

Full Length Research Paper

Comparative degradation of sawdust by microorganisms isolated from it

J. A. Lennox^{1*}, C. Ariba¹, Bello N. Alabi¹ and F. C. Akubueyi²

¹Department of Microbiology, University of Calabar, Calabar, Cross River State, Nigeria.

²Department of Biological Sciences, Cross River State, University of Science and Technology, Calabar, Cross River State, Nigeria.

Accepted 22 June, 2010

Microorganisms isolated from sawdust have been demonstrated to be effective in its degradation. Eight bacteria and eight fungi were isolated from wet decaying sawdust. These were tested for their capability to degrade sawdust. Among the bacteria, *Cellulomonas* sp. was found to be the most effective degrading agent based on its high percentage degradation (18.3%). This was followed by *Micrococcus* sp. (16.0%) and *Pseudomonas* sp. (14.6%), *Cytophaga* sp. and *Bacillus* sp. had the lowest percentage degradation of 0.2 and 7.7%, respectively. The fungi, *Penicillium* sp. had the highest percentage degradation of 14.3%, followed by *Mucor* sp. (13.3%) and *Trichoderma* sp. (9.5%). *Asp. ergillus* sp. and *Absidia* sp. had the lowest percentage degradation of 4.3 and 6.5%, respectively. This report shows that indigenous microorganisms possess the capacity to degrade sawdust.

Key words: Degradation, sawdust, utilizing, autochthonous microorganisms.

INTRODUCTION

Sawdust a by product of wood processing is generally regarded as a waste. It is often heaped near carpenters' shades, burnt or dumped into rivers. Consequently, they block the water ways and if burnt, produce very thick smoke with high environmental consequences. Wastes and their disposal is a subject of environmental concern worldwide especially when they are non biodegradable to useful goods and services (Banjo and Kubuoye, 2000).

Sawdust is made up of 3 major components; cellulose, hemicellulose and lignin (Alexander, 1997; Erikson et al., 1990). Lignin is the most recalcitrant and protects the cellulose and hemicellulose from enzymatic attack by some microorganisms (Bonnarme and Jeffries, 1998). Cellulose constitutes one-third to one-half of the approximately 150 billion tones of organic matter synthesized annually (Shewale and Sadana, 1978; Bayer and Moray, 1994). Hemicellulose is an ill-defined group of carbohy-

drate and is of the major plants constituents, second in quantity to cellulose.

The general recalcitrance of cellulose, lignin and hemicellulose and the importance of their biodegradation in the environment have received much attention for several years (Erikson et al., 1990). In microbial ecology, cellulose, the most abundant as in naturally occurring biopolymer is a vital component of the biospheric carbon cycle and its bioconversion to fuel and chemicals is of great interest (Philips and Humphrey, 1993). Cellulose is totally insoluble in water and has about 2000 – 10 000 glucose subunits with molecular weight determination value that ranges from 200 000 to about 2.4 million (Gilkes et al., 1988; Wu et al., 1988). Cellulose fibrils have high tensile strength which is used in the textile industry, paper and miscellaneous materials like vulcanized fibre, plastic filters, filtering media and surgical cotton. Other uses include adhesives, explosives, thickening agents, coated paper, cellophane, artificial leather, films and foils (Hitchner and Leatherwood, 1982).

Wood sawdust have been reported (Shide et al., 2004)

*Corresponding author. E-mail: josyl2k@yahoo.com.

Table 1. Indigenous bacterial isolates from sawdust.

Isolates	Identified	Organisms
A	<i>Flavobacterium</i>	sp.
B	<i>Xanthomonas</i>	sp.
C	<i>Pseudomonas</i>	sp.
D	<i>Micrococcus</i>	sp.
E	<i>Streptococcus</i>	sp.
F	<i>Bacillus</i>	sp.
G	<i>Cellulomonas</i>	sp.
H	<i>Cytophaga</i>	sp.

Tables 2. Indigenous fungi isolates from sawdust.

Isolates	Identified	Organisms
1	<i>Mucor</i>	sp.
2	<i>Penicillium</i>	sp.
3	<i>Absidia</i>	sp.
4	<i>Diplosp. orium</i>	sp.
5	<i>Rhizopus</i>	sp.
6	<i>Fusarium</i>	sp.
7	<i>Trichoderma</i>	sp.
8	<i>Asp. ergillus</i>	sp.

to be degradable by *Lentinus squarrosulus* (Mont) singer, a basidiomycete also known as a white rot fungi to form protein, glucose and ethanol. Wuyep et al. (2003) reported the cultivation of enzymes for the degradation of lignocellulosic materials. Fungi of the classes hyphomycetes, zycomycetes, pyrenomycetes, hymenomycetes and the actinomycetes and bacteria of the groups *Cytophaga*, *Erwinia*, *Pseudomonas*, *Sp. oroiytophaga*, *Xanthomonas* and *Streptomonas* degrade hemicellulose (Durrant, 1996; Wuyep et al., 2003; Bonnarme and Jeffries, 1998).

