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ROLE OF FUNGI ON BIODEGRADATION OF SUGARCANE BAGASSE

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ABSTRACT:

In order to check the rate of biological degradation and biochemical changes of bagasse by saprophytic fungi, further processes on sugarcane bagasse were done. To find out fungi responsible for biodegradation we isolated 24 fungi on PDA from sugarcane bagasse, among them 10 dominant fungi were selected for further processes by standard methods. Degradation was estimated after three intervals of every 15 days. We found that the fungi namely Aspersgillus niger, Aspergillus flavus, Fusarium dimerum, Alternaria alterneta, are responsible for quick and faster biodegradation and fungi namely, Alternaria dainthe, Fusarium semitectum, Penicillium citrinum, Penicillium olivicolor, Trichoderma harzianum, Trichoderma atroviride are noted for average biodegradation. Results were observed in the variation of 15, 30, 45 days. The maximum degradation was observed in 45 days.

Keywords: Sugarcane bagasse (SCB), Fungi, Biodegradation, etc.

INTRODUCTION:

Sugarcane bagasse (magasse) is raw material of sugarcane industry which is rich in cellulose, lignin, glucose, carbohydrates, etc. These contents are useful in the view of agro-industrial applications. Sugarcane bagasse contains approximately 50% cellulose, 25% hemicellulose and 25% lignin. Due to its high availability, it could serve as a substrate for microbial production of value-added products, such as protein-rich animal feed, enzymes, amino acids, organic acids and compounds of pharmaceutical importance (Parameswaran 2009). There are various sources for this biomass is from agricultural and nonagricultural based, in agricultural sources sugarcane bagasse occupying highest range of availability. This biomass also uses as a potential renewable energy source. Similarly lignocellulosic biomass is one of them which can be used to produce alternative liquid fuel sources. However, the production cost of liquid fuel such as ethanol from lignocellulosic biomass is higher, primarily because of high cost for cellulosic separation and hydrolysis. Buswell and Odier, (1987). The structure of the lignocellulosic biomass is the main problem which composes mainly of cellulose, hemicellulose and lignin (Fox et. al., 1987; Sun and Cheng, 2002). The cellulose fibers are mainly embedded in an amorphous matrix of hemicellulose and lignin (Pareek, 2000). The economic importance of sugarcane is directly related to its production. Sugarcane bagasse is used for various agro-industrial purposes such cultivation substrate for edible and commercial mushrooms (Wang et al., 2017). It is an abundant agricultural waste commonly used as a texturizer in bioremediation. Recently, sugarcane bagasse has been vastly used in

wastewater treatment, energy co-generation, cellulose production and as fertilizer. Sugarcane bagasse contents various biochemicals such as lignin, cellulose, hemicellulose, protein, glucose, carbohydrates, fat and waxes (Huang et al. 2012, Xu et al. 2010). The biological degradation of the sugarcane bagasse involves the enzymatic hydrolysis of the glycosidic linkages from the cellulose chain and an attack on the lignin polymer. Considering the importance of bagasse and role of fungi in its degradation experiments were carried out on biodegradation with dominating fungi.

MATERIAL AND METHOD

Fungi Culture

Ten fungi were successfully isolated from the bagasse of different sugarcane industry on the PDA medium. Cultures of fungi were sub-cultured on Potato Dextrose Agar (PDA) slants and stored at 30^0C until required for study.

Preparation of Inoculum:

To prepare suspension, spores of each fungi separately washed from seven-day agar slant culture with 10 ml sterile distilled water.

Treatment of Substrate:

Bagasse was kindly provided by the Chatrapati Sugars Factory Ltd. Sawargaon of Beed (MS) and Sambhaji sugar factory Aurangabad (MS). Biodegradation of sugarcane bagasse take 25 gm of moistened bagasse was transferred to each flask and make sterilization after that 10 ml spore suspension culture of ten fungi were added. The inoculated flasks were incubated at 30^0C and results for biodegradation were noted up to three intervals of 15 days.

Analytical Procedures:

Treated bagasse and untreated bagasse were dried by oven at 105^0C, for analysis of cellulose, hemicelluloses, lignin and carbohydrates.

