PSM Journals

PSM
Microbiology

Editorial 2026 | Volume 11 | Issue 1 | 76-78

Open Access

Article Information

Published: May 30, 2026

Authors' Contribution

MK designed the study, wrote and revised the paper.

Citation

Karuppasamy, M., 2026. Cellulase Enzymes in *Eudrilus eugeniae* Vermiwash: Sustainable Alternatives for Biotechnological Applications. PSM Microbiol., 11(1): 76-78.

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Cellulase Enzymes in *Eudrilus eugeniae* Vermiwash: Sustainable Alternatives for Biotechnological Applications

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Abstract:
No abstract is available.

INTRODUCTION

Cellulose enzyme (Cellulase) is well known to break down cellulose into simpler glucose units and has been quite extensively used for various industrial applications such as the production of biofuel, textile processing, and detergents manufacturing (Bhardwaj *et al.*, 2021; Imran *et al.*, 2019; Imran *et al.*, 2016; Iqbal *et al.*, 2011). Cellulolytic enzymes, apart from these, are also used in various other industrial applications such as the enhancement of digestibility of various feedstuffs, fruit juice processing, and baking (Ranjan *et al.*, 2023; Rodrigues and Odaneth, 2021).

Moreover, the applicability of cellulases can be expanded to various sectors since the cellulases have the ability to de-ink paper (AL-Sa'ady *et al.*, 2024). While cellulase production has numerous applications, finding new and cheaper sources as well as efficient production methods is still a big challenge (Afe *et al.*, 2023). An alternative to this is vermiwash, which is a liquid extract from vermicomposting processes and has proven to be a potential source of various beneficial soil microbes and active enzymes, including cellulose (Nandy *et al.*, 2021; Saha *et al.*, 2025). This liquid metabolite, which is produced as a byproduct, is enhanced by the action of microbes and earthworms and is an eco-friendly and sustainable solution for enzyme recovery (Kadam and Pathade, 2017).

In particular, the earthworms (*Eudrilus eugeniae*) have a diversified cellulolytic microbial consortium in their gut, which makes an important contribution to the enzymatic profile of vermiwash (Kadam and Pathade, 2017; Karthika *et al.*, 2020). This biological improvement in vermiwash provides a possibility to utilize natural cellulases in the vermiwash, thereby minimizing the use of microbial fermentation route for the production of cellulase, which is comparatively costly (Karthika *et al.*, 2020).

Identification and characterization of such enzymes in vermiwash can prove to be promising sustainable alternatives for several biotechnological applications. Furthermore, specific cellulase components or enzymes, including endoglucanases and exoglucanases, need to be understood, since complex substrates such as filter paper require full hydrolysis of the substrate by the synergistic action of various cellulases (Dey *et al.*, 2018).

It can be argued that future research should focus on detailed quantitative studies of particular enzyme activity, like cellulases in vermiwash of *Eudrilus eugeniae* under the different dietary conditions, so as to derive a detailed insight into the industrial applicability of the vermiwash. Furthermore, the study of *Eudrilus eugeniae* gut microbiome at the genome and proteome level may lead to a better understanding of the enzymatic pathways in cellulose degradation and the discovery of new enzymes of interest for industry. Such research can also help understand the earthworm-microbe cooperation in degrading organic matter and provide a blueprint for the creation of optimized bioprocesses for waste management and the production of biofertilizers (Dey *et al.*, 2018).

CONFLICT OF INTEREST

The author declares that this article content has no conflict of interest.

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