 ± 4.32
January 2000	1.62 ± 3.42	4.90 ± 6.21	2.28 ± 3.42
February	4.01 ± 3.42	4.80 ± 11.21	5.10 ± 5.41
March	3.89 ± 8.31	4.52 ± 4.31	4.81 ± 6.32
April	1.62 ± 8.21	4.11 ± 4.42	0.810 ± 2.31
May	1.62 ± 4.21	5.10 ± 3.41	4.52 ± 8.32
Jun	4.86 ± 8.32	3.27 ± 4.23	1.62 ± 6.23
July	2.88 ± 2.13	3.10 ± 3.21	2.17 ± 9.32
August	3.64 ± 6.42	3.1 ± 3.42	3.01 ± 8.21
Average	3.10	4.3	3.33

A = Textile mill effluent
B = Electroplating effluent
C = Tannery effluent

Table No. 6

Monthly variation in Free Carbon dioxide (mg/lit) of three different industrial effluents (A,B & C) from Kolhapur.

Month	A	B	C
September 1999	Nil	4.18 ± 4.32	1.76 ± 8.91
October	Nil	4.09 ± 1.432	14.30 ± 9.31
November	6.38 ± 4.82	17.8 ± 1.432	14.52 ± 9.38
December	Nil	4.00 ± 2.141	20.24 ± 4.313
January 2000	5.28 ± 3.41	5.23 ± 3.141	17.6 ± 2.311
February	3.96 ± 4.32	9.02 ± 2.31	2.28 ± 6.71
March	6.16 ± 4.72	11.60 ± 1.211	7.48 ± 8.21
April	3.52 ± 8.42	3.96 ±6.41	4.62 ± 3.42
May	4.84 ± 8.00	3.52 ± 1.141	6.82 ± 1.012
June	9.02 ± 9.01	8.82 ± 3.23	5.28 ± 8.11
July	4.40 ± 1.233	4.29 ± 1.531	14.3 ± 1.113
August	2.96 ± 1.321	4.00 ± 1.476	14.3 ± 2.34
Average	3.87	6.70	10.97

A = Textile mill effluent
B = Electroplating effluent
C = Tannery effluent

Fig. 5 : Monthly variation in Dissolved Oxygen (mg/lit.) of three different industrial effluents (A, B & C) (Sept. 1999 to Aug. 2000) from Kolhapur

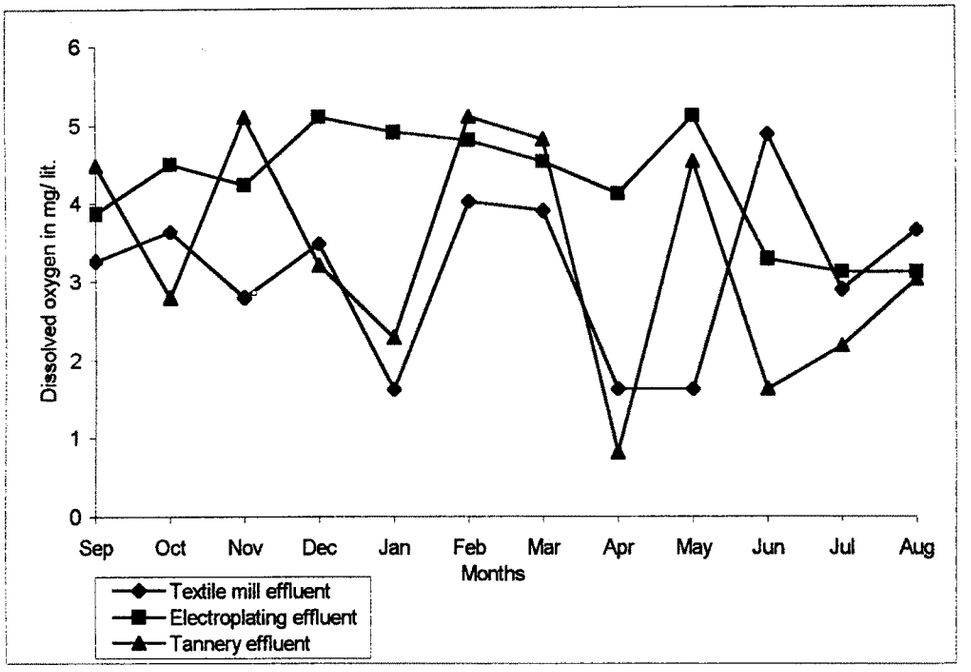
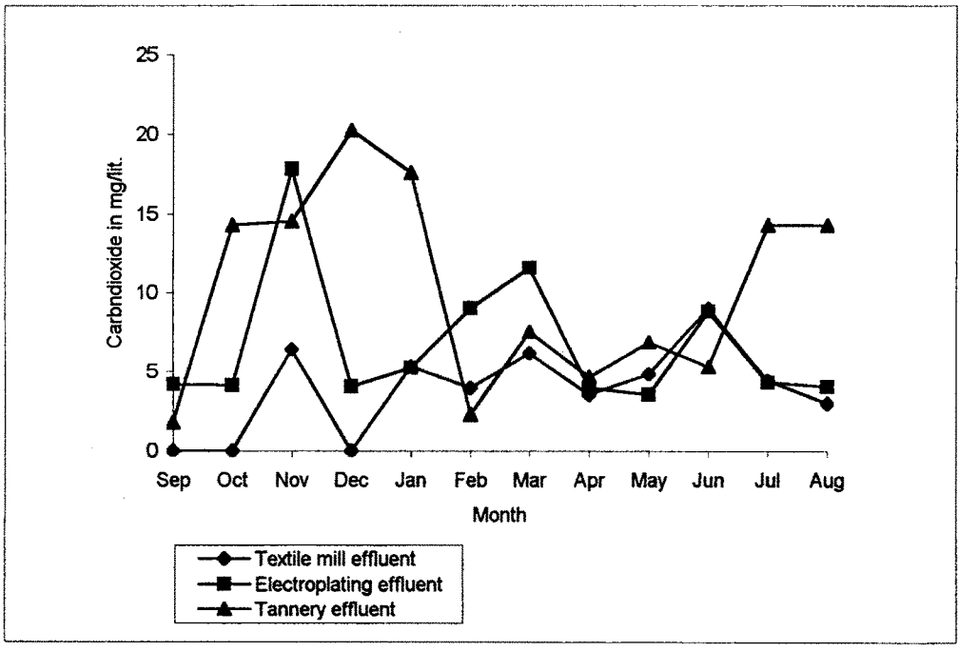


Fig. 6 : Monthly variation in free Carbondioxide (mg/ Lit.) of three different industrial effluents (A, B & C) (Sept. 1999 to Aug. 2000) from Kolhapur



in December and May. In tannery effluent it was minimum in April and maximum in November and February (Fig. 5).

Free Carbon-dioxide :

The free carbondioxide showed fluctuations ranging from 1.76 to 20.24 mg/l for all the three effluents. It ranged from 2.96 – 9.02 mg/l for textile mill effluent with an average of 3.87 mg/l. The range for electroplating effluent was 3.52 – 17.80 mg/l with an average of 6.70 mg/l and for tannery effluent it was 1.76-20.24 mg/l with an average of 10.97 mg/l. Results are presented in Table No. 6 (Fig. 6).

In textile mill effluent the maximum free CO_2 was in June and minimum in August, while it was absent in September, October and December. It was maximum in November and minimum in May for electroplating effluent and in tannery effluent it was maximum in December and minimum in September (Fig. 6).

Hardness (CaCO3) :

The hardness ranged for 72.0- 580.0 mg/l for all the three effluents. The range for textile mill effluent was from 72.0- 318.0 mg/l, with an average value of 217 mg/l. For electroplating effluent it was from 58.0-580.0 mg/l with an average value of 341.9 mg/l and for tannery effluent it was 48.0 – 534.0 mg/l with an average value of 310.66 mg/l. Results are presented in Table 7.

Table No. 7

Monthly variation in Hardness (mg/lit) of three different industrial effluents (A,B & C) from Kolhapur.

Month	A	B	C
September 1999	318 ± 3.121	58 ± 7.82	152 ± 9.31
October	150 ± 9.131	352 ± 2.131	270 ± 9.32
November	92 ± 8.31	548 ± 2.132	250 ± 5.621
December	72 ± 9.12	508 ± 3.142	268 ± 4.442
January 2000	276 ± 4.311	490 ± 9.42	312 ± 8.72
February	262 ± 7.42	580 ± 4.182	534 ± 2.142
March	228 ± 9.79	430 ± 4.311	426 ± 3.142
April	292 ± 2.131	388 ± 9.42	474 ± 5.411
May	310 ± 4.32	508 ± 9.41	344 ± 11.32
June	204 ± 4.011	62 ± 8.31	48 ± 2.34
July	124 ± 11.32	86 ± 9.31	224 ± 4.111
August	276 ± 6.32	352 ± 3.111	426 ± 4.321
Average	217	341.91	310.66

A = Textile mill effluent
B = Electroplating effluent
C = Tannery effluent

Table No. 8

Monthly variation in Chlorinity (mg/lit) of three different industrial effluents (A,B & C) from Kolhapur.

