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Changes in Biochemical Characteristics of Paddy Leaves Grown in Agro-Fields near Durgapur Thermal Power Station, WB, India

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Abstract—*Present paper deals with the observation of changes in biochemical characteristics like chlorophyll, sugar, amino acid, protein, phenol, ascorbic acid, RNA, DNA content of paddy leaves grown in the agro fields in the vicinity of Durgapur Thermal Power Station (under DVC), WB, India. The results were compared with the results obtained from the paddy leaves collected from Burdwan University Crop Research and Seed Multiplication Farm which is situated in a non industrial site. Results revealed that the sugar content in paddy leaf was significantly reduced ($p<0.01$ during monsoon; $p<0.05$ during summer) at the DTPS area, in comparison to the control zone. Protein content of the paddy leaf was significantly ($p<0.05$) reduced during summer at the DTPS site but no significant difference in protein content of the paddy leaf between both of the studied area was observed during monsoon. Total chlorophyll content in paddy leaves were significantly lower ($p<0.01$) at DTPS surrounding agro–ecosystem; and during monsoon the difference was found at 5% level of significance. Chlorophyll 'a' and Chlorophyll 'b' content were significantly reduced ($p<0.01$) in the paddy plant leaves grown at the DTPS-surrounding agro–fields. Amino acid content was significantly reduced in paddy leaves at DTPS zone than that of control zone ($p<0.01$during monsoon; $p<0.05$ during summer). No significant difference ($p<0.05$) in DNA level has been found between both the studied area. The RNA concentration was significantly decreased ($p<0.05$) in paddy leaves collected from the DTPS surrounding agro–fields during summer but no significant difference in RNA level ($p<0.05$) was found during monsoon. Phenol content and ascorbic acid content of paddy leaves were significantly increased ($p<0.01$) in the paddy leaves at the DTPS site agro–fields.*

Keywords*: Thermal power station, chlorophyll, phenol, paddy plants, ascorbic acid.*

1. INTRODUCTION

The demand of electricity or energy supply is increasing day by day in such way that the fossil fuels will account for 85% of the energy market by 2030 as per IEA. Coal based thermal power stations are now considered as foremost global concern as these are emitting

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huge amount of SOx, NOx, PM, fly ash [12] and a number of trace elements to the environment. Besides the effluent from thermal power stations carries the load of oil and grease, free available chlorine including a wide range of inorganic and organic pollutants. Thus thermal power stations affect the surrounding agro-field soil quality directly or indirectly by dumping the pollutants into those fields and produce some adverse or detrimental effects on nearby agro-ecosystem. The trace elements like Pb, reduces the enzymatic activity of the biota and as a result incompletely decomposed organic material accumulates in the soil. The enhanced level of Cd in soil produces negative impact on the food grains as well as makes it unfit for human consumption [1]. Chauhan and Joshi (2010)[3] recorded significant reduction in total chlorophyll, carotenoid, ascorbic acid in wheat and mustard plants grown at polluted sites. Keeping in mind the negative impact of thermal power plant on surrounding agro-ecosystem, this paper discuss with the study carried out to measure the changes in bio-chemical characteristics of paddy leaves grown in the agro-fields in the vicinity of coal-based Durgapur Thermal Power Station, WB, India.

2. MATERIALS AND METHODS

Durgapur is an industrial city in the state of WB, India, and located at 23°48’ N and 87°32’ E (Fig 1), and it is 160 km away from Kolkata. It is one of the most important urban industrial zones of eastern India. It has an average elevation of 65 meters and the topography is undulating. Durgapur area is covered by a thin alluvial layer and forms a transition zone between hard rock and flat gently sloping alluvial terrain. The climate of this area is humid and tropical. Average temperature during summer season is 32° C and at the cold season is 20° C. Average rainfall is 150 mm and maximum rainfall occurs around the July-September period.

