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EFFECT OF CARBOHYDRATE ENRICHMENT ON THE BIODEGRADATION OF LIGNOCELLULOSIC WASTES WITH *PLEUROTUS FLORIDA* AS ANIMAL FEED.

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Abstract : degradation of structural carbohydrate will be at a faster rate if a simple polysaccharide is made available in the substrate. In the present study, lignocellulosic by-products were enriched with conventional source of carbohydrates and the associate effect on the biodegradation of the structural components of the by-product was studied.

INTRODUCTION: Lignin appears to be a difficult proposition to digest unless a readily available high energy diet is substituted in animal feeds (Harkin, 1978). With a similar view Savoie et al. (1992) added corn steep liquor to straw and achieved high digestion of straw by *Agaricus bisporus*. Rai et al. (1993) reported that the fungus generally required an easily assimilable additional carbohydrate for its initial growth in the substrate. These observations indicated that degradation of structural carbohydrate will be at a faster rate if a simple polysaccharide is made available in the substrate. In the present study, lignocellulosic by-products were enriched with conventional source of carbohydrates and the associate effect on the biodegradation of the structural components of the by-product was studied.

MATEREIALS AND METHODS

The by-products such as coir dust, cashew waste and karad hay were mixed with carbohydrate source, viz., rice bran or wheat bran or maize at 3:1 ratio. One hundred gram of the mixed substrate was placed separately in each polypropylene bag of 12 x 18 cm size and maintained in triplicate sets. The substrate was moistened with deionized distilled water and autoclaved in a steam sterilizer for 20 minutes at 15 psi. About 5 g of well grown *Pleurotus florida* spawn was spread over the substrate in each bag and the bags were sealed and maintained in a BOD incubator at 30°C for a required duration of incubation period (30 days). Fermented sample bags were tear-opened and placed in a hot-air oven maintained at a temperature of 60°C for about 3 days until the moisture is completely evaporated. pH of the substrate was measured as per Savoie et al. (1992). Neutral detergent fibre (NDF), Acid detergent fibre (ADF) and lignin were estimated as per Vansoest (1963). Cellulose was estimated as per Cline et al (1966), Organic carbon as per Walkly and Black (1934), and total nitrogen as per AOAC (1973). Substrate digestibility was evaluated by two stage *in vitro* digestion technique using strained rumen liquor (Tilly and Terry, 1963).

RESULT AND DISCUSSION

In coir dust, on visual examination of the inoculated samples, it was observed that growth of the fungi appeared to be more prominent in the control group than in substrate enriched coir dust. However, on chemical analysis, it was identified that the ADF content was reduced by 23.64 % in rice bran incorporated samples as against 10.10% in control, i.e. coir dust alone.

The reduction in ADF was apparently due to the loss of cellulose and lignin of the by- product material (Table I).

Substantially high amount of lignin degradation was observed with rice bran enrichment. Wheat bran enrichment had less effect on lignin degradation. Higher loss of organic matter in coir dust was estimated in maize enriched sample where the growth of fungal mycelium was also extensive but marked reduction in lignin was not recorded.

Cellulose was reduced by 16.31% in control and 5.28% in maize added sample (Table I). Higher utilisation of cellulose in the control group, i.e. coir dust, was due to non availability of other cabohydrates as energy source. In maize added sample any available simple carbohydrates might have been utilized as the primary source of nutrient and therefore the cellulose was apparently utilised only to a limited extent. The loss of organic matter was16.42% in coir dust added with rice bran treatment whereas it was 20.9% with maize-enriched fermentation

In cashew apple waste, maximum reduction in ADF was observed in rice bran added sample. The acid detergent fibre content was reduced by 31.99% in rice bran enriched cashew apple waste whereas the percent reduction in the control group was 8.72. In maize enriched substrate, the reduction in ADF was 29.89% which is rather comparable to rice bran treatment.

Cellulose was degraded to a maximum extent in all the treatments in CAW. In maize and rice bran enrichment, reduction in cellulose was 26.90% and 16.64% respectively. In control and wheat bran added samples percent reduction in cellulose was 11.99% and 16.90%.

Lignin was reduced by 20.11% in maize enriched substrate as against 7.23% in control and 18.47% in rice bran added sample due to enhanced fungal growth in these two treatments.

In cashew apple waste reduction in cellulose was higher in the early stage of fermentation and lignin was degraded more in the latter stages indicating that lignin degradation was more only when the available source carbohydrate was limited. In all treatments, except in rice bran added substrate, degradation of cellulose was prominent than lignin. The nature of lignocellulosic structure in cashew fruit and the easily available carbohydrate source could be the possible reasons for preferential degradation of cellulose in this substrate Kalra and Singh 1986 reported the enhanced degradation of cellulose in the presence of soluble carbohydrate.

The karad hay is highly lignocellulosic with 33.75% cellulose and 12% lignin. Although its digestibility is poor, it is used as substitute for paddy strawin animal feeding. Limited effort has been made to study the susceptibility of hay to substrate fermentation(Madan et al. 1995; Kishan Singh, 1989). Therefore, attempt was made to digest the complex structure through enrichment using fungi in the present work. Effect of enrichment on biodegradation of the substrate after 30 days of fermentation was studied through analysis of the hay for nutrients.