Month	A	B	C
September 1999	208.74 ± 5.101	34.08 ± 7.00	176.08 ±2.101
October	362.1 ± 5.200	134.9 ± 3.100	1285.1 ± 5.105
November	119.28 ± 2.100	298.2 ± 8.100	1491 ± 4.500
December	90.88 ± 5.31	440.2 ± 2.142	1633 ± 5.112
January 2000	205.9 ± 4.211	269.8 ± 3.411	1789.2 ± 2.543
February	174.66 ± 7.31	110.76 ± 4.101	3308.6 ± 4.241
March	167.56 ± 5.00	124.96 ± 4.32	1952.5 ± 4.321
April	140.58 ± 8.72	210.16 ± 5.311	232.88 ± 2.120
May	195.96 ± 4.100	134.9 ± 8.11	1008.2 ± 5.212
June	224.36 ± 11.01	106.5 ± 7.03	1207 ± 1.812
July	176.08 ± 3.42	1775 ± 4.182	468.6 ± 7.83
August	119.28 ± 4.32	910.16 ± 8.62	1789.2 ± 5.322
Average	168.86	320.70	992.21

A = Textile mill effluent
B = Electroplating effluent
C = Tannery effluent

Fig. 7 : Monthly variation in Hardness (mg/ lit.) of three different industrial effluents (A, B & C) (Sept. 1999 to Aug. 2000) from Kolhapur

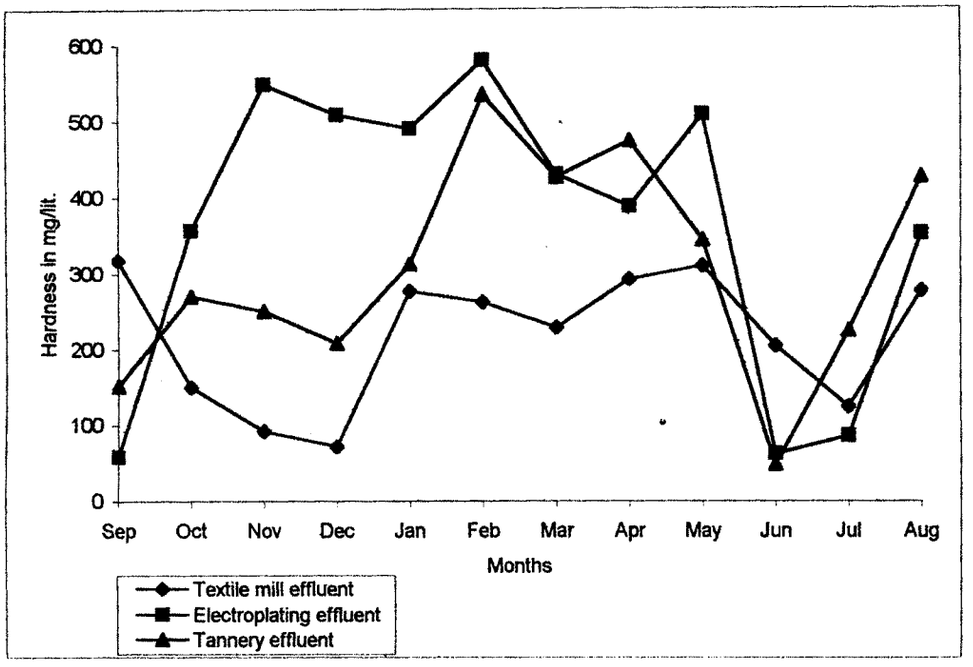
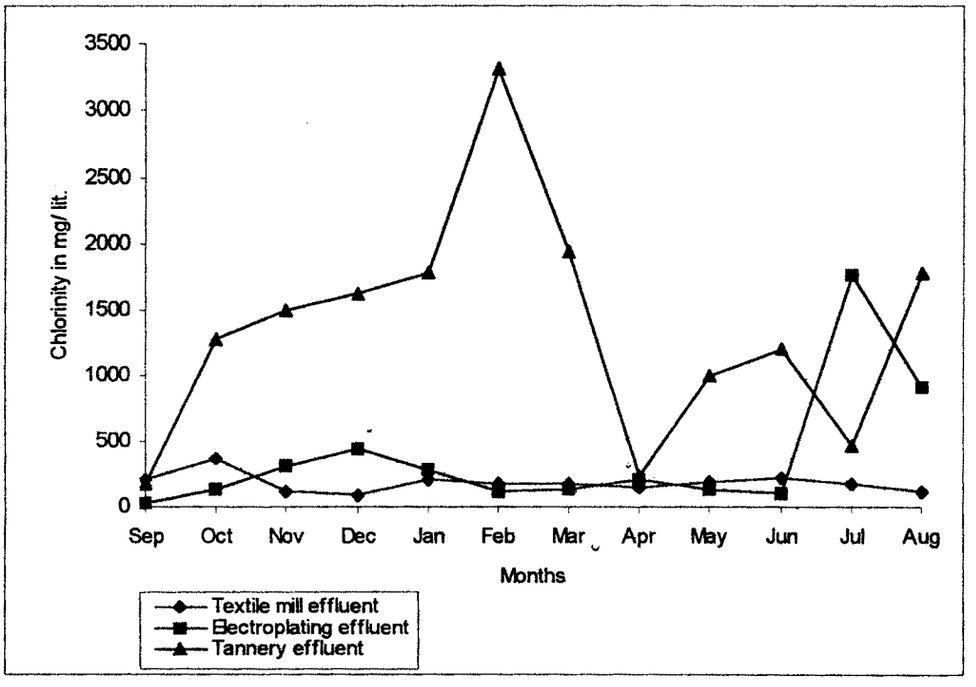


Fig. 8 : Monthly variation in Chlorinity (mg/ lit.) of three different industrial effluents (A, B & C) (Sept. 1999 to Aug. 2000) from Kolhapur



Hardness of the effluents is contributed by cations of calcium and magnesium, carbonates, sulphates, chlorides, nitrates and silicates. The average values of hardness for electroplating and tannery effluents exceeds than that of ICMR Standard (300.0 mg/l).

In textile mill effluent, the maximum hardness was in September and minimum in December, in electroplating effluent it was maximum in February and minimum in September, and in tannery effluent it was maximum in February and minimum in June. Maximum hardness of electroplating and tannery effluent was observed in February (Fig.7).

Chlorides :

The range of chloride content for all the three effluents was 34.08-3308.6 mg/l. The range for textile mill effluent was 90.88-362.1 mg/l with an average value of 168.86 mg/l. The range for electroplating effluent was 34.08-1775.0 mg/l with an average of 320.70 mg/l and for tannery effluent it was 176.08-3308.6 mg/l with an average value of 992.21 mg/l. Results are presented in Table 8.

Maximum chlorinity was observed in October in textile mill effluent and minimum in December. In electroplating effluent it was maximum in July and minimum in September, while it was maximum in February and minimum in September in tannery effluent. Chlorinity was minimum in September in electroplating and tannery effluents (Fig. 8).

Alkalinity :

Alkalinity of all the three effluents ranged from 65.0-905.0 mg/l. The alkalinity for textile mill effluent ranged from 330.0-905.0 mg/l. with an average of 446.62 mg/l for electroplating effluent it ranged from 80.0-670.0 mg/l with an average of 166.58 mg/l and for tannery effluent it ranged from 65.0-630 mg/l with average of 215.8 mg/l Results are presented in table 9.

In textile mill effluent the alkalinity was maximum in October and minimum in December, in electroplating effluent it was maximum in May and minimum in December and absent in September and October. Alkalinity in tannery effluent was maximum in December and minimum in February. It was minimum in textile mill and electroplating effluent in December (Fig. 9).

Acidity :

Acidity of these effluents ranges from 42.5-737.2 mg/l. For textile mill effluent, it ranged from 42.5-425.0 mg/l with an average of 149.79 mg/l, for electroplating effluent from 105.0 to 737.2 mg/l with an average of 356.80 mg/l and for tannery effluent it ranged from 110.0-435.0 mg/l with average of 205.41 mg/l. Results are presented in table 10.

Acidity in textile mill effluent was maximum in September and minimum in January and absent in October and December. In electroplating effluent it was maximum in January and minimum in

Table No. 9

Monthly variation in Alkalinity (mg/lit) of three different industrial effluents (A,B & C) from Kolhapur.

Month	A	B	C
September 1999	455 ± 3.41	Nil	275 ± 7.82
October	905 ± 8.41	Nil	110 ± 2.181
November	675 ± 6.12	120 ± 2.34	80 ± 6.23
December	330 ± 2.111	80 ± 4.82	630 ± 8.73
January 2000	400 ± 4.72	200 ± 6.81	205 ± 1.221
February	350 ± 5.411	115 ± 9.72	65 ± 4.81
March	690 ± 8.721	95 ± 4.00	70 ± 5.82
April	475 ± 4.97	290 ± 2.182	210 ± 1.017
May	435 ± 6.42	670 ± 1.121	160 ± 6.021
June	475 ± 2.421	210 ± 8.67	315 ± 4.311
July	390 ± 4.82	190 ± 7.23	265 ± 3.141
August	675 ± 1.871	290 ± 9.28	205 ± 4.12
Average	446.62	166.58	215.8

A = Textile mill effluent
B = Electroplating effluent
C = Tannery effluent

Table No. 10

Monthly variation in Acidity (mg/lit) of three different industrial effluents (A,B & C) from Kolhapur.

Month	A	B	C
September 1999	425 ± 18.21	105 ± 7.23	110 ± 4.82
October	Nil	700 ± 19.11	435 ± 4.39
November	42.5 ± 41.23	220 ± 2.91	192.5 ± 8.00
December	Nil	320 ± 12.31	167.5 ± 9.42
January 2000	90 ± 7.00	737.2 ± 13.14	112.5 ± 7.12
February	125 ± 7.89	200 ± 11.21	425 ± 11.92
March	337.5 ± 23.21	195 ± 14.67	262.5 ± 7.42
April	117.5 ± 13.14	255 ± 4.34	142.5 ± 7.23
May	302.5 ± 12.1	687 ± 21.01	142.5 ± 6.31
June	105 ± 2.34	352.5 ± 8.21	245 ± 6.43
July	210 ± 14.12	255 ± 4.72	117.50 ± 11.21
August	42.5 ± 8.25	255 ± 9.21	112.5 ± 14.01
Average	149.79	356.80	205.41

A = Textile mill effluent
B = Electroplating effluent
C = Tannery effluent

Fig. 9 : Monthly variation in Alkalinity (mg/ lit.) of three different industrial effluents (A, B & C) (Sept. 1999 to Aug. 2000) from Kolhapur

