Biochemical changes during *in vitro* decomposition of wheat crop residues by *Trichoderma lignorum* (Tode) Harz.

Dr. Raj Singh
H.O.D, Department of Biotechnology, Faculty of Science, S.V. Subharti University, Meerut, U.P., India.

Mr. Vineet Girdharwal
Senior Lecturer, Department of Zoology, Faculty of Science, Swami Vivekanand Subharti University, Meerut (U.P.)

Dr. Anju Rani
Assistant Professor, Department of Botany, Faculty of Science, S.V. Subharti University, Meerut, U.P., India.

Ms. Gyanika Shukla
Lecturer, Department of Biotechnology, Faculty of Science, Swami Vivekanand Subharti University, Meerut (U.P.)

Dr. Amit Kumar
Assistant Professor, Department of Biotechnology, Faculty of Science, S.V. Subharti University, Meerut, U.P., India.

***Abstract*-**The biochemical changes during decomposition of the different components of wheat residues by *Trichoderma lignorum in vitro* were assessed. The samples of decomposing wheat internodes, leaves, chaff and straw were collected at different stages of decomposition for 40 and 60 days. The samples were subjected to biochemical analysis and the results were compared with non decomposed initial samples. The fungus causes maximum decomposition of leaves (29.62%, 33.99%), followed by chaff (23.79%, 27.80%), straw (20.30%, 26.75%) and internodes (14.31%, 16.46%). The maximum loss in the dry weight of wheat leaves was due to loss of cellulose as well as water and ether soluble fractions. In case of internodes and chaff loss in the dry weight was mainly due to the degradation of cellulose and water soluble fractions. However in case of wheat straw, cellulose and hemicelluloses are maximum disappear during decomposition.

Key words: Fungal decomposition, wheat intetrnodes, leaves, chaff and straw, *Trichoderma lignorum*, biochemical analysis.

I. INTRODUCTION

Wheat straw is made up of mainly lignocellulosic substances. As well as lignin and cellulose, wheat straws are made up of hemicelluloses, pectin, fat and waxes, starch, simple sugar, minerals and lignin [3]. Therefore, it is essential to find out that during *in vitro* decomposition which biochemical changes occurred and which natural compound had degraded. Chang (1967) studied the biochemical changes that take place in the wheat straw during composting [2]. Charaya (1985) compared the biochemical changes occurring in wheat straw decomposing above ground, on soil surface and beneath soil [3]. Robinson *et al.* (1994) studied the biochemical changes during decomposition of wheat stem and leaves separately [15]. Emtiazi *et al* (2001) reported that 250 CMC or endogluconase produced during decomposition of straw [6]. In the present investigation different

components are wheat internodes, leaves, chaff and straw, *Trichoderma lignorum* was used as a potential decomposer.

II. MATERIAL AND METHOD

The bundles of wheat crop residues were collected from village Kanauja, District – Ghaziabad (U.P.) and separated into internodes, leaves and chaff. Mixed form was also used as a combined straw. Therefore four types of substrates were used.

A. Preparation of samples: ability of selected fungi to decompose crop residues have been determined previously *in vitro* by slightly modifying the method [10,11]. The wheat internodes, leaves and chaff as well as combined straw were cut into small pieces and were air dried. Two grams of each residue was placed in 15 Erlenmeyer conical flasks of 250 ml capacity. Out of these 3 flasks were containing wheat internodes, 3 flasks were containing wheat leaves, 3 flasks were containing wheat chaff and 3 flasks were containing combined straw. Rest of 3 were kept as control in this investigation.

B. Inoculation and incubation: the test fungus *Trichoderma lignorum* was grown on Czapek's Dox Agar media. When growth was abundant, the surface growth was removed with sterile spatula and mycelia and spores were mixed thoroughly in 150 ml of sterile distilled water in 250 ml flask. 10 ml inoculum of this fungus was added centrally to each of the set of 12 flasks. The flasks were incubated at 25 ± 1^{o}C in BOD incubator for two months.

