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Article *in* Malaysian Journal of Microbiology · September 2017

DOI: 10.21161/mjm.94416

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Malaysian Journal of Microbiology, Vol 13(3) September 2017, pp. 172-179

Malaysian Journal of Microbiology
Published by Malaysian Society for Microbiology
(In SCOPUS since 2011)

Ability of endophytic fungi isolated from *Nepenthes ampullaria* to degrade polyurethane

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Received 21 September 2016; Received in revised form 31 October 2016; Accepted 8 December 2016

ABSTRACT

Aims: Waste electric and electronic equipment (WEEE) are among the fastest growing waste products worldwide and solutions to their remediation are urgently needed. Bioremediation is a green approach that is helpful to minimize environmental pollution associated with Electronic waste (E-waste). The present study aimed at exploring the potential of endophytic fungi from *Nepenthes ampullaria* for bioremediation purposes of the plastic component in E-waste, polyurethane (PUR) polymers.
Methodology and results: Endophytic fungal isolates were assessed for their ability to degrade PUR as well as their ability to utilise PUR as sole carbon source. Nine (9) out of 150 isolates demonstrated the ability to efficiently degrade polyurethane in solid medium and the top three (3) isolates were able to grow on PUR as the only carbon source. These three isolates were identified using ITS1 and ITS4 and found to be closely related to the genus *Pestalotiopsis*. The top two of the three isolates were then assessed for their esterase enzyme activity as well as changes in their proteome when grown with and without PUR. The highest enzymatic activity was found to be 1850.4 U/mL when tested using *p*-nitrophenol acetate as the substrate. Analyses of the 2-dimensional electrophoresis profile revealed changes in the abundance of proteins when treated with polyurethane.
Conclusion, significance and impact of study: This study is to our knowledge the first on endophytes isolated from *N. ampullaria* that can degrade PUR, and also their proteomes. Results obtained from this study can in the future help to reduce polyurethane wastes. Besides degrading PUR polymer, endophytic fungi produce potential valuable proteins that may find broad applications in bioremediation applications.

Keywords: Biodegradation, *Pestalotiopsis*, *Nepenthes*, polyurethane, proteome

INTRODUCTION

Waste electric and electronic equipment (WEEE) has been recognized by the European Union (EU) as one of the fastest growing waste streams in the region, with an estimation of up to 20 kg of WEEE per person being dumped every year (Darby and Obara, 2005); accounting for approximately 8% of the total solid waste in EU member countries (Wath *et al.*, 2010). It has been estimated that 20-50 million tons of E-waste are discarded annually with Asian countries accountable for around 12 million tons (Cobbing, 2008). The largest generator of E-waste in the world is the USA with a total accumulation of 3 million tons per year while China is the second largest, generating 2.3 million tons every year (Oliveira *et al.*, 2012).

Waste electric and electronic equipment is predominantly a mixture of metals and plastics. Plastics are lightweight and essential as an electric or thermal insulator. The portion of plastics in EEE has constantly increased from about 14% in 1980 to 18% in 1992, and 23% in 2005 (Buekens and Yang, 2014).

Resource depletion and litter problems have occurred due to the massive quantities of used PUR-containing equipment that are disposed in landfills and incinerators (Zheng *et al.*, 2005). Several studies have demonstrated that groundwater contamination can be caused by landfills accepting electronic devices or old landfills containing E-wastes (Yang, 1993; Schmidt, 2002). Pollutants have the potential to migrate within and around

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 ISSN (print): 1823-8262, ISSN (online): 2231-7538