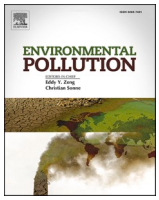
Environmental Pollution 364 (2025) 125330

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol



Shallow shotgun sequencing of healthcare waste reveals plastic-eating bacteria with broad-spectrum antibiotic resistance genes☆

Shing Wei Siew [a,d], Mohamad Hazwan Fikri Khairi [b], Norhisham Abdul Hamid [c], Mohd Fazli Farida Asras [d], Hajar Fauzan Ahmad [d,e,*]

[a] B-Crobes Laboratory Sdn. Bhd, 18 & 20, Lintasan Perajurit 17G, Taman Teknologi Industri & Perusahaan Ipoh, 31400, Ipoh, Perak, Malaysia
[b] Cancer Research Malaysia, Subang Jaya Medical Centre South Tower, 1, Jalan SS12/1A, Ss 12, 47500, Subang Jaya, Selangor, Malaysia
[c] Hazardous Substances Division, Department of Environment, Ministry of Natural Resources and Environmental Sustainability, 62574, Putrajaya, Malaysia
[d] Faculty of Industrial Sciences and Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, Lebuh Persiaran Tun Khalil Yaakob, 26300, Gambang, Pahang, Malaysia
[e] The Microbiome Lab (TML), Universiti Malaysia Pahang Al-Sultan Abdullah, Lebuh Persiaran Tun Khalil Yaakob, 26300, Gambang, Pahang, Malaysia

ARTICLE INFO

Keywords:
Metagenomics
Antimicrobial resistance
Carbapenem
Plastic degradation
Microplastics

ABSTRACT

The burgeoning crises of antimicrobial resistance and plastic pollution are converging in healthcare settings, presenting a complex challenge to global health. This study investigates the microbial populations in healthcare waste to understand the extent of antimicrobial resistance and the potential for plastic degradation by bacteria. Our metagenomic analysis, using both amplicon and shallow shotgun sequencing, provided a comprehensive view of the taxonomic diversity and functional capacity of the microbial consortia. The viable bacteria in healthcare waste samples were analyzed employing full-length 16S rRNA sequencing, revealing a diverse bacterial community dominated by *Firmicutes* and *Proteobacteria* phyla. Notably, *Proteus mirabilis* VFC3/3 and *Pseudomonas* sp. VFA2/3 were detected, while *Stenotrophomonas maltophilia* VFV3/2 surfaced as the predominant species, holding implications for the spread of hospital-acquired infections and antimicrobial resistance. Antibiotic susceptibility testing identified multidrug-resistant strains conferring antimicrobial genes, including the broad-spectrum antibiotic carbapenem, underscoring the critical need for improved waste management and infection control measures. Remarkably, we found genes linked to the breakdown of plastic that encoded for enzymes of the esterase, depolymerase, and oxidoreductase classes. This suggests that specific bacteria found in medical waste may be able to reduce the amount of plastic pollution that comes from biological and medical waste. The information is helpful in formulating strategies to counter the combined problems of environmental pollution and antibiotic resistance. This study emphasises the importance of monitoring microbial communities in hospital waste in order to influence waste management procedures and public health policy. The findings highlight the need for a multidisciplinary approach to mitigate the risks associated with antimicrobial resistance and plastic waste, especially in hospital settings where they intersect most acutely.

1. Introduction

Plastic pollution and antimicrobial resistance (AMR) are two interrelated issues that pose serious risks to human health and are at the centre of the increasingly complicated global health crisis (Cubas et al., 2023; Pham et al., 2021; Wang et al., 2023). The rapid spread of superbugs, and emergence of drug-resistant infection brought by pathogens caused by the AMR in clinically relevant microorganisms constitutes a major concern in both hospital and environmental settings (Bañuls et al., 2018; Magnano San Lio et al., 2023; Murray et al., 2022). Hence, the microplastic-antibiotic resistance has been reported as a new threat to public health, particularly with the increased disposal of plastics in healthcare waste (HCW) (Piergiacomo et al., 2022; Tuvo et al., 2023). The use of single-use plastics in hospital treatment is

☆ This paper has been recommended for acceptance by Meththika Vithanage.

* Corresponding author. Faculty of Industrial Sciences and Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, Lebuh Persiaran Tun Khalil Yaakob, 26300, Gambang, Pahang, Malaysia.
E-mail addresses: shingwei999@gmail.com (S.W. Siew), hazwanfikri0505@gmail.com (M.H.F. Khairi), nhh@doe.gov.my (N.A. Hamid), mohdfazli@umpsa.edu.my (M.F.F. Asras), fauzanahmad@umpsa.edu.my (H.F. Ahmad).

https://doi.org/10.1016/j.envpol.2024.125330
Received 30 June 2024; Received in revised form 17 October 2024; Accepted 15 November 2024
Available online 16 November 2024
0269-7491/© 2024 Elsevier Ltd. All rights are reserved, including those for text and data mining, AI training, and similar technologies.