At the end of the experiment, the flasks were dried in an oven for 48 hours at 70^{o}C and the dry weight of the residues was recorded. The loss in the weight of inoculated flasks minus the loss in control flask was taken as an index of the capacity of the test fungus to decompose the particular residue. Biochemical changes during decomposition: For quantitative biochemical analysis a method was followed in the present investigation as proposed by Waksman (1927) and modified by Waksman and Stevens (1930) to determine the mechanism of plant residues [17,18]. The similar method with slight modification has been followed previously [2,13]

III. RESULT

As it is evident from Table 1.1, that *Trichoderma lignorum* causes maximum decomposition of leaves (29.62%, 33.99%) followed by chaff (23.79%, 27.8%), straw (20.30%, 26.75%) and internodes (14.91%, 16.46%). The loss in internodes after 40 days of decomposition was mainly due to the degradation of cellulose and water – soluble fraction – though the loss in petroleum ether - soluble fraction (fat and waxes), hemicelluloses, lignin and pectin also contributed to the loss of weight of internodes. All the organic fractions show more or less similar picture to lose their weight of their original concentrations.

TABLE 1.1 : Major chemical fractions (% initial dry wt.) in wheat crop residues inoculated with *Trichoderma lignorum*

S. No.	Fractions	No. of Days	Wheat crop residues			
			Internodes	Leaves	Chaff	Straw
1.	Petroleum ether-soluble	00	1.05	1.10	1.10	1.05

	fraction (Fat and Waxes)	40	0.53	0.58	0.65	0.56
		60	0.25	0.52	0.23	0.23
2.	Cold water-soluble fraction (Simple sugars, amino acid, peptides, minerals)	00	6.70	9.80	2.56	7.02
		40	3.98	4.20	0.85	4.15
		60	4.10	3.78	0.85	4.11
3.	Hot water-soluble fraction (Starch, pectin, hexosans)	00	0.69	4.31	0.81	1.70
		40	0.32	2.51	0.35	1.28
		60	0.30	2.50	0.30	1.25
4.	Hemicellulose	00	19.86	23.45	31.75	28.54
		40	17.39	20.12	27.45	23.62
		60	17.34	19.13	26.44	21.42
5.	Cellulose	00	54.89	48.70	55.05	49.86
		40	47.49	33.97	41.70	42.14
		60	46.27	32.85	40.67	39.71
6.	Lignin	00	13.17	4.85	3.68	7.55
		40	12.46	3.08	1.89	4.84
		60	11.57	2.78	1.05	3.68
7.	Pectin	00	3.13	6.65	4.17	3.55
		40	2.92	4.82	2.48	2.40
		60	2.73	4.35	1.82	2.14
8.	Ash content	00	0.51	1.14	0.88	0.73
		40	0.50	1.10	0.84	0.71
		60	0.48	1.10	0.84	0.71
Total		00	100.00	100.00	100.00	100.00
		40	85.09-14.91	70.38-29.62	76.21-23.79	79.70-20.30
		60	83.54-16.46	67.01-33.99	72.20-27.80	73.25-26.75

IV. CONCLUSION

These results revealed that *Trichoderma lignorum* possessed much stronger cellulolytic and pectolytic potential and has also good fats, waxes, simple sugars, amino acids, peptides and starch utilizing activities. This aberration very well matches with its high cellulolytic ability. Cox *et al* (2001) had also observed that in the pine needles inoculated with *Trichoderma viridae* mass losses of carbohydrates were greater than lignin [4]. Similar results have been observed [1,5,8,12,14]. Hatakka (1983) studied that species of *Pleurotus* degraded the lignin component of wheat straw [9]. Veeken *et al* (2001) reported that biomacromolecules showed different rates of degradation during 4 weeks of composting, aliphatics, hemicelluloses and protein degraded faster as compare to cellulose and lignin [18]. Chong Ling Feng *et al* (2011) showed that treatment of lignocellulosic wastes with lignolytic enzyme increased the degradation ratio of lignin and hemicelluloses by 5.24% and 11.74% respectively [7].

