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XYLAN - EXTRACTION FROM AGRO RESIDUES

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Key words : Agro residues, Xylan, Xylanase, Hard wood and Softwood.

Abstract - Large quantities of agro residues dumped on the ecosystem create an environmental pollution. The main aim of this present study is to minimize the pollution creating residues and use such residues in an biotechnological manner. Since the agricultural residues are rich in lignocellulosic materials especially xylan a major polymer, using the polymer as a carbon source for the production of xylanase makes as a cheap alternative source. In this review. 1) Chemical composition 2) Xylan extraction method 3) Usage of agro residues (rich in xylan as a carbon source for xylanase production studied by few workers) are discussed.

INTRODUCTION

Lignocellulosic wastes are generated through forestry, agricultural practices and industrial processes, particularly from agro-allied industries such as breweries, paper-pulp, textile and timber industries. These wastes generally accumulate in the environment thereby causing pollution problem (Abu *et al.* 2000).

Most of the wastes are disposed by burning a practice considered as major factor in global warming (Levine, 1996). However the plant biomass regarded as "wastes" are biodegradable and can be converted into valuable products such as biofuels, chemicals, cheap energy sources for fermentation, improved animal feed and human nutrients (Howard *et al.* 2003).

Hemicellulose is a composite of different non-cellulosic polysaccharide, xylan being the major polysaccharide, glucan and mannan being present to a lesser extent. It is a polymer of xylose containing ß-1-4 xylosidic linkages (Biswas *et al.* 1986).

The dry weight of some higher plants and agricultural wastes are composed mainly of xylan these are used as the good carbon sources in the production of xylanolytic enzymes (Tokuda *et al.* 1997).

Xylanase is the one of the industrial enzyme finds wide range of applications. The use of xylanase in the pulp and paper industry has recently become an alternative bleaching technology aimed at eliminating chlorine in bleaching and reducing chlorogenic compounds in bleach plant effluents. Apart from pulp industry, it plays a wide role in application of bread making, fruit juice clarification, beverage, animal feed and fiber separation (Beg *et al.* 2000; Bajpai, 1997). Hence an attempt was made to study the xylan extraction method and its role in the production of xylanase reported by many workers.

Distribution of xylan on earth:

Xylan is a major component of hemicelluloses portion of plant cell walls and constitutes upto 35% of the total dry weight of higher plants (Saha, 1999).

Xylan is the most abundant non-cellulosic polysaccharide present in both hard wood and annual plants and accounts for 20-35% of the total dry weight in tropical plant biomass. In temperate softwoods, xylans are less abundant and comprise about 8% of the total dry weight.

Xylan is found mainly in the secondary cell wall and is considered to be forming an interpahse between lignin and other polysaccharides. Xylans are linear homopolymers that contain D-xylose monomers linked through ß-1-4- glycosyl bonds (Srinivasan *et al.* 1999).

Appreciable quantities of xylan are present in materials released from wood during paper and

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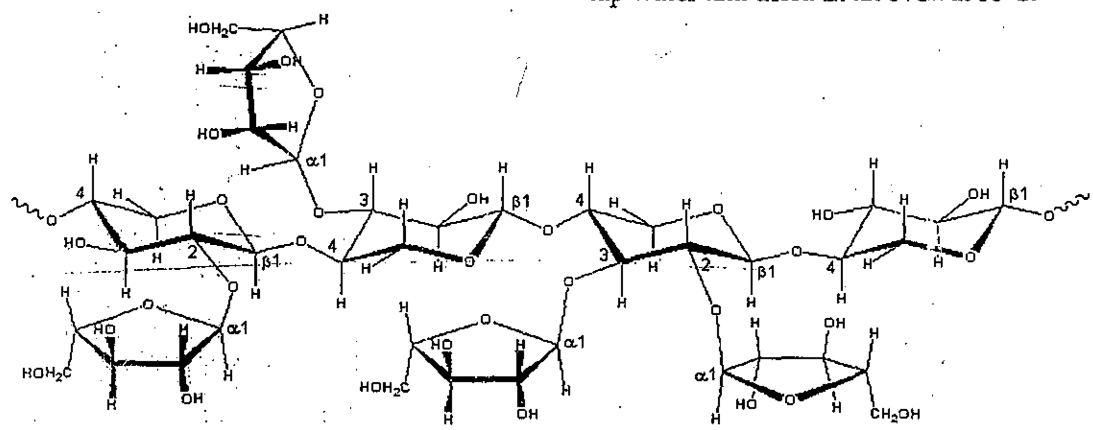
pulp processing. It is presently regarded as waste and it is often deposited in streams and rivers and hence ecologically harmful.