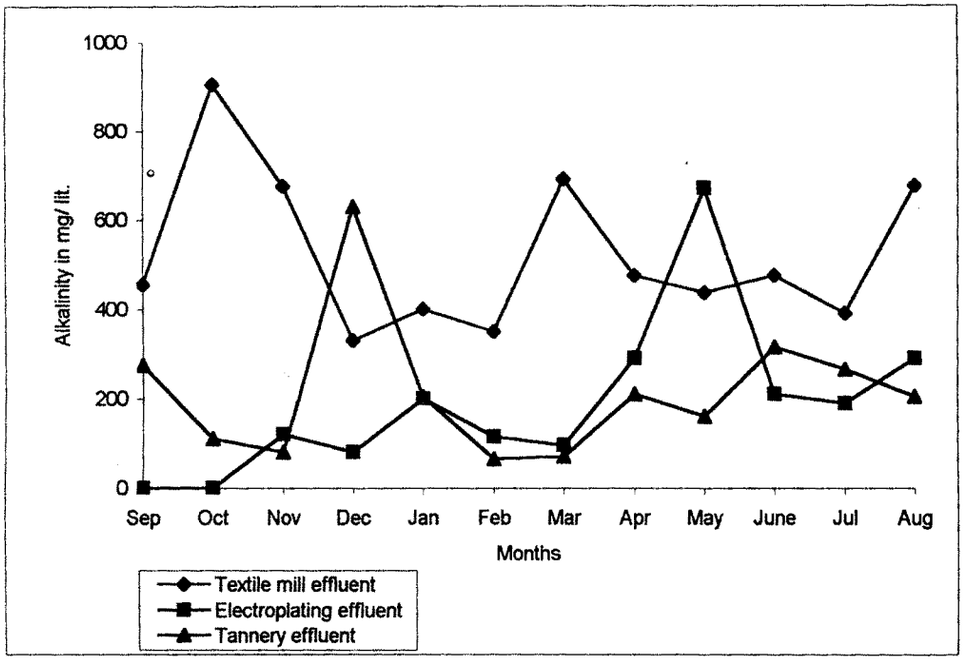
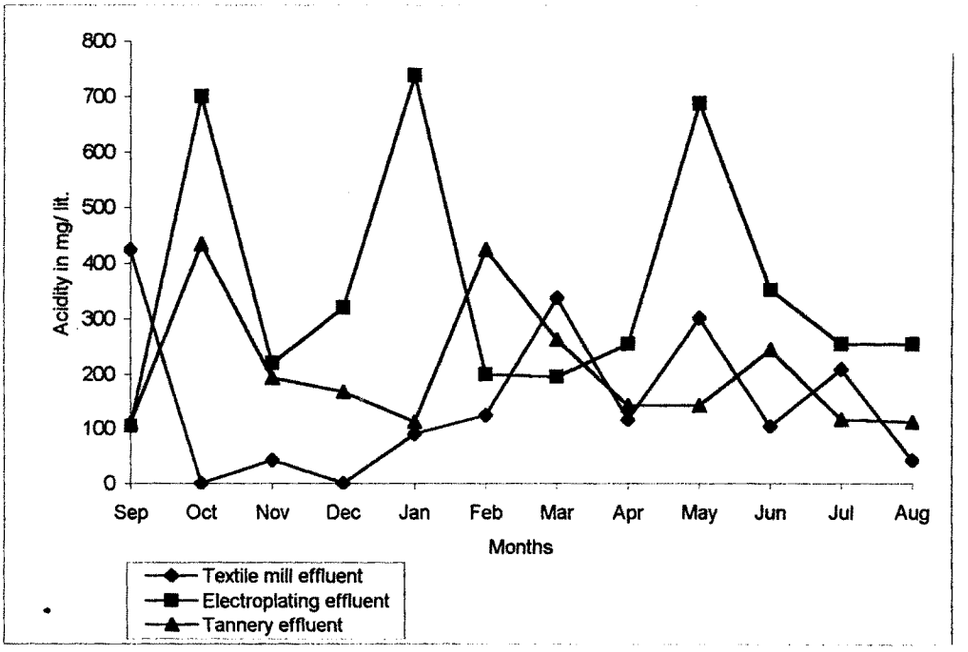


Fig. 10 : Monthly variation in Acidity (mg/ lit.) of three different industrial effluents (A, B & C) (Sept. 1999 to Aug. 2000) from Kolhapur



September, while in tannery effluent it was maximum in October and minimum in September (Fig. 10).

Phosphate – P :

Inorganic phosphate in all the three effluents ranged from 0.040-1.136 mg/l. It ranged from 0.044 – 1.136 mg/l for textile mill effluent with an average of 0.319 mg/l. For electroplating effluent it ranged from 0.048-0.740 mg/l with an average of 0.337 mg/l and for tannery effluent it ranged from 0.040-0.854 mg/l, with an average value of 0.202 mg/l.

Results are presented in Table No. 11. The phosphate content was maximum in September and minimum in November in textile mill effluent, while it was maximum in December and August in electroplating effluent. In tannery effluent, it was maximum in September and minimum in October. Phosphate content was maximum in September in Textile mill and tannery effluents (Fig.11).

Nitrate-N :

Inorganic nitrate content of the three effluents ranged from 0.231-3.332 mg/l. For textile mill effluent it ranged from 0.231-2.897 mg/l, with an average of 1.222 mg/l, for electroplating effluent from 0.741-2.661 mg/l with an average of 1.250 mg/l and for tannery effluent it ranged from 0.260-3.332 mg/l with an average of 1.204 mg/l. Results are presented in table 12. The

Table No. 11

Monthly variation in Phosphate Content (mg/lit) of three different industrial effluents (A,B & C) from Kolhapur.

Month	A	B	C
September 1999	1.136 ± 0.611	0.678 ± 0.955	0.854 ± 0.309
October	0.146 ± 0.051	0.048 ± 0.002	0.040 ± 0.013
November	0.044 ± 0.032	0.502 ± 0.031	0.051 ± 0.013
December	0.058 ± 0.036	0.740 ± 0.254	0.058 ± 0.022
January 2000	0.308 ± 0.032	0.421 ± 0.068	0.194 ± 0.013
February	0.279 ± 0.007	0.061 ± 0.003	0.200 ± 0.006
March	0.990 ± 0.041	0.140 ± 0.004	0.142 ± 0.005
April	0.223 ± 0.027	0.155 ± 0.007	0.151 ± 0.013
May	0.158 ± 0.021	0.157 ± 0.024	0.078 ± 0.089
June	0.158 ± 0.003	0.258 ± 0.017	0.383 ± 0.026
July	0.204 ± 0.010	0.147 ± 0.009	0.135 ± 0.011
August	0.279 ± 0.007	0.740 ± 0.254	0.142 ± 0.005
Average	0.319	0.337	0.202

A = Textile mill effluent
B = Electroplating effluent
C = Tannery effluent

Table No. 12

Monthly variation in Nitrate Content (mg/lit) of three different industrial effluents (A,B & C) from Kolhapur.

Month	A	B	C
September 1999	0.213 ± 0.082	2.200 ± 0.086	0.266 ± 0.082
October	0.946 ± 0.123	0.786 ± 0.131	0.720 ± 0.097
November	0.950 ± 0.029	0.766 ± 0.019	0.964 ± 0.048
December	0.992 ± 0.045	0.786 ± 0.016	0.914 ± 0.039
January 2000	1.080 ± 0.065	1.053 ± 0.821	1.040 ± 0.065
February	2.897 ± 0.011	1.541 ± 0.009	1.725 ± 0.009
March	1.518 ± 0.017	1.081 ± 0.069	1.298 ± 0.039
April	0.510 ± 0.063	1.301 ± 0.157	0.448 ± 0.017
May	1.108 ± 0.073	1.005 ± 0.110	1.712 ± 0.171
June	1.297 ± 0.011	0.741 ± 0.009	0.997 ± 0.097
July	2.213 ± 0.082	2.661 ± 0.035	3.332 ± 0.048
August	0.950 ± 0.029	1.081 ± 0.069	1.040 ± 0.065
Average	1.222	1.250	1.204

A = Textile mill effluent
B = Electroplating effluent
C = Tannery effluent

Fig. 11 : Monthly variation in Phosphate content (mg/ lit.) of three different industrial effluents (A, B & C) (Sept. 1999 to Aug. 2000) from Kolhapur

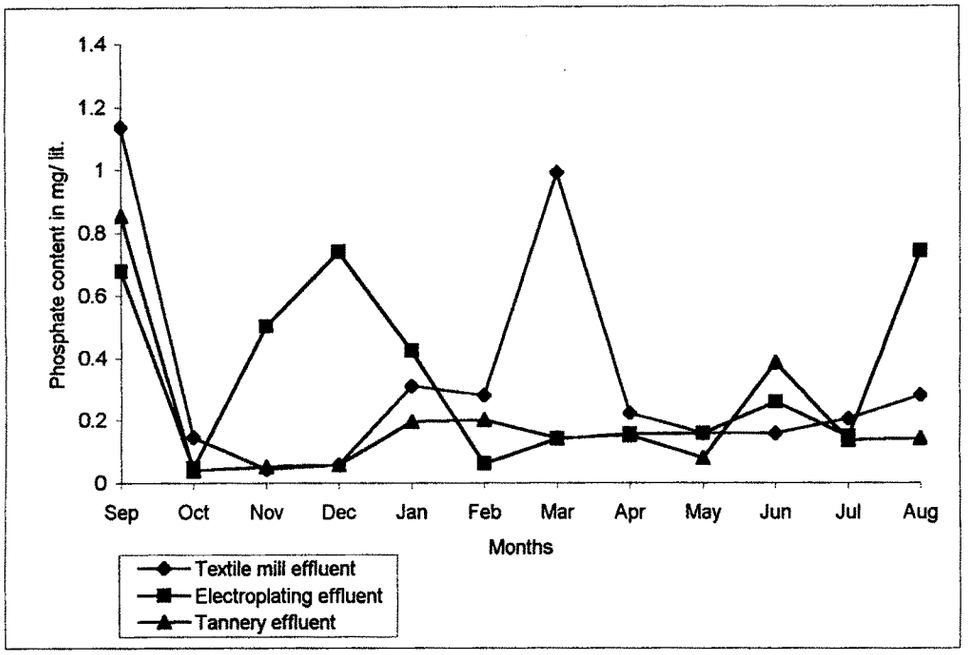
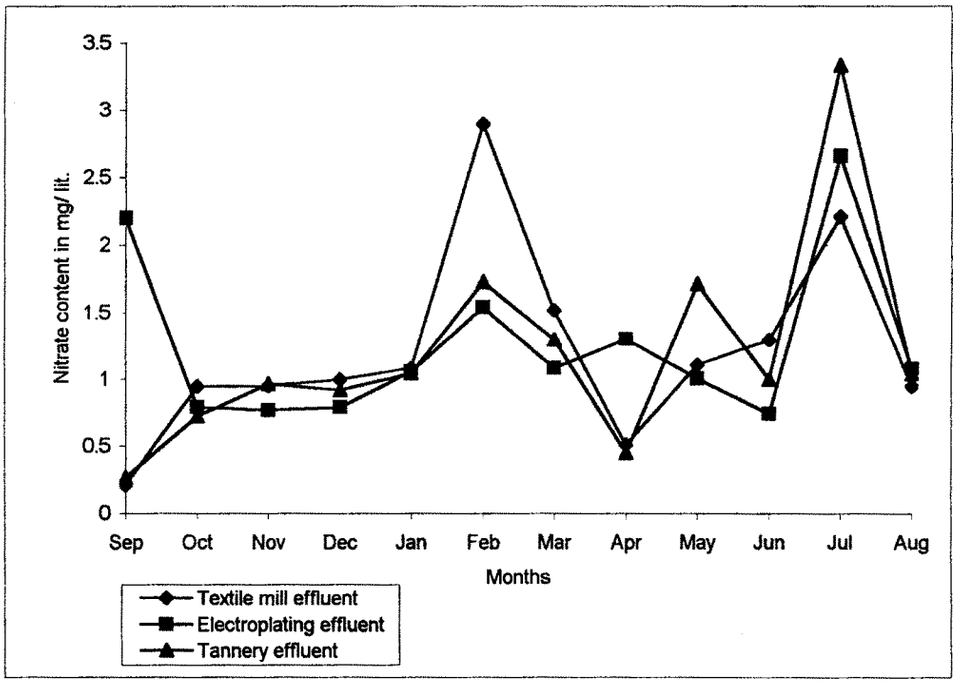