REFERENCES

1. Bhargava, S.N. (1972) Relation between decomposition rates for cellulose and wheat straw in five cereal foot rot fungi. *Trans. Br. mycol. Soc.* **58**: 348-351.
2. Chang, Y. (1967) The fungi of wheat straw compost. II. Biochemical and Physiological studies. *Trans. Br. mycol. Soc.* **50**: 667-677.
3. Charaya, M.U. (1985) *Taxonomical, ecological and physiological studies on the mycoflora decomposing wheat and paddy crop residues.* Ph.D. Thesis. Dept. of Botany, M.M. Postgraduate College, Modinagar (Meerut University, Meerut), India.
4. Cox, P., Wilkinson, S. P. and J. M. Anderson (2001) Effects of fungal inocula on the decomposition of lignin and structural polysaccharides in *Pinus sylvestris* litter. *Biology and Fertility of Soil* **33** (3): 246-251.
5. Dwivedi, R.S. and V.P.Singh (1974) Comparative cellulolytic ability of some litter inhabiting fungi. *Proc. Ind. Nat. Sci. Acad*. **40**: 420-423.
6. Emtiazi, G., N aghavi, N. And Bordbar, A. (2001) Biodegradation of lignocellulosic waste by *Aspergillus terrus. Biodegradation* **12(4):** 259-63.
7. Feng, C.L., Zeng, G.M., Haung, D.L., Hu, S., Zhao, M., Lai, C., Huang, C., Zhen, W. and N.J. Li (2011) Effect of ligninolytic enzymes on lignin degradation and carbon utilization during lignocellulosic waste composting. *Process Biochemistry,* **46(7):** 1515-20.
8. Garrett, S. D. (1975) Cellulosic rate and competitive saprophytic colonization of wheat straw by foot-rot fungi. *Soil. Biol. Biochem*. **7**: 323-327.
9. Hatakka, I.A. (1983) Pretreatment of wheat straw by white-rot fungi for enzymatic saccharification of cellulose.*European J. of Appl. Biotec.* **18(6)**: 350-57
10. Hering, T.F. (1967) Fungal decomposition of oak leaf litter. *Trans Brit. mycol. Soc*. **50**: 267-273.
11. Ivarson, K.C. (1974) Comparative survival and decomposition ability of four fungi isolated from leaf litter at low temperature. *Can. J. Soil Sci.* **54**: 245-253.
12. Jain, S. C. (1989) *A Study of potential of fungi to decompose paddy straw in relation to varying nitrogen levels.* Ph.D. Thesis, Department of Botany, M. M. Postgraduate College, Modinagar.
13. Moubasher, A.H., Abdel-Hafez, S.I.J., Abdel-Fattah, H.M. and A.M. Moharram (1982) Fungi of wheat and broad bean straw composts. I. Mesophilic fungi. *Mycopathologia* **78**: 161-168.
14. Rai, B. (1970) Comparative cellulolytic ability of some fungi. *Labdev Jour. Sci. and Tech.* **8** B : 251-252.
15. Robinson, C. H., Dighton, J., Frankland, J. C. and J. D. Roberts (1994) Fungal communities on decaying wheat straw of different resource qualities. *Soil Biol. Biochem.* **26**: 1053-1058.
16. Veeken, A.H.M., Adani, F., Nierop, K.G.J., Jager de, A.P., H.V.M. Hamelers (2001) Degradation of Biomolecules during High-Rate composting of wheat straw amended feces. *J. Enviro. Qual.* **30(5):** 1675-84.
17. Waksman, S. A. and K. R. Stevens (1930) A system of proximate chemical analysis of plant materials. *Industrial and Engineering Chemistry* **2** : 167-173.
18. Waksman, S.A. (1927) *Principles of Soil Microbiology* Williams and Wilkins, Baltimore, Md.

Authors Profile

Dr. Raj Singh has received B.Sc., M.Sc. and Ph.D. degrees from Chaudhary Charan Singh University, Meerut. He has 12 years of teaching experience. His area of interest for research is Plant Biotechnology & Microbiology.

Dr. Anju Rani has received B.Sc., M.Sc. B.ed. and Ph.D. degrees from Chaudhary Charan Singh University, Meerut. She has 9 years of teaching experience. Her area of interest for research is Plant Pathology & Food Microbiology.

Dr. Amit Kumar has received B.Sc. & M.Sc. from Chaudhary Charan Singh University, Meerut, M.Phil from Vinayak Mission University, Tamilnadu and Ph.D. degree from Sardar Vallabhbhai Patel University of Agriculture & Technology. He is ICAR-NET qualified. Meerut. He has 3 years of teaching experience. His area of interest for research is Molecular Biology & Tissue Culture.

Mr. Vineet Girdharwal has received B.Sc. & M.Sc. from Chaudhary Charan Singh University. He is CSIR-NET qualified. He has 10 years of teaching experience. His area of interest is Histopathological & Molecular study of Albino Rat.

Ms. Gyanika Shukla has received B.Sc. from Chaudhary Charan Singh University and M.Sc. from Sardar Vallabhbhai Patel University of Agriculture & Technology. She has 4 years of teaching experience. Her area of interest is Plant and Animal Biotechnology.