Xylan contains 85-93% of D-xylose, a small amount of L-arabinose and traces of glucuronic acid residues. Xylans isolated from different plants and grasses have the same backbone structure of ß (1- 4) linked xylose residues. The only difference in the branched residues is of D-glucuronic acid, L-arabinose and 4-o methylesters of D-glucuronic acid (Bastawde, 1992).

Structure of xylan

The hemicelluloses are those polysaccharides, soluble in alkali and are associated as a cementing matrix between cellulose and lignin. The principal monomers present in most of the hemicelluloses are D-xylose, D-mannose D-galactose and L-arabinose. The main heteropolymers are xylan, mannan, galactan and arabinan, xylan contains D-xylose as monomeric unit and traces of L-arabinose, galactan consists of D-galactose and mannan is made up of D-mannose units, while arabinan is composed of L-arabinose.



Occurrence

The primary walls of monocotyledons plants include as a major hemicelluloses, an arabinoxylan with rather more glucuronic acid. The primary walls of dicotyledons have small amounts of glucuronoarabinoxylan whereas the secondary wall contains glucuroxylan.

Types of xylan

There are two types of hemicelluloses, the acetylated xylan of hardwood and arabinoxylan of softwood (Timell, 1967).

Hardwood xylan is typically O-acetyl 4-O methyl glucuronic xylan with approximately 10% xylose units substituted with a 1-2 linked 4-O methyl glucuronic acid side chain and 70% of xylose residues are actylated at the C2 or C3 position. Actylation occurs more frequently at the C3 and double acetylation of a D-xylose unit has also been reported (Bouveng, 1967). The presence of acetyl groups makes the xylan significantly soluble in water. It constitutes about 15-30% of the cell wall content.

Soft wood xylan is commonly arabinoxylan in which 10% of xylose units are substituted with a-2-3 linked arabino furanose residues. It consists about 7-10% of the cell wall content (Whistler, 1970 and Biely, 1985).

Xylan extraction

The method of Panbangred *et al.* (1983) was followed for xylan extraction from agrowastes. To 50 g finely powerded agrowastes 100mL of 3% NaOH was added and incubated at 121°C for one hour. 50mL of ethanol was added and mixed thoroughly with glass rod. Xylan was precipitated and the precipitate was washed many times with tap water and dried in an oven at 50°C.

Table 1. Comparative account of cell wall components in soft and hard wood (Anderson, 1983)

Chemical	Softwood (%)	Hard wood (%)
Cellulose	37-42	42-51
Glucomannan	15-20	1-3
Xylan	4-6	20-30
Other Polysaccharides	3-5	2-4
Lignin	27-32	21-26
Extratives	2-5	1-4

Table 2. List showing cheaper agro residues as substrates for xylanase production