Fig. 12 : Monthly variation in Nitrate content (mg/ lit.) of three different industrial effluents (A, B & C) (Sept. 1999 to Aug. 2000) from Kolhapur



nitrate content in textile mill effluent was maximum in February and minimum in September, in electroplating effluent it was maximum in July and minimum in June and in tannery effluent it was maximum in July and minimum in September. The phosphate content was maximum in July for all the effluents and minimum in September in textile mill and tannery effluent (Fig.12).

Metal Detection : (From September 1999 to August 2000)

The effluents used for experimentation were analysed for quantitative estimation of some heavy metals, which showed very high values as compared to the normal standards. Metals such as copper, nickel, cadmium, aluminium etc. were detected.

Textile Mill Effluent :

In textile mill effluent the range of copper concentration was 0.007 to 0.080 mg/l (average 0.028). The range of nickel concentration was 0.008 – 1.621 mg/l (average 0.273). Cadmium was absent. The range of zinc concentration with 0.03- 0.18 mg/l (average 0.075) lead and chromium was absent, and the range of aluminium was 0.008- 0.124 mg/l (average 0.034) (Table No.13).

In textile mill effluent, the copper content was maximum in June and minimum in February, for nickel it was maximum in October and minimum in March, for zinc it was maximum in May and minimum in November and for aluminium it was maximum in March and minimum in May. The concentration of zinc and

Table No. 13

Monthly variation in Heavy metal (mg/ lit) content of Textile Mill effluent from Kolhapur

MONTH	COPPER	NICKEL	CADM-IUM	ZINC	LEAD	CHRO-MIUM	ALUMI-NIUM
SEP. 1999	00.013	1.062	NIL	0.03	NIL	NIL	TRACES
OCT. 1999	00.010	1.621	NIL	0.04	NIL	NIL	NIL
NOV. 1999	00.011	0.040	NIL	0.03	NIL	NIL	NIL
DEC. 1999	00.008	0.123	NIL	0.06	NIL	NIL	0.08
JAN. 2000	0.013	0.098	NIL	0.08	NIL	NIL	TRACES
FEB. 2000	00.007	0.044	NIL	0.05	NIL	NIL	0.062
MAR 2000	00.016	0.008	NIL	0.12	NIL	NIL	0.124
APR 2000	00.060	0.080	NIL	0.09	NIL	NIL	0.022
MAY 2000	00.020	0.072	NIL	0.18	NIL	NIL	0.008
JUN 2000	00.080	0.009	NIL	0.12	NIL	NIL	0.062
JUL 2000	00.052	0.068	NIL	0.04	NIL	NIL	0.022
AUG 2000	00.046	0.054	NIL	0.06	NIL	NIL	0.034
AVERAGE	0.028	0.273	NIL	0.075	NIL	NIL	0.034

aluminium was maximum in May. In general, the concentration of Ni was maximum followed by Zn, Al and Cu.

Electroplating Effluent :

In electroplating effluent the concentration of copper ranged from 2.05- 3.90 mg/l, with an average of 2.892 mg/l, for nickel the range was 0.041-0.092 mg/l, with an average of 0.069 mg/l for cadmium it was 2128 to 3.198 mg/l with an average of 2.687 mg/l for zinc it was 4.48 – 7.24 mg/l with an average 0.075 mg/l. The lead concentration ranged from 0.022- 0.098 mg/l with an average of 0.067 mg/l that of chromium ranged from 17.08- 27.46 mg/l with an average of 24.95 mg/l and concentration of aluminium ranged from 1.222- 2.822 mg/l with an average 2.122 mg/l (Table No.14).

In electroplating effluent copper content was maximum in July and minimum in October, nickel content was maximum in January and minimum in November, cadmium content was maximum in August and minimum in May and zinc content was maximum in September and minimum in February. The lead content of electroplating effluent was maximum in December and minimum in September. Chromium content was maximum in March and minimum in September and aluminium content was maximum in November and minimum in September.

In general the concentration of Cr was maximum followed by Zn, Cu, Cd, Al, Ni and Pb.

Table No. 14

Monthly variation in Heavy metal (mg/ lit) content of Electroplating effluent from Kolhapur

MONTH	COPPER	NICKEL	CADM-IUM	ZINC	LEAD	CHRO-MIUM	ALUMI-NIUM
SEP. 1999	02.28	0.062	3.162	7.24	0.022	17.08	1.222
OCT. 1999	02.05	0.062	3.182	7.00	0.082	20.82	1.420
NOV. 1999	02..90	0.041	2.168	6.00	0.049	28.81	2.822
DEC. 1999	02.82	0.082	2.006	5.84	0.098	25.72	2.252
JAN. 2000	02.64	0.092	2.922	6.38	0.069	26.00	2.312
FEB. 2000	02.62	0.044	3.135	4.48	0.072	24.96	2.292
MAR 2000	03.86	0.078	2.346	6.45	0.068	27.46	2.244
APR 2000	02.66	0.080	3.192	5.92	0.058	25.22	1.822
MAY 2000	02.82	0.072	2.128	7.08	0.072	24.86	2.308
JUN 2000	02.68	0.089	2.528	6.32	0.088	26.32	2.246
JUL 2000	03.90	0.068	2.282	6.84	0.074	25.90	2.222
AUG 2000	03.48	0.062	3.198	5.44	0.062	26.32	2.302
AVERAGE	2892	0.069	2.687	6.249	0.067	24.95	2.122

Tannery effluent :

In tannery effluent, the concentration of copper ranged from 0.85-2.28 mg/l with an average of 1.732 mg/l, for nickel the range was 2.66- 3.64 mg/l with an average of 3.048 mg/l, for cadmium the range was 0.82- 2.35 mg/l with an average of 1.730 mg/l, and for zinc the range was 1.92- 2.48 mg/l with an average of 2.200 mg/lt. The lead concentration ranged from 0.024- 0.082 mg/l with an average of 0.055- mg/l, that of chromium ranged from 4.81- 7.46 mg/l with an average of 5.912 mg/l, and concentration of Al ranged from 0.118- 0.312 mg/l with average of 0.243 mg/l (Table No.15).

In tannery effluent copper content was maximum in February and minimum in October, nickel content was maximum in February and minimum in July, cadmium content was maximum in February and minimum in November, and zinc content was maximum in February and minimum in April. The lead content was maximum in November and minimum in October, chromium content was maximum in March and minimum in November and aluminium content was maximum in January and minimum in November. It was observed that, concentration of Cd, Cr and Al was minimum in November, while concentration of Cu, Ni, Cd and Zn was maximum in February In general, the concentration of Cr was maximum followed by Ni, Zn, Cd, Cu, Al and Pb.

Table No. 15

Monthly variation in Heavy metal (mg/ lit) content of Tannery effluent from Kolhapur

MONTH	COPPER	NICKEL	CADM-IUM	ZINC	LEAD	CHRO-MIUM	ALUMI-NIUM
SEP. 1999	02.00	3.22	2.16	2.24	0.044	7.08	0.223
OCT. 1999	00.85	2.82	1.28	2.00	0.024	6.28	0.123
NOV. 1999	01.34	3.11	0.82	2.00	0.082	4.81	0.118
DEC. 1999	01.82	2.85	2.00	2.14	0.054	5.72	0.252
JAN. 2000	01.64	2.92	1.92	2.38	0.049	6.00	0.312
FEB. 2000	02.28	3.64	2.35	2.48	0.062	4.96	0.292
MAR 2000	02.02	3.35	2.04	2.18	0.058	7.46	0.244
APR 2000	01.66	2.80	1.92	1.92	0.048	5.22	0.222
MAY 2000	02.12	3.04	2.12	2.08	0.068	4.86	0.308
JUN 2000	01.68	2.89	1.52	2.32	0.042	6.32	0.246
JUL 2000	01.90	2.66	2.28	2.22	0.074	5.92	0.282
AUG 2000	01.48	3.28	198	2.44	0.060	6.32	0.302
AVERAGE	1.732	3.048	1.730	2.200	0.055	5.912	0.243

ACUTE TOXICITY

Tannery Effluent :

There was no mortality at 10% and 15% concentration, whereas mortality began at 20% concentration after 24 hr. and at the end of 96 hr there was 50% mortality at 20% concentration. there was 90% mortality in 25% concentration and 100% mortality at 30% concentration at the end of 96 hr. (Table No.16)

Electroplating Effluent :

There was no mortality at 2% and 3% concentrations of electroplating effluents at 96 hr. Mortality began to occure in 4% concentration after 96 hr while in 5%, 6%, 7% and 8% concentration it occurs after 24 hr. There was 10% mortality at 4% concentration after 96 hr, whereas there was 30% mortality after 72 hr at 5% concentration. There was 50% mortality after 96 hr at 6% concentration, 80% mortality after 96 hr at 7% concentration and 100% mortality at 8% concentration after 96 hr. (Table No.17).