Fig. 1: Study area

Collection of Leaf from Paddy Plants

The leaves of paddy plants were collected through random sampling technique from the agro-fields near DTPS. Five different places were selected randomly and from each places samples were collected from four sub-places. Sample collection was made during summer and

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monsoon of 2009, because during winter, paddy cultivation was not done at these places. The leaves were kept into separate labelled plastic bags and then those were brought into laboratory and kept into freezing condition. The flag leaves were chosen and then biochemical analysis was done within a very short period of time especially the chlorophyll content was estimated immediately after collection of the leaf sample. Beside the collection of sample from Durgapur, paddy leaf samples were also collected from agro fields of Burdwan Seed Multiplication Farm, Golapbag for control study, following the same method. The farm is chosen from the non industrial belt and it is almost 65 km away from Durgapur and located at with an average elevation of 40 meters. This is the brief history of sample collection. In laboratory bio-chemical parameters like Chlorophyll [2], Protein [8], Phenol [9], RNA and DNA [4], Sugar [10], Ascorbic acid [11], Amino acid [7] were analysed.

3. RESULT AND DISCUSSION

The analytical results are represented in tabular form (Table 1, Table 4 and Table 7). From the Table 2, it is found that the sugar content in paddy leaf was significantly reduced ($p<0.01$ during monsoon; $p<0.05$ during summer) at the DTPS area, in comparison to the control zone. Table 5 indicates that protein content of the paddy leaf was significantly ($p<0.05$) reduced during summer at the DTPS site but no significant difference in protein content of the paddy leaf between both of the studied area was observed during monsoon. Table 3 discloses that Total chlorophyll content in paddy leaves were significantly lower ($p<0.01$) at DTPS surrounding agro–ecosystem and during monsoon the difference was found at 5% level of significance. Chlorophyll 'a' and Chlorophyll 'b' content were also significantly reduced ($p<0.01$) in the paddy plant leaves grown at the DTPS-surrounding agro–fields. Table 5 represents that the amino acid content was significantly lower in paddy leaves at DTPS zone than that of control zone ($p<0.01$ during monsoon; $p<0.05$ during summer). Although average DNA level in paddy leaf was lower at the DTPS area but no significant difference ($p<0.05$) has been found between both the studied area (Table-6). The RNA concentration were significantly lower ($p<0.05$) in paddy leaves collected from the DTPS surrounding agro–fields during summer but no significant difference in RNA level ($p<0.05$) was found during monsoon (Table 6). Govindaraju et al, (2010) [5] observed reduction in the photosynthetic pigments of plants growing in the polluted site which is exposed to the lignite–based thermal power plant emission. Iqbal et al, (2010) [6] found that the coal smoke emission reduced the photosynthetic pigments in leaves of *Triumpfetta rhomboidea* while protein and sugar content were decreased at the polluted site. Significance Table 2 indicates that the phenol content and ascorbic acid content of paddy leaves were significantly increased ($p<0.01$) in the paddy leaves at the DTPS site agro–fields.

Table 1: Phenol (mg/g), Ascorbic acid (mg/g), Sugar content (mg/g) in paddy leaves (in the year 2009)

Sample area	Phenol(mg/g)		Ascorbic acid (mg/g)		Sugar content (mg/g)	
	Summer	Monsoon	Summer	Monsoon	Summer	Monsoon
P1	0.276± 0.015	2.544± 0.084	5.027± 0.199	4.026± 0.129	6.661± 0.634	3.562± 0.373
P2	0.199± 0.007	2.031± 0.052	5.546± 0.144	4.959± 0.139	9.267± 0.639	3.186± 0.293

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P3	0.381± 0.017	1.033± 0.035	4.482± 0.159	3.626± 0.145	15.059± 1.036	3.765± 0.097
P4	0.393± 0.009	2.069± 0.057	6.016± 0.166	4.255± 0.231	10.570± 0.545	2.838± 0.273
P5	0.437± 0.022	1.959± 0.059	4.504± 0.184	4.207± 0.216	12.598± 1.046	3.736± 0.254
C1	0.069± 0.006	0.609± 0.013	2.524± 0.101	1.369± 0.077	14.299± 0.956	4.467± 0.095
C2	0.093± 0.004	0.489± 0.018	2.047± 0.054	1.496± 0.138	17.014± 0.432	6.031± 0.133
C3	0.082± 0.003	0.699± 0.024	2.300± 0.107	2.074± 0.093	13.973± 0.604	5.691± 0.147
C4	0.123± 0.008	0.757± 0.033	1.949± 0.124	2.149± 0.086	17.557± 0.552	5.893± 0.347
C5	0.114± 0.007	0.587± 0.014	2.765± 0.101	1.712± 0.147	16.399± 0.807	5.299± 0.255

