**Sustainable Agricultural Solid Waste Management Through Phyllosphere Microbes**

Dr. Bipasha Mridha Ghosh

Department of Environmental Science

NSHM Knowledge Campus

Durgapur, India

[bipasha.mghosh@gmail.com](mailto:bipasha.mghosh@gmail.com)

ABSTRACT

All over the world researchers are working on development and upgradation of sustainable technologies for solid waste management either through degradation or volume reduction or conversion of waste to useful product. Solid Waste Management (SWM) by sustainable technologies in agricultural field are need of hours. Literature reveals that use of microbial strain (bacteria and/or fungus) is in practice but more study requires to explore efficient application of knowledge in agricultural field. The situation desires novel strains with better capacities to degrade solid waste materials quicker than the available strains. This work emphasis on finding of microbiota, specifically fungi and apply different isolated strains on waste materials to examined decomposition capabilities. In search of novel strain of fungi, 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 laboratory environment and pure cultures are applied to different types of waste materials to know their capabilities of degradation and enzyme assay method also applied. The study reveals that among all isolated fungal strains produces different categories of enzyme, among them amylase enzyme, catalase enzyme and polyphenol oxidase enzyme production capabilities are examined here. Study suggests application of more than one fungal strains together are effective to agricultural solid waste management and sustainable bioremediation technology for future generation.

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

# 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 strain, 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 any other area. Moreover, phyllo sphere microbiota (fungi) has given emphasis because many researchers already worked on 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].

# Material &Methods

## **Study site**

The coastal zone of West Bengal in the lower ‘Bengal Basin’ comprises of the district paraganas both south and north and partly Medinapore, which lies 73% area within W.B lie between longitude 860 E & 890 10’ E and latitude 21030’N to 22030’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.

## **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 foot wears are necessary to save foot from injuries. Throughout the year three times samples are collected to find out microbiological diversity. The plants selected for study are *Avicennia officinalis, Exocaria agallocha, Heritaria globose, Acanthus ilicifolius, Brugeria gymnoriza, Xyllocarpus obovatus, Pseropsus decandrop, Sonneratia apelata*. Phyllosphere is occupied with various types of microbes but this study mainly emphasis on fungus. Imprint has taken from dorsal and ventral surface of the leaves and it is allowed to grow in PDA (Potato Dextrose Agar) medium.

# RESULT

## **Result of Fungal Spectrum Study**

The study reveals the biological spectrum or microbial colony differs from one leave to another within same species of plant, even it differs from dorsal surface of leaves to ventral surface of leaf. In *Accanthus illicifolius* highest biological spectrum is 7.54% Aspergillus versicolor and lowest is *Aspergillus niger* (1.749%) during winter season. In three different season overall 14 different fungal population were grown and they are: *Aspergillus versicolor, A.niger, A. nidulas, A. flavus, A.ochraceous, Pyricularia, Penicillium expansum, Penicillium funiculosum, Chacotonium globesum, Mucor racemosus, Fusarium sp, Helminthosporium expansum.* Out ofthese 14 fungi, *Alternaria alternate, Fusarium sp, Pyricularia, Helminthosporium expansum* are pathogenic fungus [4]-[6] so these four are not considered for enzyme assay. The result of enzyme assay is tabulated in Table-1.

## **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 body or hyphae.

# DISCUSSION

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 which 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 as 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 to prevent wilt in “Tomato” plant [8].

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 has the capacity to 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 to waste break down, specifically organic waste. Agricultural solid wastes are rich in organic material and combination of these fungal strain will support the degradation of organic waste faster and partially it converts to bio-fertilizer. This bioremediation will be supportive to increase fertility of soil and can be preventive against pathogenic attack.

##### REFERENCES

[1] N.G. Shrivastava, (2022). Bioremediation of Solid Waste Management. In: Baskar, C., Ramakrishna, S., Baskar, S., Sharma, R., Chinnappan, A., Sehrawat, R. (eds) Handbook of Solid Waste Management. Springer, Singapore. <https://doi.org/10.1007/978-981-16-4230-2_48>

[2] R. Baskaran, et al. (2012): "Phyllosphere microbial populations of ten true mangrove species of the Andaman Island." *Int. J. Microbiol. Res* 3 124-127.

[3] J. H. Andrews,, and R. F. Harris**.** 2000. The ecology and biogeography of microorganisms on plant surfaces. Annu. Rev. Phytopathol. **38:**145–180.

[4] Takashi Tsuge et al.,( 2013) Host-selective toxins produced by the plant pathogenic fungus Alternaria alternata, FEMS Microbiology Reviews, Volume 37, Issue 1, January 2013, Pages 44–66, <https://doi.org/10.1111/j.1574-6976.2012.00350.x>

[5] Kistler, H. C. (1997). Genetic diversity in the plant-pathogenic fungus Fusarium oxysporum. *Phytopathology*, *87*(4), 474-479.

[6] Ghabrial, S. A., Soldevila, A. I., & Havens, W. M. (2002). Molecular genetics of the viruses infecting the plant pathogenic fungus Helminthosporium victoriae. *dsRNA Genetic Elements: Concepts and Applications in Agriculture, Forestry, and Medicine*, 213-236.

[7] Frederik Gadeyne, Nympha De Neve, Bruno Vlaeminck, Veerle Fievez. (2017) State of the art in rumen lipid protection technologies and emerging interfacial protein cross‐linking methods. European Journal of Lipid Science and Technology 119:5, pages 1600345.

[8] Tan, S., Dong, Y., Liao, H., Huang, J., Song, S., Xu, Y., & Shen, Q. (2013). Antagonistic bacterium Bacillus amyloliquefaciens induces resistance and controls the bacterial wilt of tomato. Pest management science, 69(11), 1245-1252.

[9] Maphuhla NG, Lewu FB, Oyedeji OO. (2022 ) Enzyme Activities in Reduction of Heavy Metal Pollution from Alice Landfill Site in Eastern Cape, South Africa. Int J Environ Res Public Health. 2022 Sep 23;19(19):12054. doi: 10.3390/ijerph191912054. PMID: 36231352;

PMCID: PMC9565107

[10] Srivastava, V., de Araujo, A.S.F., Vaish, B. et al. (2016). Biological response of using municipal solid waste compost in agriculture as fertilizer supplement. Rev Environ Sci Biotechnol 15, 677–696 <https://doi.org/10.1007/s11157-016-9407-9>

[11] Chandrakant S. Karigar, Shwetha S. Rao, ( 2011) "Role of Microbial Enzymes in the Bioremediation of Pollutants: A Review", Enzyme Research, vol. 2011, Article ID 805187, 11 pages, 2011. <https://doi.org/10.4061/2011/805187>

[12] Mojumdar, A., Deka, J. Recycling agro-industrial waste to produce amylase and characterizing amylase–gold nanoparticle composite. Int J Recycl Org Waste Agricult 8 (Suppl 1), 263–269 (2019). <https://doi.org/10.1007/s40093-019-00298-4>

[13] Naik, B., Kumar, V., Rizwanuddin, S. et al. (2023). Agro-industrial waste: a cost-effective and eco-friendly substrate to produce amylase. Food Prod Process and Nutr 5, 30 (2023). <https://doi.org/10.1186/s43014-023-00143-2>

[14] Uguru, G. C., Akinyanju, J. A., & Sani, A. (1997). The use of yam peel for growth of locally isolated Aspergillus niger and amylase production. Enzyme and microbial technology, 21(1), 48-51.