Textile Mill Effluent :

There was no mortality at 16% and 18% concentration of textile mill effluent at 96 hr. There was 20% mortality in 20% concentration after 24 hr, whereas in 22% and 24% concentration there was 50% and 100% mortality at the end of 96 hr. (Table No.18).

Table No. 16

Acute toxicity of Tannery effluent to *Labeo rohita*

Period in hours	Concentrations in Percentage					
	10%	15%	20%	25%	30%	
24	-	-	1 (d)	2 (d)	3 (d)	LC_0 -15%
48	-	-	2 (d)	3 (d)	3 (d)	LC_{50}-20%
72	-	-	-	3 (d)	2 (d)	
96	-	-	2 (d)	1 (d)	2 (d)	
M	0%	0%	50%	90%	100%	

Table No. 17

Acute toxicity of Electroplating effluent to *Labeo rohita*

Period in hours	Concentrations in Percentage							
	2%	3%	4%	5%	6%	7%	8%	
24	-	-	-	1 (d)	1 (d)	2 (d)	3 (d)	LC_0 – 3%
48	-	-	-	1 (d)	2 (d)	2 (d)	2 (d)	LC_{50}- 6%
72	-	-	-	1 (d)	-	1 (d)	3 (d)	
96	-	-	1 (d)	-	2 (d)	3 (d)	2 (d)	
M	0%	0%	10%	30%	50%	80%	100%	

Table No. 18

Acute toxicity of Textile mill effluent to *Labeo rohita*

Period in hours	Concentrations in Percentage					
	16%	18%	20%	22%	24%	
24	-	-	2 (d)	2 (d)	3 (d)	LC_0 –18%
48	-	-	-	2 (d)	6 (d)	LC_{50}-22%
72	-	-	-	1 (d)	1 (d)	
96	-	-	-	-	-	
M	0%	0%	20%	50%	100%	

- NO mortality, (d) = No. fish died, M - % mortality

Thus it was observed that the LC_0 and LC_{50} concentrations for tannery effluent was 15% and 20%, for electroplating effluent it was 3% and 6% and for textile mill effluent it was 18% and 22%.

Behaviour of fish after exposure to effluents :

The behaviour of the fish, *Labeo rohita* was observed during experimental period alongwith control group. The acclimatized fishes were transferred to the experimental plastic containers in groups of ten having different concentrations of the effluents. The fishes showed remarkable changes in their behaviour. It is important to study the behaviour of fishes, as their response to the intensity of the toxicant.

Following behavioural patterns were observed in tannery effluent :

1. The effect was observed by erratic swimming and frequent stricking against the wall of the container.
2. The rapid and jerky movements of the body was observed.
3. Excess amount of mucous secretion was noticed.
4. Fishes tried to jump out of the container to avoid toxic concentration.
5. There was increase in the respiratory activity in the beginning and then there was gradual decrease in opercular movements
6. Fishes often swam near the surface to engulf the atmospheric air.

7. The yellow patches were observed on the belly of the fishes at higher concentrations.
8. Fishes did not show any response to touch in the later phase.
9. The mortality was confirmed by absence of any movement or respiration and finally after death, fishes settled down at the bottom of the container.
10. Dead fishes showed disclouration of the body.

Following behavioural patterns were observed in electroplating effluents :

1 Initially the movement of the fishes was restricted, when they were released to various effluent concentrations they show body torsion and loss of balance for some time and again recovered after some time in lower concentration.

2 There was heavy mucous secretion.

3. Loss of reflex to touch was observed.

4. Shedding of scales was observed.

5. Infection to the snout and eyes was observed.

6. The fishes finally became inverted (belly upward), floated near the surface for some time and after death they settled at the bottom of the container. The bluish tinge was observed as the dorsal surface of the body.

Following behavioural patterns were observed in textile mill effluent :

1. The effect of the effluent showed erratic swimming movement among the fishes.
2. The rapid jerky movements were observed.
3. The fishes tried to jump out of the container.
4. There was no much mucous secretion.
5. The fishes often swam towards the surface to avoid toxic concentration and to gulp the atmospheric air directly.
6. As the period of experiment progressed, they lost co-ordination and balance of the movement.
7. Finally after death the fishes settled at the bottom of the plastic container.

BIOCHEMICAL STUDIES

Total Glycogen :

Changes in the total glycogen in gill, liver, muscle, kidney and brain of *L. rohita* exposed to tannery effluent after acute exposure for 96 hr are shown in table No.19.

Control of Acute Test :

The glycogen level in different body tissues was in the order of liver> gill> muscle> brain> kidney (Table No.19).

Tannery Effluent :

The glycogen content in all the organs was decreased considerably upon acute exposure to 15% of tannery effluent.

Table No. 19

Effect of tannery effluent on glycogen content in various organs of the fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)

Organ	Control	LC_0	LC_{50}
Gill	0.516 ± 0.031	0.216 ± 0.031 -(58.13) * *	0.350 ± 0.040 - (32.17) *
Liver	3.500 ± 0.020	1.578 ± 0.026 - (54.91) * *	0.866 ± 0.051 - (75.25) * *
Muscle	0.433 ± 0.031	0.353 ± 0.031 - (18.47) *	0.491 ± 0.031 (13.39) *
Kidney	0.180 ± 0.050	0.133 ± 0.031 - (26.11) *	0.185 ± 0.031 (2.77) N.S.
Brain	0.201 ± 0.070	0.157 ± 0.040 - (21.89) *	0.178 ± 0.020 - (11.44) *

The values in paranthesis are percent change

* = P< 0.05

** = P< 0.001

NS= Non significant

± = S.D. of 5 animals

Although the relative decrease varied from tissue to tissue, the per cent depletion was more significant ($P < 0.001$) in gill (58.13), followed by liver (54.91) and less significant ($P< 0.05$) in kidney (26.11), brain (21.89) and muscle (18.47).

In LC_{50} group there was more significant ($P< 0.001$) percent depletion in the levels of glycogen in liver (75.25). Less significant ($P < 0.05$) decrease in glycogen content was in gill (32.17) followed by muscle (13.39) and brain (11.44). There was non-significant increase in kidney (2.77) in the glycogen content due to lethal concentration (20%) of tannery effluent.

In general, there was significant decrease in glycogen level in both LC_0 and LC_{50} groups, when compared to control (fig.13) but it was more in LC_{50} group than LC_0 (Table No.19).

Changes in the total glycogen in gill, liver, muscle, kidney and brain of *L.rohita* exposed to electroplating effluent after acute exposure for 96 hr are shown in the table No.20.

Control of Acute Test :

The glycogen levels in different body tissues was in the order of liver > gill > muscle> brain > kidney (Table No.20).

Electroplating Effluent :

The glycogen content in all the tissues decreased considerably upon acute exposure to 3% of electroplating effluent. Although the relative decrease varied from tissue to tissue, the percent depletion

Table No. 20

Effect of electroplating effluent on glycogen content in various organs of fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)

Organ	Control	LC_0	LC_{50}
Gill	0.517 ± 0.004	0.492 ± 0.020 - (4.83) N.S.	0.488 ± 0.015 - (5.60) N.S.
Liver	3.910 ± 0.006	2.287 ± 0.020 - (41.50) * *	2.344 ± 0.007 - (40.05) * *
Muscle	0.587 ± 0.007	0.482 ± 0.046 - (17.88) *	0.339 ± 0.008 - (42.24) * *
Kidney	0.181 ± 0.008	0.161 ± 0.022 - (11.64) *	0.125 ± 0.004 - (30.93) *
Brain	0.401 ± 0.006	0.349 ± 0.013 - (12.96) *	0.386 ± 0.011 - (3.74) N.S.

The values in paranthesis are percent change

* = P< 0.05

** = P< 0.001

NS= Non significant

± = S.D. of 5 animals

Fig. 13 : Effect of tannery effluent on glycogen content in various organs of the fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)

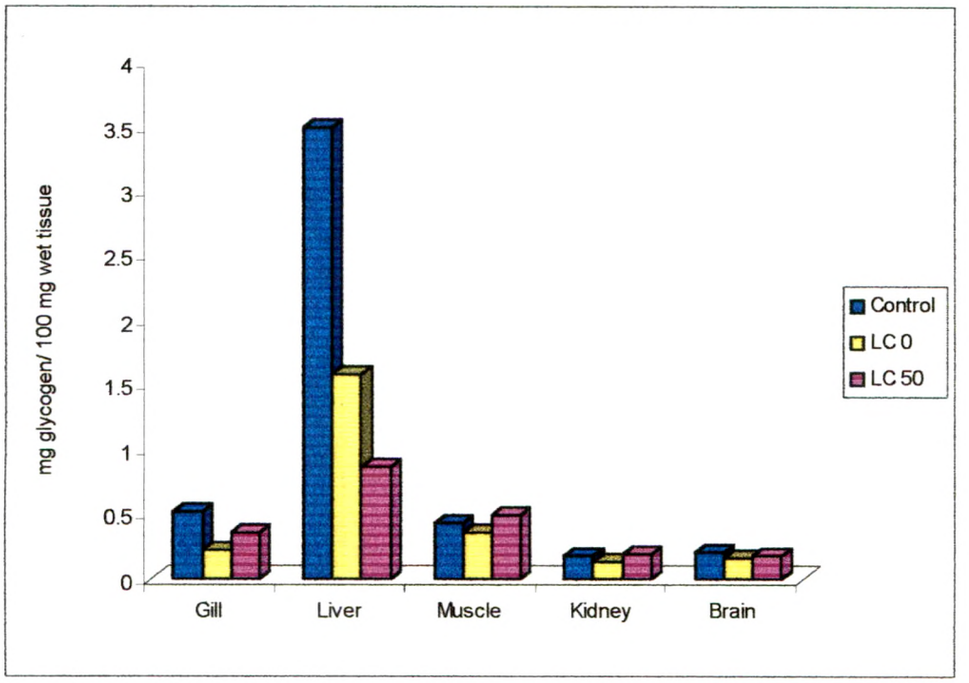
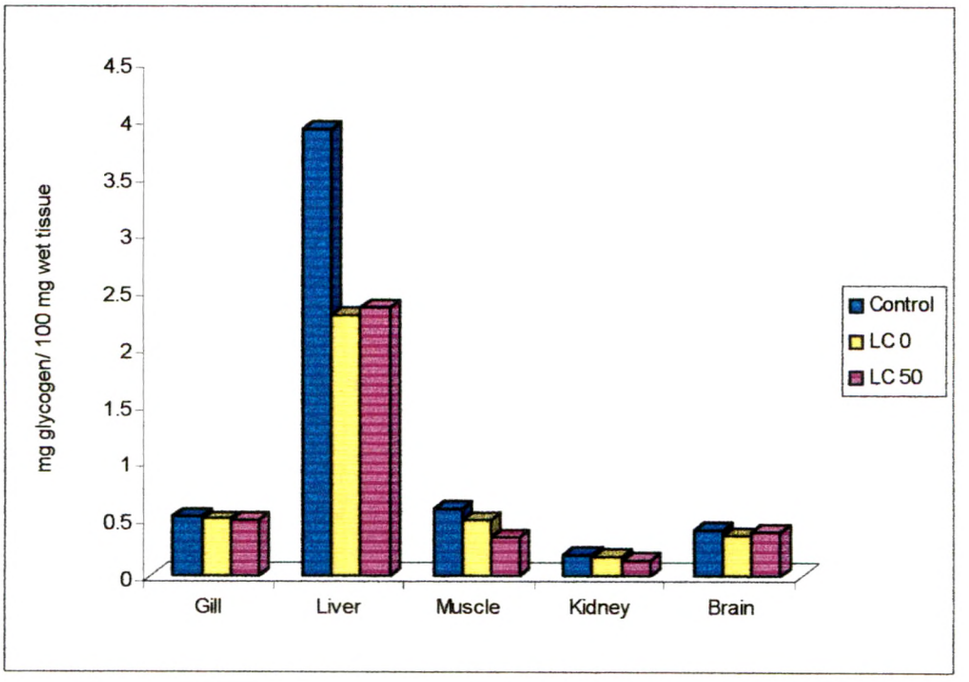