Of the four treatments, the substrate without enrichment, i.e. the control, has maximum reduction in ADF after fermentation (38.71%). The percent reduction of ADF was lowest in wheat bran enriched samples (7.87%). In rice bran and maize incorporated treatments the reduction was 21.27% and 13.66% respectively (Table I).

Cellulose was degraded to the maximum extent of 27.65% in maize added substrate. With rice bran alone 22.08% reduction was observed in karad hay.

Lignin was degraded to the maximum extent of 29.28% in the rice bran enriched sample. In maize enrichment only a minimum reduction of 7.45% was observed. In the control, however, substantially high reduction of 27.15% was observed. In wheat bran enriched sample it was only 13.89% .

The IVDMD estimated after 96 hr of digestion is presented in TableII. The digestibility of coir dust was 38.76% in control where as it was 47.34% in fermented coir dust with an increase of 22.14% in digestibility. In fermented cashew apple waste and karad hay the increase was 8.17% and 22.32% respectively. There was no significant improvement in the digestibility of enriched coir dust and cashew apple waste with any of the added substrate.

In all the treatment it was observed that enrichment of substrate with rice bran has improved lignin degradation. When the the substrate was enriched with mauize fungal growth was more and loss of organic matter was also higher. In cashew apple waste, degradation of cellulose was more prominent than lignin with all treatments.The study indicated that the agro-industrial wastes which are highly lignocellulosic can be biodegraded more effectively through enrichment with conventional feed ingredients like rice bran.

References

A.O.A.C. 1975. Official Methods of Analysis. (Twelth Edition.) Association of Official Analytical Chemists. Washington, D.C.

Chaudhary,L.C., Rameshwar Singh and Kamra,D.N. 1994. Biodelignification of sugarcane bagasse by Pleurotus florida and Pleurotus cornucopie. Indian J.Microb.34:55-57.

Goering,J.K. and Van Soest,P.J. 1970. Forage Fibre Analysis (Apparatus, reagents, procedure and some applications). ARS .USDA. Agr.Hand Book No.379. Washington D.C

Harkin,J.1969. Recent Adv.in Phytochem.2:35-67.

Savoie,J.M., Ricard,I. and Olivier,J.M. 1992. Microbiol activities and transformations of substrates during compositing, under controlled conditions, of straw plus corn steep liquor or poultry manure. Mushroom Res.1:103-114.

Snedecor,G.W. and Cochran, W.G. 1967. Statistical Methods. Sixth Edition. Oxford and IBH Publishing Co., Bombay.

Tilley,J..M.A. and Terry,R.A. 1963. A two stage technique for the invitro digestion of forage crops. Journal of the British grassland society.18:104-111.

Van Soest,P.J. 1963. Use of detergents in the analysis of fibrous feeds. U.S.D.A. Handbook number,68

Table I . Effect of added substrate on the structural carbohydrate of by-products (Percent Nutrient reduced on dry matter basis)*.

Treatment	Nutrient	CD	CAW	KRD
	ADF	10.09	8.72	38.70
PI	CEL	16.30	11.99	16.78
	LIG	18.24	7.23	27.15
	ADF	23.64	31.99	21.27
RB	CEL	8.66	16.64	22.08
	LIG	33.21	18.47	29.28
	ADF	13.73	10.79	7.87
WB	CEL	15.19	16.90	13.29
	LIG	13.97	9.04	13.89
	ADF	5.52	29.89	13.66
M	CEL	5.28	26.90	27.65
	LIG	19.49	20.11	7.45

· Mean value of six replicates

CD - Coir dust
CAW - Cashew apple waste
KRD - Karad hay
PL - Pleurotus florida
CEL - Cellulose
RB - Rice bran
WB - Wheat bran
M - Maize
ADF - Acid detergent fibre
LIG - Lignin

***Table II. Effect of substrate enrichment on the in vitro drymatter digestibility of by-products after fermentation (% DM Digested) with* P.florida**

By - product	Substrate added	Control	Fermented	Difference	% increased
CD	Cont	38.76±2.81	47.34±3.16	8.58	22.14
	RB	44.91±1.96	50.40±2.41	5.50	12.23
	WB	49.12±1.72	54.28±2.15	5.16	10.50
	M	51.62±1.27	56.11±2.30	4.49	8.69
CAW	Cont	51.33±2.03	55.52±1.95	4.19	8.17
	RB	48.69±1.05	52.35±1.21	3.66	7.52
	WB	52.80±2.11	57.04±2.33	4.24	8.03
	M	55.41±1.68	60.89±2.14	5.48	9.89
KRD	Cont	39.65±1.56	48.49±2.07	8.85	22.32
	RB	44.27±2.05	50.21±1.98	5.94	27.29
	WB	51.17±1.01	52.56±1.24	1.39	21.27
	M	52.75±1.20	56.27±1.51	3.53	36.22

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