S.No	Substrates	Organisms	References
1.	Wheat bran	*Aspergillus niger,*	Shigeyuki *et al.* (1975)
		Bacillus subtilis	Yoshika *et al.* (1981)
		Thermomyces lanuginosus	Hoq and Deckwer (1995)
		Aspergillus flavus	Ruckmani and Rajendran (2001)
		Arthrobacter sp	Khande parkar and Bhosle (2006)
		Bacillus subtilis	Yuan *et al.* (2005)
		Bacillus pumilus	Asha poorna and Prema (2006)
		Bacillus pumilus strain	Mukesh Kapoor *et al.* (2007)
		Thermobacillus xylanilyticus	Beaugrand *et al.* (2004)
		Aspergillus niger	Okafor *et al.* (2007)
		Penicillium chrysogenum	Okafor *et al.* (2007)
		Streptomyces cyaneus	Ninawe *et al.* (2006)
		Aspergillus niger, Thermoascus aurantiacus	Stoilova *et al.* (2007)
2.	Rice bran	*Bacillus pumilus*	Asha poorna and Prema (2006)
		Paenibacillus sp	Harada *et al.* (2006)
		Arthrobacter sp	Khande parkar and Bhosle (2006)
		Aspergillus niger	Tokuda et al., (1997)
3.	Wheat straw	*Trichoderma viride*	Gomes *et al.* (1992)
		Streptomyces sp	Lumba *et al.* (1992)
		Bacillus pumilus strain	Mukesh Kapoor et al., (2007)
		Bacillus circulans	Dhillon and Khanna (2000)
4.	Rice straw	*Bacillus pumilus*	Asha poorna and Prema (2006)
		Bacillus circulans	Heck *et al.* (2006)
		Aspergillus niger & A.terrus	Gawande and Kamat (1999)
		Aspergillus niger	Kim *et al.* (1997)
5.	Sugarcane bagasse	*Humicola lanuginosa,*	Anand and Vithayathil (1990)
		Trichoderma reesei, Aspergillus niger, A.phoenicis	Gutierrez *et al.* (1998)
		Aspergillus oryzae	Sangeetha *et al.*(2004)
		Arthrobacter sp	Khande parkar and Bhosle (2006)
		Bacillus circulans	Bocchini *et al.* (2005)
		Bacillus pumilus	Asha poorna and Prema (2006)
		Streptomyces sp	Flores *et al.* (1997)
		Streptomyces olivaceoviridis	Ding *et al.* (2004)
6.	Sugarcane pulp	*Aspergillus niger*	Oxafor *et al.* (2007)
		Penicillium chrysogenum	Okafor *et al.* (2007)
7.	Corn cob	*Streptomyces* sp	Kusakabe *et al.* (1983)
		Thermomyces langinosus	Hoq and Deckwer (1995)
		Streptomyces olivaceoviridis	Ding *et al.* (2004)
		Aspergillus oryzae	Sangeetha *et al.* (2004)
8.	Corn fibre	*Fusarium verticillioides*	Saha (2001)
9.	Sorghum straw	*Thermomyces lanuginosus*	Sonia *et al.* (2005)
10.	Saw dust	*Bacillus pumilus*	Asha poorna and Prema (2006)
		Aspergillus niger	Okafor *et al.* (2007)
		Penicillium chrysogenum	Okafor *et al.* (2007)
11.	Jute fibre	*Trichoderma viride*	Gomes *et al.* (1992)
12.	Jute sticks	*Trichoderma viride*	Gomes *et al.* (1992)
13.	Soybean hull	*Aspergillus terrus, A.niger*	Gawande and Kamat (1999)
		Bacillus circulans	Heck *et al.* (2006)
14.	Cassava bagasse	*Aspergillus oryzae*	Sangeetha *et al.* (2004)
15.	Cymbopogan martini	*Phanerochaete chrysosporium*	Dutt *et al.* (2007)
16.	Soyabean fibre	*Bacillus circulans*	Heck *et al.* (2006)
17.	Coconut pith	*Bacillus pumilus*	Poorna and Prema (2006)

Contd............

18.	Corn husk	*Bacillus* sp	Tachaapaikoon *et al.* (2006)
19.	Oats straw	*Aspergillus niger , Thermoascus aurantiacus*	Stoilova *et al.* (2007)
20.	Beet root	*Aspergillus niger , Thermoascus aurantiacus*	Stoilova *et al.* (2007)
22.	Maize stalk	*Streptomyces cyaneus*	Ninawe *et al.* (2006)
23.	Gram husk	*Streptomyces cyaneus*	Ninawe *et al.* (2006)
24.	Black gram husk	*Streptomyces cyaneus*	Ninawe *et al.* (2006)
25.	Lemon peel	*Streptomyces* sp	Flores *et al.* (1997)
26.	Cotton seed husk	*Streptomyces olivaceoviridis*	Ding *et al.* (2004)
27.	Grape pomace	*Aspergillus awamori*	Carolina *et al.* (2007)

Table 3. Xylan extraction method for various authors

S.No.	Substrate	Author & Year	Alkali	Acid
1.	Sugarcane bagasse	Bocchini *et al.* (2005)		0.5 mL of H_2SO_4
2.	Corn husk, bagasse, Corn cob, Rice straw, Rice bran	Tachaapaikoon *et al.* (2006)	1N NaOH	
3.	Corn cob	Ebringerova *et al.* (1998).	5% NaOH	
4.	Corn cob	Yang *et al.* (2005)		1.0 g/l H_2SO4
5.	Barley straw	Rezaeian *et al.* (2005)	3 mL of NaOH	
6.	Sesamum indicum seed cake	Ghosh *et al.* (2005)	0.4% KOH and 0.4% $NaBH_4$	
7.	Benincasa hispida	Mazumder *et al.* (2005)	4M KOH and 20Mm $NaBH_4$	
8.	Corn cob	Wang and Zhang (2006)	NaOH	
9.	Lignified tissue of grasses & woody plants	Bastawde (1992)	4% to 10% KOH (or) NaOH	

Both hardwood and softwood xylans have a reducing end group constituting of rhamnosyl, galactouronosyl and xylosyl residues (Anderson, 1983).

The chemical composition of hard and soft woods are given in Table 1.

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Nucleotide ▾

GenBank

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GenBank: KT985614.1

FASTA Graphics

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      721 aactcgactg cgtgaagctg gaatcgctag taatcgcgga tcagcatgcc gcggtgaaca
      781 cgttccccgg ccttgtacac accgcccgct ctccacgagc gtttcg
//
```