Fig. 14 : Effect of electroplating effluent on glycogen content in various organs of the fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)



was more significant ($P < 0.001$) in liver (41.50) whereas less significant ($P < 0.05$) in muscle (17.88) followed by brain (12.96) and kidney (11.64). There was non-significant decrease in glycogen level in gill (4.83%).

In LC_{50} group, there was more significant ($P < 0.001$) percent depletion in the glycogen level was in muscle (42.24) and in liver (40.05), whereas less significant ($P < 0.05$) in kidney (30.93). Non-significant depletion in glycogen content was observed in gill (5.60%) and brain (3.74%) as compared to control upon exposure to lethal concentration of 6% electroplating effluent.

In general there was significant decrease in glycogen level in LC_0 and LC_{50} groups (Fig. 14). But it was more in LC_{50} group than LC_0 (Table No.20).

Changes in the total glycogen in gill, liver, muscle, kidney and brain of *L. rohita* exposed to textile mill effluent after acute exposure for 96 hr are shown in table No.21.

Control of Acute Test :

The glycogen levels of different body parts was in the order of liver> gill> muscle> brain> kidney (Table No.21).

Textile Mill Effluent :

The glycogen content in all the tissues decreased considerably upon acute exposure to 18% of textile mill effluent. Although the relative decrease varied from tissue to tissue, the percent depletion

Table No. 21

Effect of textile mill effluent on glycogen content in various organs of fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)

Organ	Control	LC_0	LC_{50}
Gill	0.495 ± 0.002	0.236 ± 0.012 - (52.32) * *	0.150 ± 0.010 - (69.69) * *
Liver	3.215 ± 0.008	2.248 ± 0.006 - (30.07) *	3.101 ± 0.012 - (3.54) N.S.
Muscle	0.383 ± 0.003	0.147 ± 0.005 - (61.61) * *	0.312 ± 0.011 - (18.53) *
Kidney	0.185 ± 0.009	0.131 ± 0.011 - (29.18) *	0.223 ± 0.006 (20.54) *
Brain	0.258 ± 0.006	0.213 ± 0.021 - (17.44) *	0.183 ± 0.008 - (29.06) *

The values in paranthesis are percent change

* = P< 0.05

** = P< 0.001

NS= Non significant

± = S.D. of 5 animals

was more significant (P< 0.001) in muscle (61.61) and gill (52.32) and less significant (P< 0.05) in liver (30.07) followed by kidney (29.18) and brain (17.44).

In LC_{50} group there was significant (P< 0.001) percent depletion in glycogen content in gill (69.69). There was less significant (P< 0.05) depletion in glycogen level in brain (29.06) and muscle (18.53), whereas slight increase in kidney (20.54) was observed. Non-significant depletion in glycogen level was observed in liver (3.54) due to lethal concentration of 22% of textile mill effluent.

In general, there was significant decrease in glycogen level in LC_0 and LC_{50} groups when compared to control (Fig.15) but it was more in LC_{50} group than LC_0 (Table No.21).

Total Protein :

Changes in the total protein in gill, liver, muscle, kidney and brain of *L. rohita* exposed to tannery effluent after acute exposure for 96 hr are shown in table No.22.

Control of Acute Test :

The protein content in different body parts was in the order of muscle > gill> kidney> brain > liver (Table No.22).

Tannery Effluent :

Total protein content decreased significantly (P< 0.05) in kidney (26.60%) followed by gill (23.23%), Muscle (13.04%) and

Table No. 22

Effect of tannery effluent on protein content in various organs of fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)

Organ	Control	LC_0	LC_{50}
Gill	20.40 ± 2.776	15.66 ± 3.205 - (23.25) *	24.93 ± 4.240 (22.20) *
Liver	12.33 ± 1.602	11.73 ± 1.602 - (4.86) N.S.	10.20 ± 2.776 - (9.97) N.S.
Muscle	26.06 ± 4.240	22.66 ± 1.602 - (13.04) *	18.13 ± 1.602 - (30.42) *
Kidney	18.53 ± 1.602	13.60 ± 2.776 - (26.60) *	14.73 ± 3.205 - (20.50) *
Brain	13.6 ± 2.776	12.21 ± 4.240 - (10.22) *	10.20 ± 2.776 - (25.00) *

The values in paranthesis are percent change

* = $P < 0.05$

** = $P < 0.001$

NS= Non significant

± = S.D. of 5 animals

Fig. 15 : Effect of textile effluent on glycogen content in various organs of the fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)

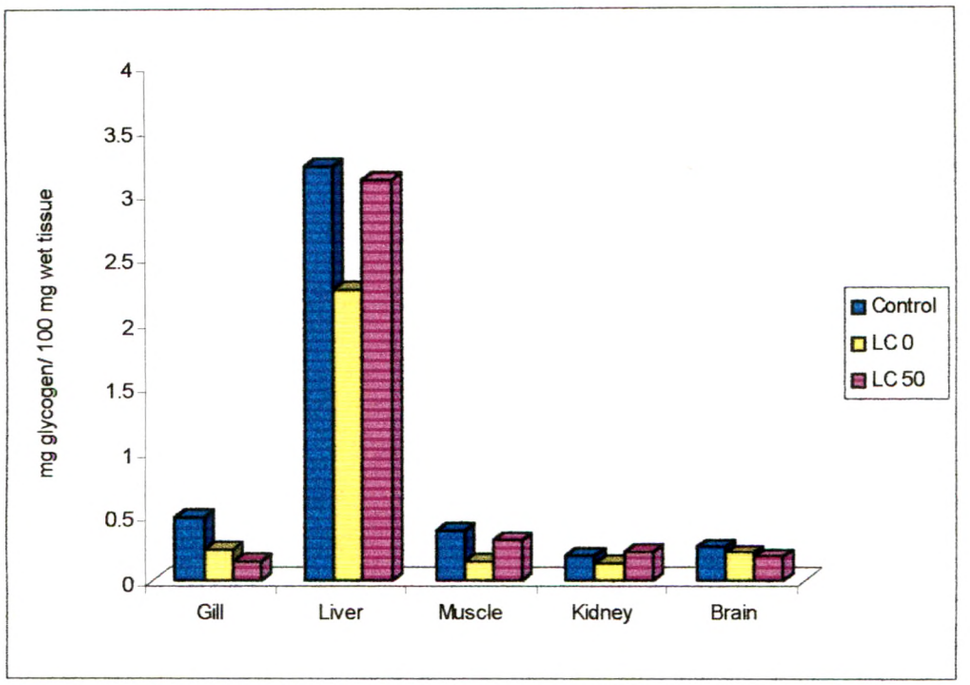
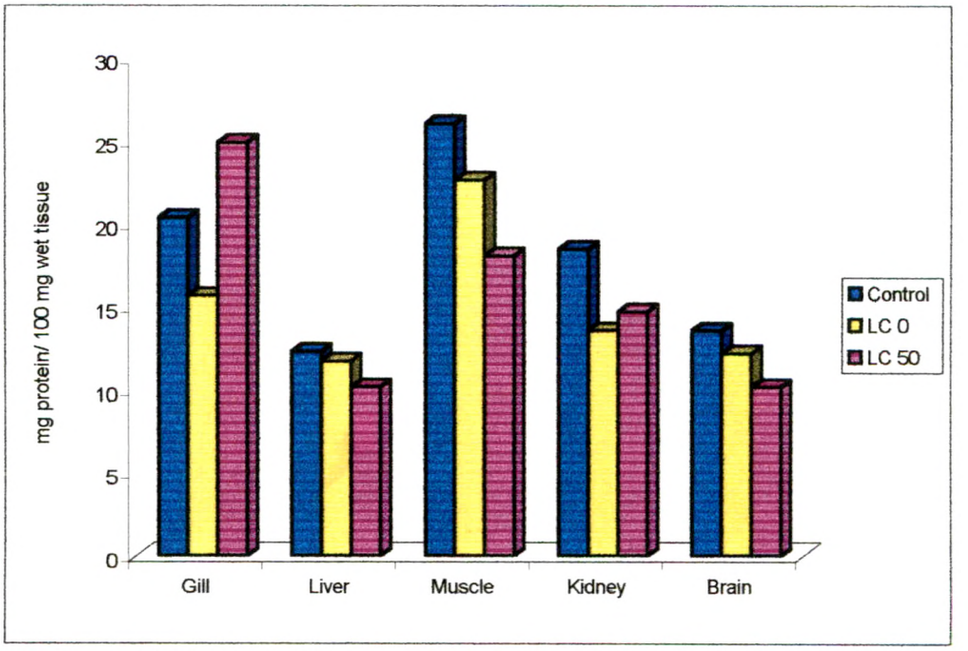


Fig. 16 : Effect of tannery effluent on protein content in various organs of the fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)



brain (10.22%). There was non significant decrease in protein content in liver (4.86%) upon acute exposure to 15% of tannery effluent.