The current effort is aimed at the determination of the biodegradability of sawdust by indigenous micro-organisms.

MATERIALS AND METHODS

Sources of samples

Wet decomposing sawdust samples, fresh and dry undecomposed sawdust samples were collected from MCC timber market, Calabar, Cross River State, Nigeria.

Isolation and identification of bacteria

Bacteria were isolated and identified by carrying out a ten fold dilution of the wet decomposing sawdust. Antifungal agent, nystatin

was incorporated into nutrient agar. One milliliter of the diluted solution of the sawdust was plated and incubated. The discrete colonies were sub-cultured and stock cultures were prepared from the pure cultures and stored at 4°C until needed.

Characterization and identification of the isolates

The isolates were gram stained and biochemical tests were performed.

Isolation of fungi

The method of Anderson et al. (1973) was used in the isolation of fungi. 1 ml from the dilution above was plated on potato dextrose agar and incubated at 27°C for 7 days. The discrete colonies were sub cultured and the pure cultures were stocked and stored until needed. The isolated colonies were characterized and identified.

Determination of cellulose content of fresh dry sawdust

Cellulose content of the sawdust was determined using ASTM standard method (1974) as reported by Ochonogor (1990).

Screening test for degradation of sawdust using the microbial isolates

Eighteen test tubes were obtained and 2 g of sawdust was introduced into each. 18 ml of distilled water was also added into each of the test tubes. The content of the test tubes were autoclaved at 121°C for 15 min. The tubes for the bacterial isolates were labeled A-H and control, while those of fungal isolates were numbered 1-8 and control. Each isolate was inoculated into each tube except the controls. The tubes that contained the bacterial isolates were incubated at 37°C for 30 days while those of fungal isolates were incubated at 27°C for 30 days. At the end of the 30 days, the liquid contents in the tubes were carefully decanted. The sawdust in each tube was digested using the ASTM standard method (1974). The cellulose content of each tube was finally determined.

RESULTS AND DISCUSSION

A total of 16 microbial species were isolated from the decaying sawdust; 8 bacteria and 8 fungi. Table 1 shows the bacterial isolates and Table 2 shows fungi Isolates. The percentage of cellulose for each degraded sawdust after digestion was determined. Table 3 shows the comparative degradation of cellulose in the sawdust.

Microbial degradability of sawdust through the isolation of autochthonous bacterial and fungal utilizing sawdust and the observation of differences in cellulose content of sawdust before and after treatment have been demonstrated.

16 microbial species isolated from the decaying sawdust; 8 bacterial (Table 1) and 8 fungal (Table 2) had different capabilities of degradation of the cellulose component of the sawdust. This indicates that only few of

Table 3. Comparative degradation of cellulose in sawdust by bacteria.

Microbial Isolated	Organism	Initial cellulose (%)	Final cellulose (%)	% Difference
A	<i>Flavobacterium</i> sp.	53	43.3	9.7
B	<i>Xanthomonas</i> sp.		39.7	13.3
C	<i>Pseudomonas</i> sp.		38.5	14.6
D	<i>Micrococcus</i> sp.		37.0	16.0
E	<i>Streptococcus</i> sp.		38.5	14.5
F	<i>Bacillus</i> sp.		45.3	7.7
G	<i>Cellulomonas</i> sp.		34.7	18.3
H	<i>Cytophaga</i> sp.		43.4	9.6
I	Control		52.8	0.2

Table 4. Comparative degradation of cellulose in sawdust by fungi.

Microbial Isolated	Organism	Initial cellulose	Final cellulose	% Difference
1	<i>Mucor</i> sp.	53	39.70	13.3
2	<i>Penicillium</i> sp.		38.5	14.5
3	<i>Absidia</i> sp.		46.4	6.4
4	<i>Diplosp. orium</i> sp.		45.3	7.7
5	<i>Rhizopus</i> sp.		44.4	8.6
6	<i>Fusarium</i> sp.		46.5	6.5
7	<i>Trichoderma</i> sp.		43.5	9.5
8.	<i>Asp. eriqillus</i> sp.		48.2	4.3
9.	<i>Fungal control</i>		52.5	0.5

the isolates are capable of utilizing sawdust as its source of carbon and energy for growth. This corroborates the findings of Godliving and Yoshitoshi (2002) that bacteria and fungi degrade wood sawdust. Focher et al. (1991) also reported the biodegradability of cellulose. This agrees with the finding of Dosoretz et al. (1990), when they reported the reduction in carbon content of sawdust when subjected to microbial degradation.

