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Evaluation of the Deterioration of Untreated Commercial Polystyrene by Psychrotrophic Antarctic Bacterium

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Abstract: Polystyrene (PS) and microplastic production pose persistent threats to the ecosystem. Even the pristine Antarctic, which is widely believed to be pollution-free, was also affected by the presence of microplastics. Therefore, it is important to comprehend the extent to which biological agents such as bacteria utilise PS microplastics as a carbon source. In this study, four soil bacteria from Greenwich Island, Antarctica, were isolated. A preliminary screening of the isolates for PS microplastics utilisation in the Bushnell Haas broth was conducted with the shake-flask method. The isolate AYDL1 identified as *Brevundimonas* sp. was found to be the most efficient in utilising PS microplastics. An assay on PS microplastics utilisation showed that the strain AYDL1 tolerated PS microplastics well under prolonged exposure with a weight loss percentage of 19.3% after the first interval (10 days of incubation). Infrared spectroscopy showed that the bacteria altered the chemical structure of PS while a deformation of the surface morphology of PS microplastics was observed via scanning electron microscopy after being incubated for 40 days. The obtained results may essentially indicate the utilisation of liable polymer additives or "leachates" and thus, validate the mechanistic approach for a typical initiation process of PS microplastics biodeterioration by the bacteria (AYDL1)—the biotic process.

Keywords: polystyrene microplastics utilisation; weight loss; additives; Antarctic soil; *Brevundimonas* sp.

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1. Introduction

Various plastics have been manufactured, marketed, and used since the 1950s as their functional features facilitate many human activities. Plastic is commonly described as a lightweight, inexpensive, durable, and robust material that is practical and easy to mould into any shape [1]. According to Chen et al. [2], plastic production hit 359 million tonnes (Mt) in 2018 and is projected to reach beyond 800 Mt by 2040. The significant growth of plastic usage and low recycling rate increases the plastic waste accumulation in the environment, thus causing plastic waste to be a global issue [3].

Plastics can break down abiotically into microplastics when exposed to high temperatures, ultraviolet light, and natural mechanical forces [4]. These processes are usually the initiators in plastic degradation such as cracking, cleavage, or oxidation of the chemical bonds create smaller particles, known as microplastics with a larger surface area and higher hydrophilicity that enhance microbial activity [3]. On the other hand, the biotic process of plastic degradation involves microorganisms such as bacteria, fungi, and algae to interact and alter the properties of polymers [5].