In LC_{50} group, there was less significant decrease ($P< 0.05$) in muscle (30.42%) followed by brain (25.00%) and kidney (20.50%). There was significant ($P< 0.05$) increase in gill (22.20%). Non-significant decrease in protein content was observed in liver (9.97%) as compared to control, upon exposure to lethal concentration (20%) of tannery effluent.

In general, there was decrease in the protein content of different tissues in LC_0 group while, decrease in LC_{50} group except gill as compared to control (Fig.16).

Changes in the total protein in gill, liver, muscle, kidney and brain of *L.rohita* exposed to electroplating effluent after acute exposure for 96 h are shown in table No.23.

Control of Acute Test :

The protein content in different body parts was in the order of muscle> gill> kidney> brain> liver (Table No.23).

Electroplating Effluent :

The protein content in all the tissues decreased considerably upon acute exposure to 3% electroplating effluent. Although the relative decrease varied from tissue to tissue, the percent depletion was significant ($P < 0.05$) in muscle (33.36) and brain (14.24),

Table No. 23

Effect of electroplating effluent on Protein content in various organs of fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)

Organ	Control	LC_0	LC_{50}
Gill	22.66 ± 4.240	21.53 ± 4.240 - (4.98) N.S.	19.26 ± 1.602 - (15.00) *
Liver	14.73 ± 4.240	13.60 ± 2.776 - (7.67) N.S.	13.60 ± 2.776 - (7.67) N.S.
Muscle	23.80 ± 2.776	15.86 ± 4.240 - (33.36) *	13.60 ± 5.552 - (42.85) **
Kidney	17.00 ± 7.344	15.86 ± 4.240 - (6.70) N.S.	19.26 ± 4.240 (13.29) *
Brain	15.86 ± 4.240	13.60 ± 4.240 - (14.24) *	17.00 ± 5.552 (7.18) N.S.

The values in paranthesis are percent change

* = $P < 0.05$

** = $P < 0.001$

NS= Non significant

± = S.D. of 5 animals

whereas, there was non-significant decrease in protein level in liver (7.67) followed by kidney (6.70) and gill (4.98) due to sub lethal concentration (3%).

In LC_{50} group, there was significant decrease in protein content of all tissues except kidney and brain upon exposure to lethal concentration of 6% electroplating effluent. The percent depletion in protein content was more significant ($P< 0.001$) in muscle (42.85) and less significant ($P< 0.05$) in gill (15.00) while, non-significant decrease in liver (7.67) except kidney and brain was observed. There was significant ($P< 0.05$) increase in kidney (13.29) and non-significant increase in brain (7.18).

In general, there was depletion in the protein content of all tissues in LC_0 group while there was depletion in protein content of gill, liver and muscle (except kidney and brain) in LC_{50} group as compared to control (Fig.17).

Change in the total protein content in gill, liver, muscle, kidney and brain of *L. rohita* exposed to textile mill effluent after acute exposure (96 hr) is shown in table No. 24.

Control of Acute Test :

The protein content in different body parts was in order of muscle> gill> kidney> brain> liver (Table No.24).

Table No. 24

Effect of textile mill effluent on Protein content in various organs of fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)

Organ	Control	LC_0	LC_{50}
Gill	19.26 ± 5.778	13.60 ± 5.552 - (29.38) *	12.46 ± 4.240 - (35.30) **
Liver	13.60 ± 2.776	14.73 ± 4.240 (8.30) N.S.	12.46 ± 1.602 - (8.38) N.S.
Muscle	24.93 ± 4.240	21.53 ± 5.778 - (13.63) *	17.00 ± 2.776 - (31.80) *
Kidney	17.00 ± 2.776	20.40 ± 2.776 (20.00) *	14.73 ± 4.240 - (13.35) *
Brain	15.80 ± 5.778	12.46 ± 4.240 - (21.13) *	11.33 ± 1.602 - (28.29) *

The values in paranthesis are percent change

* = P< 0.05

** = P< 0.001

NS= Non significant

± = S.D. of 5 animals

Fig. 17 : Effect of electroplating effluent on protein content in various organs of the fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)

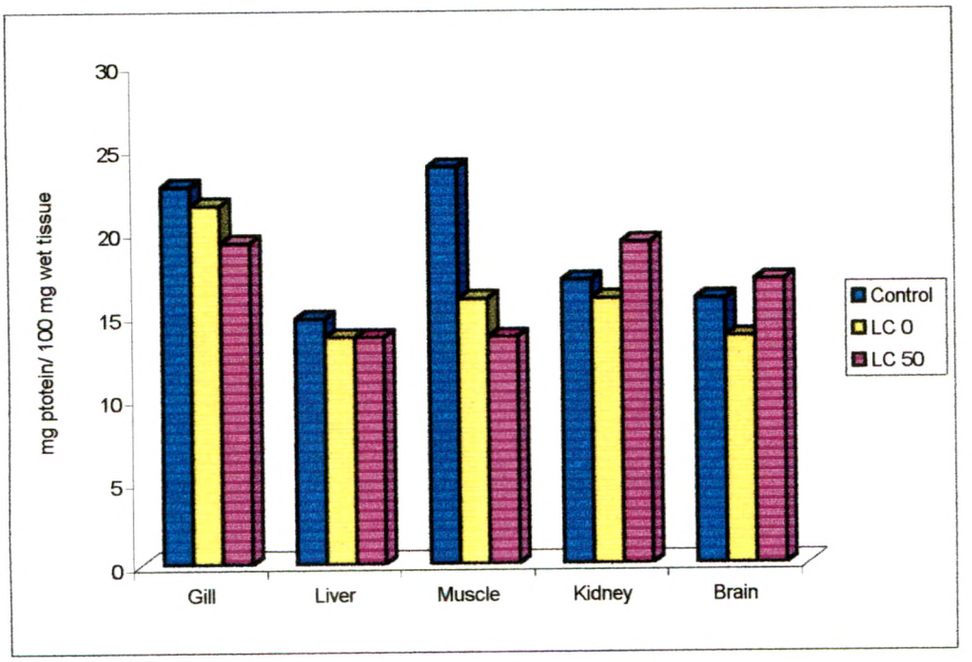
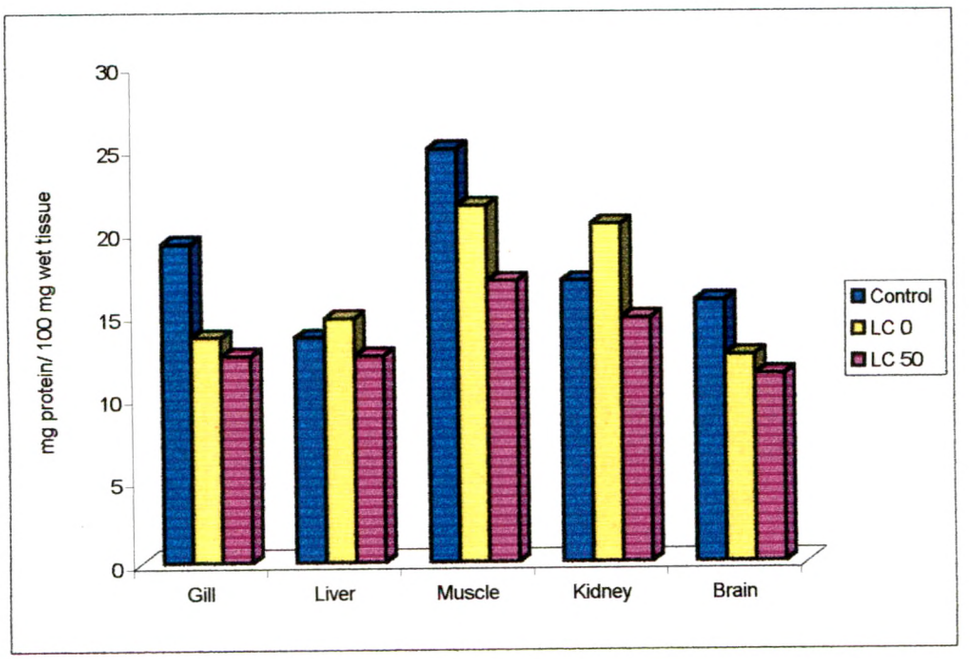


Fig. 18 : Effect of textile mill effluent on protein content in various organs of the fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)



Textile Mill Effluent :

The protein content was significantly ($P< 0.05$) decreased in gill (29.38%) followed by brain (21.13%) and muscle (13.63%), whereas there was significant ($P< 0.05$) increase in kidney (20.00%) and non-significant increase in liver (8.30%) upon acute exposure to 18% of textile mill effluent, as compared to control.

In LC_{50} group, the glycogen content in all the tissues decreased considerably upon lethal concentration of 22% of textile mill effluent. The percent depletion in the level of glycogen was more significant ($P< 0.001$) in gill (35.30), while less significant ($P < 0.05$) in muscle (31.80) followed by brain (28.29) and kidney (13.35). There was non-significant decrease in protein content in liver (8.38).

In general, there was decrease in protein content in gill, muscle and brain in LC_0 group except liver and kidney, while there was decrease in all the organs in LC_{50} group as compared to control (Fig.18).

TOTAL LIPID

Changes in the total lipid content in gill, liver, muscle, kidney and brain of *L. rohita* exposed to tannery effluent after acute exposure for 96 hr is shown in table No.25.