Hitchner and Leaderwood (1982) reported the ability of cellulase enzyme in the degradation of cellulose. Table 3 shows that *Cellulomonas* sp. has the highest percentage cellulose degradation of 18.3%, followed by *Micrococcus* sp. (16.0%) and the least been *Cytophaga* sp. and *Bacillus* sp. (7.7%). This indicates that *Cellulomonas* sp. had the highest capacity to secrete cellulase enzyme and subsequently degraded cellulose. Table 4 shows that *Penicillium* sp. which utilized cellulose to 14.5% had the highest potency in cellulose degradation, followed by *Mucor* sp (13.3%) and the least been *Aspergillus* sp. (4.3%). The efficacy of fungi in cellulose degradation has also been reported (Deeble and Lee, 1985; Kelsey and Shafizadeh, 1980). These reports have provided insight into the possibility of degradation of sawdust using indigenous microorganisms, thereby paving way for enhanced natural attenuation of sawdust polluted sites.

REFERENCES

- Alexander M (1997). Soft rot bacteria. Introduction to soil Microbiology 6th Ed. John Wiley and Sons, New York, pp. 148-162.
- Anderson NA, Wang SS, JW Schwandt (1973). The *Pleurotus ostreatus* sapidus species complex – Mycologia, 6: 28-35.
- Banjo NO, Kubuoye AO (2000). Comparison of the effectiveness of some common Agro-industrial wastes in growing three tropical edible mushroom. Proceedings of the internal conference on Biotechnology: commercialization and food supply, Nigeria, pp. 161-168
- Bayer FAE, Moray (1994). The cellulose– a treasure-trove for biotechnology. TIBTECH 12: 379-386
- Bonnarme D, Jeffries TW (1998). Mn (11) regulation of lignin peroxidase and mangares – dependent peroxidase from lignin – degrading white – rot-fungi. Appl. Environ. Microbiol., 56: 210-217
- Deeble MF, Lee JM (1985). Enzymatic hydrolysis of cellulosic substances in an attrition bioreactor. Biotechnol. Bioengr. Symp., 15: 277-293.
- Dosoretz GG, Chenn HC, Greth Lein HE (1990). Effect of Environmental conditions of extracellular protease activity in lignolytic cultures of phanerochaete chrusosporium. Appl. Environ. Microbiol., 56: 395-400.
- Durrant LR (1996). Biodegradation of lignocellulosic materials by soil fungi isolated under anacrobic conditions. Int. Biodeterioration Biodegr., 37: 189-195.
- Erikson KEL, Blanchette RA, Ander P (1990). Microbial and Enzymatic Degradation of wood and wood components. Wood decomposition. Springer-Verlag, New York. pp. 41-62.
- Focher B, Marzetti A, Beltrame PL, Carnici P (1991). Structural features of cellulose and cellulose derivative and their effects on enzymes hydrolysis. Biosynthesis and Biodegradation of cellulose. Marcel

- Dekker, New York, USA, pp. 293-310.
- Gilkes NR, Warren RAJ, Miller RC Jr, Kilburn DG (1988). Cellulose in Wood. *J. Biochem.*, 263: 10401–10407.
- Godliving M, Yoshitoshi (2002). Continuous production of lignin degrading enzymes by *Bjerkandera adusta* immobilized on polyurethane foam. *Biotechnol. Lett.*, 24: 173-1747.
- Hitchner EV, Leatherwood J (1982). Use of cellulose depressed mutant of *Cellulomonas* in the production of single-cell-protein from cellulose. *Appl. Environ. Microbiol.*, 41: 465-583.
- Kelsey RG, Shafizadeh F (1980). Enhancement of cellulose accessibility and enzymatic hydrolysis by simultaneous wet milling. *Biotechnol. Bioengr.*, 22: 1025-1036.
- Philips JA, Humphrey EA (1993). An overview of process Technology for the production of liquid fuels and chemical Feed stocks via fermentation. *Organic Chemical for Biomass*. Wise DW, Menia Pack CA. Benjamin Cuning's Publishing Company. pp. 249-304.
- Shewale JG, Sadana JC (1978). Enzymatic hydrolysis of cellulosic materials by *Sclerotium rolfsii*, culture filtrate of sugar production. *Can. J. Microbiol.*, 25: 773-783.
- Shide EG, Whyep PA, Nok AJ (2004). Studies on the degradation of wood sawdust by *Lentinus squarrosulus* (Mont) singer. *Afr. J. Biotechnol.*, 3(8): 395-398.
- Wu JHD, Orme-Johnson WH, Demain AL (1988). Decomposition of cellulose. *Biochemistry*, 27: 1703-1787.