

The Influence of Microbial Communities, Environmental Factors and Structures In Biodegradation of Tannins in Soil

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Background: Tannin are polyphenols that come from plants and affect soil microorganism and the way nutrients move through the soil. They may either inhibit or initiate microbial activity change the structure of the soil. Some microbes, like bacteria, fungi, and yeast can breakdown tannins. There is still not a lot of research on microbial communities, enzymes, environmental factors, and tannin structure that are crucial to biodegradation.

Methods: This systematic review, including studies from 2012 to 2025, aimed to assess the influences of microbial communities, environmental variables and tannin structures on the biodegradation of tannins in soil. The databases examined were Scopus, Web of Science, and Pubmed, using the search keyword “Biodegradation AND Tannins AND Soil”, resulting in cumulative total of 328 items (Scopus:82, WOS: 36, PubMed:210). Titles and abstracts were looked over, and 211 titles and 65 summarizes were thrown out. After getting rid of duplicates, the factors for inclusion like language, document type and important release years found 31 articles. After quality check, 15 studies were selected for review.

Results: This study found number of different fungi (*Aspergillus*, *Penicillium*, DSEs) and bacteria (*Bacillus haynesii*, *Enterobacter hormaechei*, *Pseudomonas* spp.) that break down tannins. Microorganisms can break down simple, ester-linked phenolic acids in hydrolysable tannins more easily than they can break down complex, carbon-carbon bond polymers in condensed tannins. The optimal temperature for tannin biodegradation is between 25 to 37 degrees Celcius, with aerobic conditions, a slightly acidic pH, the right type of soil, and metal ions like manganese. On the other hand, extreme heat, anoxic conditions, and metals that stop it, like zinc, slow it down.

Conclusion: In conclusion, 15 studies on soil tannin biodegradation, emphasizing the function of microorganism, tannin structure, and environmental variables. It emphasises future research in microbial genetics, anaerobic conditions, and practical bioremediation applications with the objective of harnessing microbial degradation for long-term soil restoration and industrial waste management.

Keywords: Biodegradation, Tannins, Soil

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