Table No. 25

Effect of tannery effluent on lipid content in various organs of fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)

Organ	Control	LC_0	LC_{50}
Gill	0.523 ± 0.124	0.366 ± 0.205 - (30.01) *	0.333 ± 0.249 - (36.32) **
Liver	0.753 ± 0.249	0.701 ± 0.124 - (6.90) N.S.	0.656 ± 0.081 - (12.88) *
Muscle	0.563 ± 0.124	0.292 ± 0.081 - (48.13) **	0.240 ± 0.163 - (57.37) **
Kidney	0.660 ± 0.163	0.416 ± 0.169 - (36.96) **	0.246 ± 0.249 - (62.72) **
Brain	0.389 ± 0.124	0.354 ± 0.081 - (8.99) N.S.	0.326 ± 0.081 - (16.19) *

The values in paranthesis are percent change

* = P< 0.05

** = P< 0.001

NS= Non significant

± = S.D. of 5 animals

Control of Acute Test :

The lipid levels in different body organs was in the order of liver> kidney> muscle> gill> brain (Table No.25).

Tannery Effluent :

The lipid content in all the tissues decreased considerably upon the acute exposure to 15% of tannery effluent. Although the relative decrease varied from tissue to tissue, the percent depletion in lipid content was more significant ($P< 0.001$) in muscle (48.13) and kidney (36.96), while it was less significant ($P< 0.05$) in gill (30.01). There was non-significant decrease in brain (8.99) and liver (6.90) as compared to control.

In LC_{50} group there was significant ($P< 0.01$) percent depletion in lipid content in kidney (62.72), followed by muscle (57.37) and gill (36.32), while less significant ($P< 0.05$) in brain (16.19) and liver (12.88), due to lethal concentration (20%) of tannery effluent.

In general, there was decrease in lipid content in LC_0 and LC_{50} groups, when compared to control (Fig.19) but it was more in LC_{50} group than LC_0 (Table No.25).

Changes in total lipid content in gill, liver, muscle, kidney and brain of *L. rohita* exposed to electroplating effluent after acute exposure for 96 hr is shown in the table No.26.

Table No. 26

Effect of electroplating effluent on lipid content in various organs of fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)

Organ	Control	LC_0	LC_{50}
Gill	0.654 ± 0.008	0.522 ± 0.016 - (20.18) *	0.312 ± 0.016 - (52.29) **
Liver	0.801 ± 0.016	0.638 ± 0.008 - (20.34) *	0.823 ± 0.029 (2.74) N.S.
Muscle	0.682 ± 0.020	0.427 ± 0.033 - (37.39) **	0.478 ± 0.286 - (29.91) *
Kidney	0.761 ± 0.026	0.535 ± 0.033 - (49.14) **	0.519 ± 0.012 - (31.80) *
Brain	0.432 ± 0.030	0.401 ± 0.033 - (7.17) N.S.	0.346 ± 0.029 - (19.90) *

The values in paranthesis are percent change

* = $P< 0.05$

** = $P< 0.001$

NS= Non significant

± = S.D. of 5 animals

Fig. 19 : Effect of tannery effluent on lipid content in various organs of the fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)

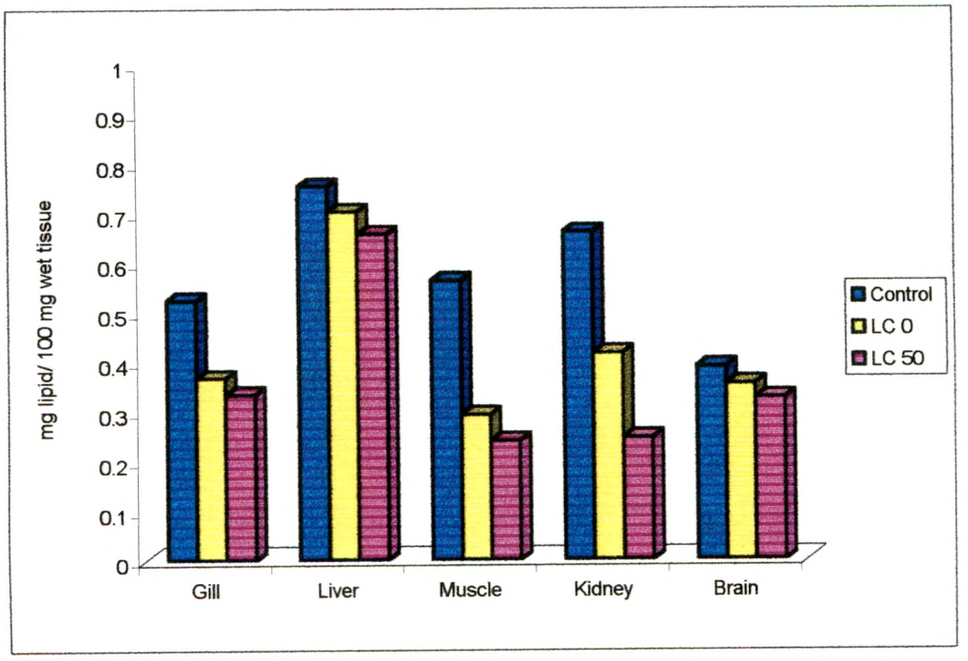
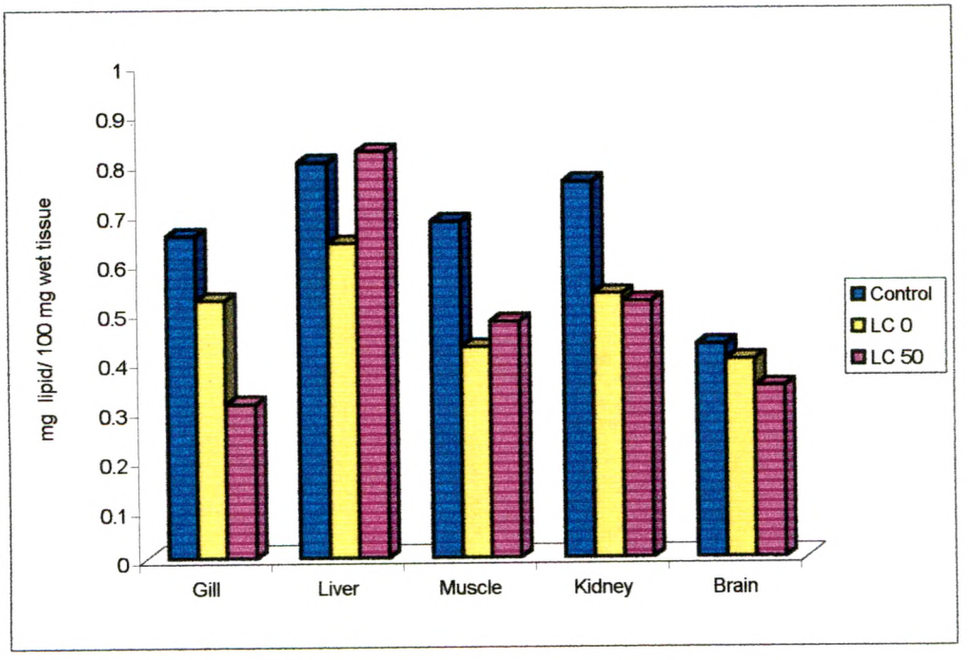


Fig. 20 : Effect of electroplating effluent on lipid content in various organs of the fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)



Control of Acute Test :

The lipid level in different body parts was in the order of liver> kidney> muscle> gill> brain (Table 26).

Electroplating Effluent :

The lipid content of all the tissues decreased considerably upon acute exposure to 3% of electroplating effluent. The relative decrease in lipid content was varied from tissue to tissue. The percent depletion in glycogen content was more significant ($P< 0.001$) in kidney (49.14) and muscle (37.39), while it was less significant ($P< 0.05$) in liver (20.34) and gill (20.18). There was non-significant decrease in lipid content in brain (7.17) as compared to control.

In LC_{50} group, there was highly significant ($P < 0.001$) decrease in lipid content in gill (52.29) and less significant ($P< 0.05$) in kidney (31.80) followed by muscle (29.91) and brain (19.90). There was non-significant increase in lipid content in liver (2.74) as compared to control upon exposure to lethal concentration (6%) of electroplating effluent.

In general, there was decrease in lipid content in LC_0 and LC_{50} groups when compared to control (Fig.20) but it was more in LC_{50} group than LC_0 (Table No.26).

Changes in the total lipid content in gill, liver, muscle, kidney and brain of fish *L. rohita* exposed to textile mill effluent after acute exposure for 96 hr are shown in the table No.27.

Control of Acute Test :

The lipid level in different body parts was in the order of liver> kidney> gill> muscle> brain (Table No. 27).

Textile Mill Effluent :

The lipid content in all the tissues was decreased considerably upon acute exposure of 18% of textile mill effluent. Although the relative decrease varied from tissue to tissue, the percent deletion in lipid level was more significant ($P< 0.001$) in muscle (49.76), while it was less significant ($P< 0.05$) in kidney (34.96) followed by brain (26.18) and gill (19.52). There was non-significant decrease in lipid level in liver (2.82) as compared to control.

In LC_{50} group, there was more significant ($P< 0.001$) percent depletion in the level of lipid content in kidney (60.33) and muscle (53.30), while it was less significant ($P< 0.05$) in gill (24.27) and brain (23.63). There was non-significant depletion in lipid level in liver (7.29) as compared to control due to lethal concentration (22%) of textile mill effluent.

In general there was significant decrease in lipid content in all tissues in LC_0 and LC_{50} groups as compared to control (Fig.21), but it was more in LC_{50} group than LC_0 (Table No.27).

Table No. 27

Effect of textile mill effluent on lipid content in various organs of fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)

Organ	Control	LC_0	LC_{50}
Gill	0.482 ± 0.142	0.412 ± 0.020 - (19.52) *	0.365 ± 0.048 - (24.27) *
Liver	0.672 ± 0.033	0.653 ± 0.040 - (2.82) N.S.	0.623 ± 0.065 - (7.29) N.S.
Muscle	0.424 ± 0.024	0.213 ± 0.044 - (49.76) * *	0.198 ± 0.024 - (53.30) * *
Kidney	0.532 ± 0.024	0.346 ± 0.029 - (34.96) *	0.211 ± 0.046 - (60.33) * *
Brain	0.275 ± 0.036	0.347 ± 0.049 (26.18) *	0.210 ± 0.053 - (23.63) *

The values in paranthesis are percent change

* = P< 0.05

** = P< 0.001

NS= Non significant

± = S.D. of 5 animals

Fig. 21 : Effect of textile mill effluent on lipid content in various organs of the fish *Labeo rohita* after acute exposure

(mg/ 100 mg wet tissue)