SUSTAINABLE AGRICULTURAL SOLID WASTE MANAGEMENT THROUGH PHYLLOSPHERE MICROBES

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Abstract

All over the world researchers are working on the development and upgradation of sustainable technologies for solid waste management either through degradation or volume reduction or conversion of waste to useful products. Solid Waste Management (SWM) by sustainable technologies in the agricultural field is needed for hours. Literature reveals that the use of microbial strains (bacteria and/or fungus) is in practice but more study requires to explore the efficient application of knowledge in the agricultural field. The situation desires novel strains with better capacities to degrade solid waste materials quicker than the available strains. This work emphasises the finding of microbiota, specifically fungi and applies different isolated strains on waste materials to examine decomposition capabilities. In search of novel strains of fungi, the phyllosphere of mangrove leaves are selected and samples were collected in three different seasons from the Sundarbans region of West Bengal, India. The isolated pure culture of microbial strains is preserved in a laboratory environment and pure cultures are applied to different types of waste materials to know their capabilities of degradation and the enzyme assay method is also applied. The study reveals that all isolated fungal strains produce different categories of enzymes, among them amylase enzyme, catalase enzyme and polyphenol oxidase enzyme production capabilities are examined here. The study suggests application of more than one fungal strain together are effective for agricultural solid waste management and sustainable bioremediation technology for future generation.

Keywords: solid waste management; fungi; agriculture, phyllosphere; bioremidiation (key words)

I. INTRODUCTION

Bioremediation is a good solution for solid waste management [1]. Across the globe, researchers are working to find out better to the best solution and remedial measures. This study also attempted to find out novel technology for solid waste degradation in a sustainable way. In search of novel strains, the mangrove forest of West Bengal is selected as that area has minimum interference of anthropogenic activities, therefore possibilities to find out new strains of microbes are higher than in any other area. Moreover, phyllo sphere microbiota (fungi) has been emphasized because many researchers already worked on the rhizosphere of mangroves, in comparison to that phyllo sphere is less explored [2]. The microbial groups of leaves are varied and include many diverse species of bacteria, yeasts, filamentous fungi, less commonly, protozoa and nematodes. Filamentous fungi are predominantly considered transient inhabitants of leaf surfaces [3].

II. MATERIAL & METHODS

1. **Study Site:** The coastal zone of West Bengal in the lower 'Bengal Basin' comprises the district Parganas both south and north and partly Medinapore, which lies 73% area within W.B lie between longitude 86^0 E & $89^0$10' E and latitude $21^0$30'N to $22^0$30'N. This entire mangrove habitat area is demarcated as the CRZ-1. Out of this region, four regions are selected and they are Bakkhali, Purandar, Pakhiralaya and Gosaba.

2. **Collection Procedure:** Samples are collected by reaching the required location by boat and after an extensive walk from the intertidal virgin forest region mangrove leaves are collected. Appropriate footwears are necessary to save the foot from injuries. Throughout the year three times samples are collected to find out microbiological diversity. The plants selected for study are Avicenniaofficinalis, Exocariaagallocha, Heritaria globose, Acanthus ilicifolius, Brugeriagymnoriza, Xyllocarpusobovatus, Pseropsusdecandrop, Sonneratiaapelata. The phyllosphere is occupied with various types of microbes but this study mainly emphasis on fungus. Imprint has been taken from the dorsal and ventral surface of the leaves and it is allowed to grow in PDA (Potato Dextrose Agar) medium.

III. RESULT&DISCUSSION

1. **Result of Fungal Spectrum Study:** The study reveals the biological spectrum or microbial colony differs from one leave to another within the same species of plant, even if it differs from the dorsal surface of leaves to the ventral surface of leaf. The Accanthusillicifolius has the highest biological spectrum and it is 7.54%. Whereas, Aspergillus versicolor and Aspergillus niger (1.749%) have the lowest value of microbial population. In three different seasons overall 14 different fungal populations were grown and they are: Aspergillus versicolor, A.niger, A. nidulas, A. flavus, A.ochraceous, Pyricularia, Penicilliumexpansum, Penicilliumfuniculosum, Chacotoniumglobesum, Mucorracemosus, Fusariumsp, Helminthosporiumexpansum. Out of these 14 fungi, Alternaria alternate, Fusariumsp, Pyricularia, Helminthosporiumexpansum are pathogenic fungi [4]-[6] so these four are not considered for enzyme assay. The enzyme assay result is tabulated in Table 1.

2. Result of Enzyme Assay Study:

Table 1: Quantitative Enzyme Assay Result

Name of Fungus	**Name of Enzymes**					
	Amylase (mg/ml)		***Catalase (mg/ml)***		**Polyphenol oxidase (mg/ml)**	
	Hyphae	***Spore***	**Hyphae**	**Spore**	**Hyphae**	**Spore**
Aspergillus versicolor	*0.145*	*0.175*	*34.13*	*34.16*	0.268	0.267
A.niger	*0.155*	*0.185*	*32.13*	*34.12*	0.238	0.258
A. nidulas	0.272	0.292	32.70	34.2	0.192	0.205
A. flavus	0.115	0.105	38.42	38.72	0.212	0.272
A.ochraceous	0.058	0.079	35.70	36.92	0.272	0.301
Penicillium expansum	0.151	0.162	43.56	46.71	0.104	0.152
Penicillium funiculosum	0.152	0.192	43.86	49.71	0.108	0.172
Chacotonium globesum	0.315	0.385	21.59	22.34	0.183	0.201
Mucor racemosus	0.211	0.272	05.10	06.20	0.137	0.262