Determination of Cellulose:

One gram of oven dried sample was taken and to it added 15ml of 80% acetic acid and 1.5ml concentrated nitric acid the content was refluxed for 20 min, and then filtered. Collected residue was washed with ethanol, dried in oven at 100-105^0C, finally weighed and labeled sample A. Then sample A was incinerated at 540^0C in muffle furnace and labeled. Cellulose content was determined by the method of Goering and Van Soest (1970).

$$\% \text{ cellulose} = \frac{\text{Sample A} - \text{Sample B}}{\text{Weight of Initial Sample}} \times 100$$

Determination of Lignin:

One gram of oven dried sample was taken and to it added 70ml of 1.25% sulfuric acid. The content was refluxed for 2 days and then filtered. Collected residue was washed with water. To this material was added 30 ml of 72% H_2SO_4 and allowed to stand for 4 Days with occasional stirring. Then filtered, washed and dried in oven at 100-105^0C, finally weighed and labeled sample A. Then sample A was incinerated at 540^0C in muffle furnace and labeled sample B. Lignin content was determined by the method of Goering and Van Soest (1970).

$$\% \text{ Lignin} = \frac{\text{Sample A} - \text{Sample B}}{\text{Weight of Initial Sample}} \times 100$$

Statistical Analysis:

All the experiments were done in three replicates of 15 days and only the mean data of the obtained results has been taken in tables. The obtained results were analyzed statistically.

RESULT AND DISCUSSION:

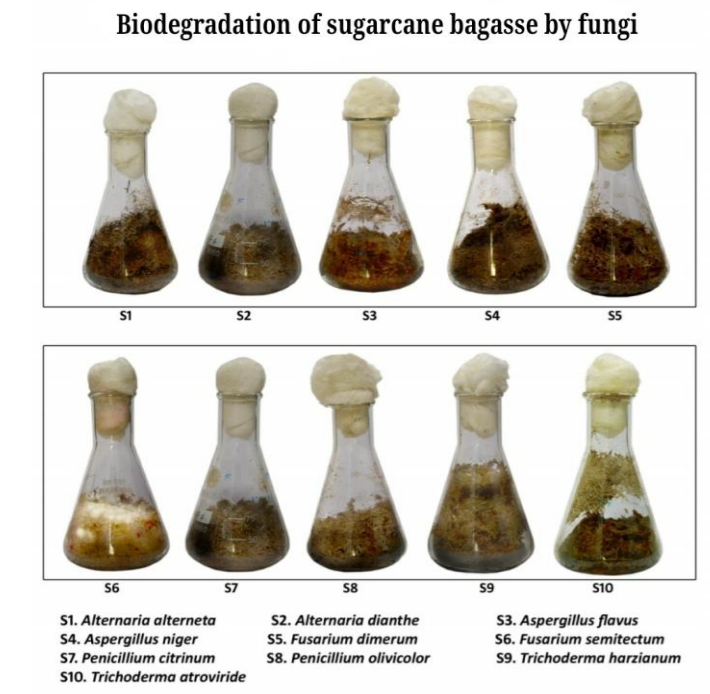
This study carried out to check the degradation rate of different fungi on sugarcane bagasse. The activity was observed for different time (i.e., 15, 30, 45 Days). After15 Days of the maximum degradation of cellulose was shown by the Fusarium dimerum i.e., 30.82% and the lowest was in Penicillium olivicolor i.e., 41.56%, similarly in Hemicellulose the highest rate seen in Aspergillus niger i.e., 15.25% and the lowest was in Trichoderma harzianum and Trichoderma atroviride i.e., 25.50% While same observed in lignin maximum degradation was observed in Aspergillus niger i.e., 13.44% and in Trichoderma harzianum i.e., 17.56%the minimum degradation was seen similar result was found by Xin et al, (2002), lignin decrease. Although lignin reduction from the mixture of the three fractions was lower than that from the WSB, the lignin reduction of the mixture was much higher than that of each fraction. The results demonstrate that WSB was more effectively degraded with MG-60 than its fractions under the same incubation conditions. Similarly in the highest degradation was shown by Aspergillus niger i.e., 37.49% and lowest by Alternaria alterneta i.e., 65.29%.As compare to in control carbohydrate degradation was 68%.

