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Comparative degradation of sawdust by microorganisms isolated from it

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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, C *ellulomonas* sp. was found to be the most effective degrading agent based on its high percentage degradation (18.3%). This was followed by M*icrococcus* 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%). *A*sp. *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 byproduct 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 carbohydrate 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)

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Table 1. Indigenous bacterial isolates from sawdust.

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

Tables 2. Indigenous fungi isolates from sawdust.

Isolates	Identified	Organisms
1	*Mucor*	sp.
2	*Penicillium*	sp.
3	*Absidia*	sp.
4	*Diplo*sp.*orium*	sp.
5	*Rhizopus*	sp.
6	*Fusarium*	sp.
7	*Trichoderma*	sp.
8	*Asp.ergillus*	sp.

to be degradable by *Lentinus squarrosolus* (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 microorganisms.

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 tenfold 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

Eigteen 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	*Flavobacterium* sp.	53	43.3	9.7
B	*Xanthomonas* sp.		39.7	13.3
C	*Pseudomonas* sp.		38.5	14.6
D	*Micrococcus* sp.		37.0	16.0
E	*Streptococcus* sp.		38.5	14.5
F	*Bacillus* sp.		45.3	7.7
G	*Cellulomonas* sp.		34.7	18.3
H	*Cytophaga* 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	*Mucor* sp.	53	39.70	13.3
2	*Penicilluim* sp.		38.5	14.5
3	*Absidia* sp.		46.4	6.4
4	*Diplo*sp.*orium* sp.		45.3	7.7
5	*Rhizopus* sp.		44.4	8.6
6	*Fusaruim* sp.		46.5	6.5
7	*Trichoderma* sp.		43.5	9.5
8.	*A*sp.*eriqillus* sp.		48.2	4.3
9.	*Fungal control*		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 C*ytophaga* 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.

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