[P -sampling sites at DTPS area, C –sampling sites at control area, Value given as (Mean ± S.E)]

Table 2: Significance Table

Season	**Phenol**			**Ascorbic acid**			**Sugar**		
	P	**C**	**|t| value**	**P**	**C**	**|t| value**	**P**	**C**	**|t| value**
Summer	0.337	0.096	6.200**	5.115	2.317	6.520**	10.830	15.850	2.970*
Monsoon	1.927	0.628	4.910**	4.215	1.760	7.770**	3.417	5.476	5.140**

(Here the Average value of P1, P2, P3, P4, P5 and similarly the average value of C1, C2, C3, C4, C5 are given in each season) [table $t_{0.01, 8}$=3.355 and table $t_{0.05, 8}$=2.306], NS-Not significant; *_Significant at 95% level of confidence; **-Significant at 99 % level of confidence Table 5.69: Significance

Table 3. Significance Table

Season	**Chlorophyll a**			**Chlorophyll b**			**Total chlorophyll**		
	P	**C**	**|t| value**	**P**	**C**	**|t| value**	**P**	**C**	**|t| value**
Summer	4.022	5.939	6.320 **	0.854	1.544	2.570 *	5.978	8.590	4.630**
Monsoon	2.714	4.692	5.470 **	0.898	1.136	4.240**	5.115	7.302	3.240 *

(Here the Average value of P1, P2, P3, P4, P5 and similarly the average value of C1, C2, C3, C4, C5 are given in each season)
[table $t_{0.01, 8}$=3.355 and table $t_{0.05, 8}$=2.306], NS-Not significant; *_Significant at 95% level of confidence; **-Significant at 99 % level of confidence Table 5.69: Significance

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Table 4. Chlorophyll a, Chlorophyll b, Total chlorophyll content (mg/g) in paddy leaves (in the year 2009)

Sample area	Chlorophyll a (mg/g)		Chlorophyll b (mg/g)		Total chlorophyll (mg/g)	
	Summer	Monsoon	Summer	Monsoon	Summer	Monsoon
P1	3.239± 0.112	2.456± 0.179	0.656± 0.092	0.583± 0.114	5.457± 0.279	4.798± 0.235
P2	4.059± 0.129	3.479± 0.179	0.636± 0.084	1.151± 0.164	5.676± 0.189	6.029± 0.089
P3	3.501± 0.202	2.491± 0.206	0.569± 0.095	0.823± 0.118	5.168± 0.262	4.984± 0.098
P4	4.301± 0.354	3.274± 0.333	1.117± 0.262	1.162± 0.178	6.245± 0.561	5.836± 0.521
P5	5.009± 0.099	1.869± 0.199	1.292± 0.255	0.771± 0.177	7.343± 0.478	3.927± 0.192
C1	5.992± 0.245	4.952± 0.117	2.203± 0.139	1.013± 0.078	9.863± 0.080	6.665± 0.416
C2	5.479± 0.202	5.837± 0.163	1.142± 0.219	1.259± 0.149	7.828± 0.411	6.377± 0.199
C3	6.029± 0.095	4.145± 0.177	1.597± 0.424	0.972± 0.078	8.569± 0.295	6.413± 0.295
C4	5.553± 0.176	3.983± 0.201	1.147± 0.291	1.431± 0.201	8.002± 0.316	8.842± 0.508
C5	6.645± 0.121	4.545± 0.206	1.632± 0.255	1.004± 0.165	8.691± 0.396	8.214± 0.319

