The Soil Re-Union
Science for Healthy Soils

4th International and
16th National Congress
of the Serbian Society
of Soil Science

Serbian
Society of
Soil Science

THE BOOK OF ABSTRACTS

Vrdnik, Fruške Terme, Serbia,
20-23. October 2025

Congress Organizer: Serbian Society of Soil Science
Co-organization: Institute of Field and Vegetable Crops,
National Institute of the Republic of Serbia

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4th International and 16th National Congress of the Serbian Society of Soil Science: “The Soil Re-Union: Science for Healthy Soils”
20-23 October 2025, Fruške terme, Vrdnik, Serbia
Congress Organizer: Serbian Society of Soil Science
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Publisher: Serbian Society of Soil Science, Nemanjina 6, 11080 Beograd – Zemun https://sdpz.rs/
For publisher: Jovica Vasin, President of the Serbian Society of Soil Science
Editors: Jordana Ninkov, Jovica Vasin and Snežana Jakšić
Design and technical preparation: Kitchen&GoodWolf

CIP - Каталогизација у публикацији
Библиотеке Матице српске, Нови Сад

631.4(048.3)

INTERNATIONAL Congress of the Serbian Society of Soil Science (4 ; 2025 ; Vrdnik)
The book of abstracts [Elektronski izvor] / 4th International and 16th National Congress of the Serbian Society of Soil Science "The Soil Re-Union: Science for Healthy Soils", 20-23 October 2025, Fruške terme, Vrdnik, Serbia ; [editors Jordana Ninkov, Jovica Vasin and Snežana Jakšić]. -
Belgrade : Serbian Society of Soil Science, 2025

Način pristupa (URL): https://fiver.ifvcns.rs/handle/123456789/5680. - Opis zasnovan na stanju na dan 15.10.2025.

ISBN 978-86-80417-99-8

1. National Congress of the Serbian Society of Soil Science (16 ; 2025 ; Vrdnik)
a) Педологија -- Апстракти

COBISS.SR-ID 177872649

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Original scientific paper
Poster presentation

FROM WASTE TO FERTILE SOIL: BIOREMEDIATION AND HUMIC ACID SYNTHESIS AS AN INDICATOR OF REVITALIZATION

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ABSTRACT

Soil is a key component of terrestrial ecosystems, and its fertility strongly depends on the quantity and quality of organic matter. Humic acids represent one of the most stable fractions of soil organic matter and serve as an important indicator of soil fertility and long-term ecological sustainability. In recent years, the valorization of waste materials through bioremediation has attracted growing attention as a strategy to address both environmental pollution and soil degradation. Bioremediation processes not only enable the detoxification and mineralization of organic pollutants, but also contribute to the transformation of waste-derived substrates into humic substances.

This study discusses the potential of bioremediation in converting industrial and organic waste streams from the petrochemical industry into value-added products, focusing on the generation of humic acids. The formation and accumulation of humic acids during biodegradation reflect the stabilization of organic matter, improved soil quality, and serve as measurable markers of soil revitalization. Moreover, the ratio of humic to fulvic acids provides insights into soil organic matter composition, with a lower ratio indicating reduced aromaticity and greater similarity to fulvic acids. These parameters also serve as indicators of soil fertility, as higher levels of humification are associated with enhanced nutrient retention, increased cation exchange capacity, improved water-holding properties, and overall biological functionality of soils. To determine the optical density of a sample containing humic and fulvic acids, the E4/E6 ratio (absorbance ratio at 465 and 665 nm) is used (Table 1). This ratio increases as the average molecular weight of the sample decreases, which means that a higher E4/E6 value indicates a greater presence of fulvic acids relative to humic acids.

Table 1: Humic acid content and E4/E6 ratio

Duration of Bioremediation [days]	**Humic Acid Content** [%]	**E_{465} (E4)**	**E_{665} (E6)**	**E4 / E6**
0	1.92	0.370	0.172	2.15
30	2.08	0.378	0.171	2.21
60	2.30	0.389	0.169	2.30
75	2.62	0.403	0.166	2.43
135	2.72	0.437	0.159	2.75
165	2.83	0.595	0.154	3.86

We conclude that the results indicate that prolonged bioremediation leads to an increase in both humic acid content and the E4/E6 ratio. This suggests that extended treatment not only enhances the accumulation of humic substances, improving soil organic matter stabilization, but also shifts the chemical composition toward a lower proportion of fulvic acids relative to humic acids. Therefore, monitoring these parameters can serve as a reliable indicator of the progress and effectiveness of bioremediation, as well as the improvement of soil quality and fertility.

Key words: bioremediation, humic acids, fulvic acids, waste valorization

ACKNOWLEDGMENT

This work was carried out in accordance with the United Nations universal strategy (Agenda 2030) and is linked to UN Sustainable Development Goal 9. It has been financially supported by the Ministry of Science, Technological Development and Innovation of Republic of Serbia (Contract Nos: 451-03-136/2025-03/200026 and 451-03-136/2025-03/ 200168).

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