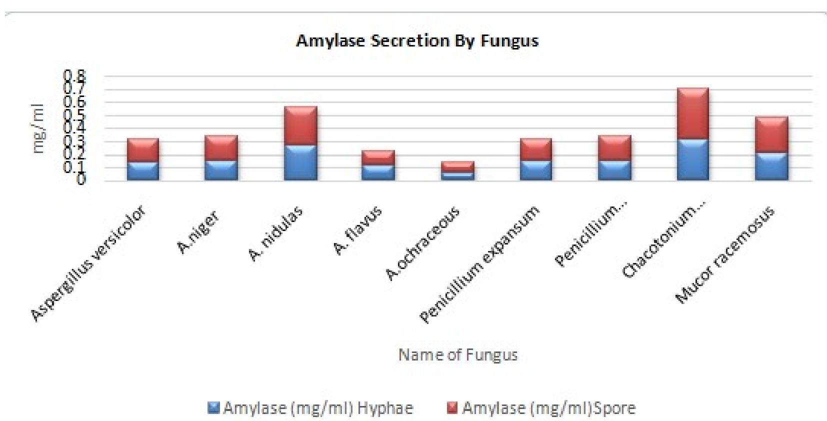

Figure 1: Fungal Amylase Enzyme Secretion

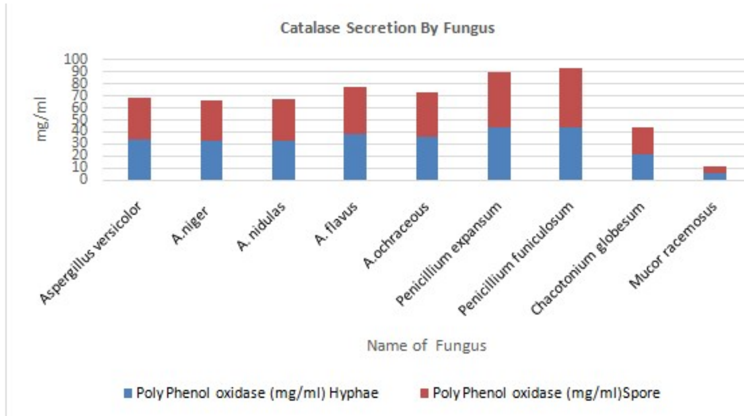

Figure 2: Fungal Catalase Enzyme Secretion

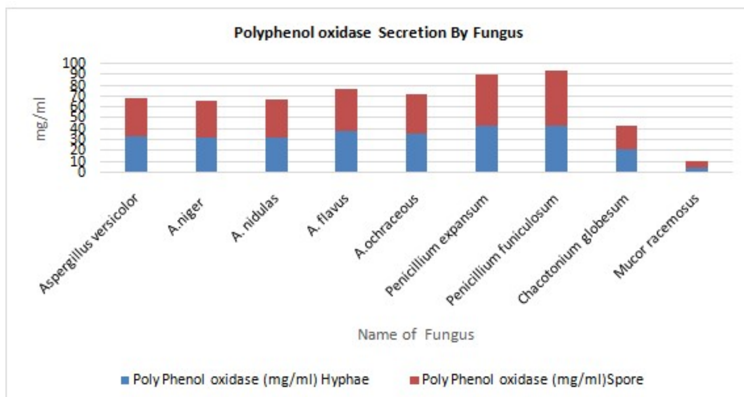

Figure 3: Fungal Polyphenol Oxidase Enzyme Secretion

Table 1, and Figure 1 to 3 represent different fungus and their enzyme production capabilities. The study reveals spores are more active and efficient in enzyme production than vegetative bodies or hyphae.

The polyphenol oxidase (PPO) enzyme catalyzes the phenolic compounds' oxidation into highly reactive quinones. Plant food wastes and by-products might have a range of enzymes that can transform bio-organic molecules, and thus they may have possible uses in bioremediation procedures. Vegetable peels are plentiful plant food waste and might be considered a hopeful means of bioremediation since they comprise the oxidative enzyme polyphenol oxidase (PPO), which can degrade or oxidize a range of pollutants [7]. The Polyphenol oxidase (PPO) is also supportive of preventing wilt in the tomato" plant [8].

IV. CONCLUSION

The enzyme catalase is known to catalyze the breakdown of hydrogen peroxide into oxygen and water. It has one of the highest turnovers of all enzymes as it can decompose more than one million molecules of hydrogen peroxide, per molecule of enzyme. Catalase has been used as an important enzyme in many biotechnological areas including bioremediation and waste management [9],[10]. Amylase enzyme is also widely used for agricultural waste management [11]-[14]. The studied fungal population reveals that it can synthesis amylase, catalase and polyphenol oxidase enzymes at a time. All these enzymes are capable of waste breakdown, specifically organic waste. Agricultural solid wastes are rich in organic material and a combination of these fungal strains will support the degradation of organic waste faster and partially it converts to bio-fertilizer. This bioremediation will be supportive of increasing the fertility of the soil and can be preventive against pathogenic attack

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