The same results were noted for 30 Days in which cellulose showed maximum degradation rate in Aspergillus flavus i.e., 26.56% and the minimum degradation was in Penicillium olivicolor i.e., 40.15% where as in hemicellulose the maximum degradation was in Aspergillus flavus i.e., 13.50% and minimum degradation was in Trichoderma atroviride i.e., 24.35%. Similarly in Lignin the maximum degradation observed in Fusarium dimerum i.e., 11.56%and the less degradation in Trichoderma harzianum i.e., 17.10%, similarly in carbohydrates shows highest degradation rate in Alternaria alterneta i.e. 64.21% and minimum degradation was in Fusarium dimerum i.e., 29.48%.

The observations were taken for the 45 Days the results do not showed much difference from the 15 and 30 Days. In case of cellulose showed that the degradation rate was maximum in the fungi Aspergillus niger i.e., 22.36% and the lowest in the Penicillium olivicolor fungi i.e., 39.56%. Brecci et al., (1997) some strains produced a slight decrease in the relative cellulose content: T. pavonia MVHC 5555 (43.6%) and T. extenuata MVHC 5304 (42.3%) at 30 and 60 days, respectively. The other strains produced a residue with values of cellulose content higher or equal to untreated LFB (45.7 f 0.3%). A cellulose rich material is indicative of fungal growth at the expense of the hemicellulosic fraction; because lignin metabolism is energetically insignificant Shimada M. and Higuchit, (1991). Whereas hemicellulose showed high amount of degradation in Aspergillus niger i.e. 10.12% and low in Trichoderma atroviride i.e., 24.11%. The component lignin showed maximum degradation in fungi Aspergillus niger i.e., 09.12% and minimum in Trichoderma harzianum i.e., 16.86. And in carbohydrates showed that highest degradation was in Aspergillus niger fungi i.e., 21.14% and lowest in Trichoderma harzianum i.e., 63.28%.

Table No. 1. Biodegradation of Sugarcane bagasse by different fungi

Fungi	Biodegradation Period (Days)	Biodegradation in %			
		Cellulose	Hemicellulose	Lignin	Carbohydrate
Alternaria alterneta	15	38.50	20.45	16.65	65.29
	30	37.26	17.16	14.80	64.21
	45	36.5	15.12	14.25	63.9
Alternaria dianthi	15	36.15	19.64	16.90	61.28
	30	35.50	16.53	16.50	60.15
	45	34.5	13.56	16.22	58.9
Aspergillus flavus	15	32.59	16.89	13.59	38.29
	30	26.56	13.50	12.54	29.48
	45	24.8	10.58	11.20	22.15
Aspergillus niger	15	31.49	15.26	13.44	37.49
	30	27.83	13.56	12.05	26.77
	45	22.36	10.12	9.12	21.14
Fusarium dimerum	15	30.82	19.56	13.54	64.59
	30	27.15	16.22	11.56	62.18
	45	23.8	16.45	10.59	61.20
Fusarium semitectum	15	31.59	19.86	14.35	64.58
	30	27.58	18.90	13.49	61.28
	45	23.68	17.86	9.55	58.29
Penicillium citrinum	15	36.25	22.36	17.26	49.58
	30	32.84	21.50	16.48	44.69
	45	29.59	19.56	15.54	37.48
Penicillium olivicolor	15	41.56	23.20	16.90	48.69
	30	40.15	21.50	16.50	43.22
	45	39.56	21.12	15.64	39.54
Trichoderma harzianum	15	38.50	25.50	17.56	64.50
	30	36.20	24.10	17.10	64.10
	45	35.76	23.86	16.86	63.28
Trichoderma atroviride	15	39.50	25.50	17.25	64.88
	30	37.10	24.35	15.50	60.26
	45	36.12	24.11	14.10	57.86
Control (C)		42	26	18	68



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