J. Mycopathol Res. 30(2) : 135-138 (1992) *Printed in India*

Hemicellulose degrading ability of Waste Water Fungi

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Fungi isolated from waste water sources discharged to Hooghly river were screened for hemicellulose degradation and utilization abilities. Significant extracellular hemicellulose activity and satisfactory hemicellulosic sugar utilization efficiency were seen to be present in a large number of filamentous and yeast fungi which might be useful in biconversion of hemicellulosic waste matters.

Key words : Ecology, Biodegradation, Fungi, Pollution

INTRODUCTION

Hemicelluloses are low molecular weight complex heteropolysaccharides found in association with cellulose in plant cell walls and constitute about 20-25% of lignocellulosic waste materials (Chahal, 1991). The commonly found sugars and acids in hemicellulose are D-xylose, D-mannose, D-galactose, D-glucose, L-arabinose, 4-0-methyl-D-glucuronic acid, D-galacturonic acid and D-glucuronic acid. By rough estimate, paper and pulp manufacture waste organics contain about 50-60% lignin and the rest as waste cellulose, hemicellulose and sugars etc. (Taber, 1976) which are principal components of BOD matter discharged to surface waters. Degradative function of waste water microorganisms is important for purification and bioconversion of waste organics in relation to pollution control and recycling of wastes.

In the present investigation attempts were made to study the hemicellulolytic activity of selected waste water fungi isolated from two sources of paper and pulp manufacture waste waters. Utilization efficiency of hemicellulosic sugars and extracellular xylanase activity of selected fungi were studied.

MATERIALS AND METHODS

Waste water fungi from two sources of pulp manufacture wastes were isolated by standard methods. The waste water sources, method of isolation and taxonomy of the fungal isolates have been described earlier (Sarkar and Chaudhuri, 1991). Growth efficiency of selected waste water fungi was studied using a basal liquid medium [Dextrose, 20g; KH_2PO_4, lg; $NaNO_3$, 2.1 g; $MgSO_4$, $7H_2O$, 0.5 g; KCl, 0.5g; mineral solution, 1 ml ($CuSO_4$, 30 mg; $ZnSO_4$, 40 mg; $MnSO_4$, 20mg; Boric Acid 10mg; Molybdic oxide 100 mg; Ferric citrate 200mg/100ml distilled water); yeast extract, 1g and distilled water 1 L] suitabty replacing the carbon sources with hemicellulose xylan or other hemicellulosic sugars like xylose, mannose, arabinose and rhamnose at carbon equivalent rates. The basal medium was sterilized in autoclave at 15 psi and G5 filter sterilized sugar sources were added aseptically. Extracellular xylanase activity was estimated by measuring the amount of reducing sugar formed in reaction mixture per unit time according to the method of Chong (1980). Residual sugar in culture medium was estimated by measuring the organic carbon following standard method (Hortwitz, 1960).

RESULTS AND DISCUSSION

Table 1 shows the utilization efficiency of some waste water fungi for hemicellulose xylan and the hemicellulosic sugar xylose in relation to glucose. It was seen that several fungi (like *Trichosporon cutaneum*, *Fusarium merismoides*, *Fusarium ventricosum*, *Aspergillus terreus*, *Penicillium oxalicum*, *Penicillium fellutanum*, *Humicola* sp. and an arthrosporic anamorph of basidiomycete) satisfactorily utilized xylan and apparently all xylan utilizers utilized xylose well. There were, however, a few fungi which utilized xylose better than xylan (*Trichosporon cutaneum*, *Acremonium strictum*, *Fusarium merismoides*, *Gliocladium roseum*, *Aspergillus niger*, *Aspergillus flavus*, *Penicillium oxalicum*, *Penicillium janthinellum*, *Preussia multispora*, and *Aspergillus ochraceus*) Considering that 50% of carbon utilized is generally respired cell mass conversion of the utilized hemicellulosic matter appeared significant for these fungi. On a comparative basis a few of the waste water fungi utilized xylan and or xylose better than glucose (*Fusarium merismoides*, *arthrosporic* isolate L_3 and *Penicillium oxalicum* for both ; *Humicola* sp.—xylan better than glucose ; *Acremonium strictum*, *Gliocladium roseum*, *Preussia multispora*, *Aspergillus ochraceus* and *Penicillium janthinellum*-xylose better than glucose).