[P -sampling sites at DTPS area, C –sampling sites at control area, Value given as (Mean ± S.E)]

Table 5. Significance Table

Season	Protein			Amino acid		
	P	C	|t| value	P	C	|t| value
Summer	5.786	6.688	2.730*	2.451	3.171	3.300*
Monsoon	7.320	8.012	0.760 NS	5.330	10.520	3.870**

(Here the Average value of P1, P2, P3, P4, P5 and similarly the average value of C1, C2, C3, C4, C5 are given in each season) [table $t_{0.01, 8}$=3.355 and table $t_{0.05, 8}$=2.306],
NS-Not Significant; *Significant at 95% level of confidence; **Significant at 99 % level of confidence

Table 6. Significance Table

Season	DNA			RNA		
	P	C	|t| value	P	C	|t| value
Summer	7.363	7.804	1.350 NS	3.004	3.348	2.810*
Monsoon	5.815	6.206	1.180 NS	1.997	2.142	0.750 NS

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(Here the Average value of P1, P2, P3, P4, P5 and similarly the average value of C1, C2, C3, C4, C5 are given in each season) [table $t_{0.01, 8}$=3.355 and table $t_{0.05, 8}$=2.306],
NS-Not Significant; *Significant at 95% level of confidence; **Significant at 99 % level of confidence

Table 7. Protein (mg/g), Amino acid (mg/g), DNA (mg/g), RNA (mg/g) content in paddy leaves (in the year 2009)

Sample area	Protein (mg/g)		Amino acid (mg/g)		DNA (mg/g)		RNA (mg/g)	
	Summer	Monsoon	Summer	Monsoon	Summer	Monsoon	Summer	Monsoon
P1	4.941± 0.209	7.035± 0.429	2.689± 0.316	4.086± 0.221	8.129± 0.261	5.503± 0.481	3.179± 0.126	1.973± 0.059
P2	5.652± 0.139	9.486± 0.292	2.495± 0.316	5.261± 0.436	6.941± 0.316	6.503± 0.617	3.100± 0.147	2.179± 0.035
P3	6.482± 0.185	7.589± 0.386	2.043± 0.195	8.069± 0.517	6.206± 0.323	5.690± 0.227	2.751± 0.099	1.848± 0.039
P4	5.771± 0.217	6.166± 0.256	2.181± 0.450	4.393± 0.476	7.894± 0.389	6.753± 0.586	2.883± 0.057	2.333± 0.170
P5	6.087± 0.425	6.324± 0.727	2.847± 0.254	4.852± 0.615	7.644± 0.174	4.627± 0.262	3.106± 0.072	1.653± 0.094
C1	6.522± 0.243	8.972± 0.238	3.795± 0.050	8.683± 1.548	8.191± 0.710	6.597± 0.083	3.295± 0.081	1.464± 0.140
C2	6.808± 0.584	8.241± 0.488	3.093± 0.083	7.763± 0.629	7.629± 0.333	6.237± 0.403	3.518± 0.141	2.448± 0.245
C3	6.364± 0.667	5.849± 0.297	3.271± 0.058	11.849± 1.527	7.378± 0.171	6.014± 0.229	3.112± 0.309	1.809± 0.238
C4	7.263±0.622	7.846± 0.371	2.856± 0.069	14.709± 0.929	8.817± 0.360	6.364± 0.436	3.638± 0.075	2.746± 0.163
C5	6.482± 0.156	9.150± 0.233	2.839± 0.085	9.602± 0.894	7.003± 0.539	5.817± 0.399	2.837± 0.277	2.242± 0.118

[P -sampling sites at DTPS area, C –sampling sites at control area, Value given as (Mean ± S.E)]

4. CONCLUSION

It is observed from the study that chlorophyll a, chlorophyll b, total Chlorophyll, sugar, protein, amino acid, RNA content (during summer only) of paddy leaves were reduced in the DTPS surrounding area whereas phenol and ascorbic acid content of the same were enhanced in that area in comparison to the control site. No significant differences were found in DNA level of the paddy leaves between the DTPS site and Control site sample.

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