Selected waste water fungi when studied for utilization efficiency of common hemicellulosic straw monosaccharides showed that several of these waste water

Table 1. Comparative efficiency of some waste water fungi for utilization of hemicellulosic glycan and glycosidic compounds for growth

Fungi	Coefficient of growth efficiency on		
	Glucose	Xylose	Xylan.
Trichosporon cutaneum	30.4	29.2	24.5
Geotrichum candidum	28 5	17.2	19.3
Acremonium persicinum	21.0	21.1	19.2
Acremonium strictum	19.8	29.2	18.4
Fusarium merismoides	21.4	32.8	24.0
Fusarium ventricosum	30.7	28.3	27.6
Gliocladium roseum	25.4	28.7	21.6
Trichoderma viride	24.2	20.1	21.8
Arthrosporic anamorph (L_6)	16.8	30.4	34.8
Preussia multispora	20.3	26.5	21.0
Phoma capitulum	23.5	13.6	13.4
Aspergillus terreus	29.0	21.7	27.0
Aspergillus fumigatus	20.4	21.2	19.8
Aspergillus niger	25.1	23.3	12.0
Aspergillus ochraceus	20.3	27.5	20.4
Aspergillus flavus	27.2	26.8	16.8
Penicillium oxalicum	21 5	34.7	29.4
Penicillium janthinellum	20 5	28.6	17.3
Penicillium fellutanum	29.0	26 8	23.5
Bahupaathra samala	17.3	18.4	21.2
Humicola sp.	29.0	26.5	33.4

Values are mg. dry matter yield per 100 mg of carbon source utilized

Table 2. Comparative growth efficiency of some waste water fungi for utilization of some hemicellulosic straw monosaccharides

Fungi	Growth index (dry matter yield) as compared to that on D-glucose (=100).		
	Mannose	Arabinose	Rhamnose
Trichosporon cutaneum	64	88	17
Acremonium persicinum	80	108	26
Fusarium merismoides	105	148	39
Gliocladium roseum	74	90	15
Arthrosporic anamorph (L6)	81	128	29
Phoma capitulum	64	77	33
Preussia multispora	79	86	43
Aspergillus fumigatus	109	162	87
Aspergillus flavus	59	64	42
Aspergillus niger	79	138	36
Aspergillus terreus	97	108	60
Penicillium oxalicum	69	72	10
Geotrichum candidum	73	91	23

fungi utilized two other common hemicellulosic monosaccharides, mannose and arabinose with comparable efficiency to that for glucose (Table 2). For a few fungi the utilization efficiency of either or both sources even better than that for glucose.

Table 3. Xylan hydrolase (Glycanase) activity of a few waste water fungi

Fungi	Reducing sugar formed(mg) per ml of culture filtrate from 0.5% Xylan substrate per 4 h
Trichosporon cutaneum	24
Fusarium merismoides	30
Humicola sp.	27
Arthrosporic anamorph (L6)	43
Penicillium oxalicum	21
Aspergillus niger	09
Phoma capitulum	11

Extracellular xylanase activity based on conversion of the hemicellulosic glycan xylan to reducing sugars was studied for some fungi which utilized xylose and xylan well (Table 3). Several of these waste water fungi showed high to very extracellular xylanase activity. Results of the study showed that hemicellulose degradative and utilization ability was prominently present among most of the waste water fungi studied and these might offer the scope for their utilization in bioconversion and recycling of hemicellulosic waste matter.

ACKNOWLEDGEMENT

The authors thank Department of Environment, Government of India for financial support.

REFERENCES

Chahlal, D. S. (1991). *Food, Feed and Fuel From Biomass* : Oxford and IBH Publishing Company Pvt. Ltd., New Delhi.

Chong, W. Chang. (1980). Starch depletion and sugar in developing cotton leaves, *Plant Physiol.* 65, 844-847.

Hortwitz, W., (1960). *Official Methods of Analysis of Association of Official Agricultural Chemists*. 9th Edn., Assoc. Off. Anal. Chem. Washington D. C.

Sarkar, J. P. and Chaudhuri, S. (1991). Forms and Distribution of Fungi in Paper and Pulp Manufacture Waste Water, *J Mycopathol Res* 29, 87-92.

Taber, W. A. (1976). Waste Water Microbiology. *Ann. Rev Microbiol* 30, 263-277.

(Accepted for publication 20 May 1992)