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Notice for the PhD Viva-Voce Examination

Ms Rashmi R, Registration Number: 1981702, PhD Scholar at the Department of Life Sciences, School of Sciences, CHRIST (Deemed to be University), Bangalore will defend her PhD thesis at the public viva-voce examination on Friday, 31 October 2025 at 11.30 am in Room No. 044, Ground Floor, R & D Block, CHRIST (Deemed to be University), Bengaluru – 560029, Karnataka, India.

Title of the Thesis : **Effect of Heavy Metals on Growth and Production of Rosmarinic Acid and Stevioside from *Salvia officinalis* L. and *Stevia rebaudiana* (Bertoni) Bertoni.**

Discipline : **Botany**

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The members of the Research Advisory Committee of the Scholar, the faculty members of the Department and the School, interested experts and research scholars of all the branches of research are cordially invited to attend this open viva-voce examination.

Registrar (Academics)

Place: Bengaluru
Date: 15 October 2025

ABSTRACT

Heavy metal pollution is a growing concern in the current scenario of industrialization and globalization. Heavy metals cause detrimental effects on humans, inducing damage to vital organs as well as acting as potent carcinogens. Consuming herbal medicines can pose a risk of heavy metal poisoning, as these plants may become contaminated from the soil or water having toxic metals during growth. Previous research supports that the exposure of heavy metals results in the quality and quantity of secondary metabolites and other biochemical parameters, along with the growth and development. In light of this, the present study examines how the growth, biochemical parameters, and secondary metabolite biosynthesis of two medicinal plants, Salvia officinalis and Stevia rebaudiana, are affected by different concentrations of cadmium (Cd) (0-200 ppm), lead (Pb) (0- 1000 ppm), chromium (Cr) (0-100 ppm), and mercury (Hg) (0-50 ppm). The results show that both plants exhibit different but overlapping stress responses, with differences depending on the type, concentration, and length of exposure of the metal.

Although Stevia rebaudiana failed to thrive in soil treated with mercury, it was able to withstand Cd, Pb, and Cr for up to 14 days. In contrast, Salvia officinalis shown tolerance for up to 90 days. Except for a minor improvement under low Cr, heavy metal exposure decreased sage's vegetative growth. Stevia showed a notable loss in growth, with Cr leading to the largest decrease in chlorophyll. Chlorophyll levels decreased in both plants, particularly in Stevia under Cr and in Salvia under Cr and Hg. Carbohydrate levels in Salvia decreased with Cd and Pb but initially rose with Hg and Cr, then declined at higher concentrations, similar to Stevia. Protein levels dropped consistently in both plants. Proline and MDA, two indicators of oxidative stress, spiked signifying cellular damage and stress reactions. In Salvia, the phenolic content increased, whereas the flavonoid level first increased and then decreased over the course of 90 days at greater concentrations. Stevia displayed a comparable pattern. Metal-dependent variations in antioxidant enzyme activity were observed: SOD increased with Pb and Cr in Salvia but decreased with extended exposure to Cd and Hg. After 90 days, APX decreased in Salvia but rose in both plants. Catalase rose initially but dropped with extended stress. With extended exposure, non-enzymatic antioxidants (DPPH, TAC, and reducing power) decreased after initially rising.

Roots accumulated more metal over time and with greater concentration than stems and leaves. Rosmarinic acid in Salvia under stress reduced, with the exception of minor increases with low Cr and Pb, indicating an impact on secondary metabolites. Stevioside in Stevia first increased when Cr was low, but at increasing levels it drastically decreased, with Cd being the most detrimental. These findings shed light on the adaptive mechanisms of Sage and Stevia under heavy metal stress and emphasize the need to create strategies to reduce metal toxicity in medicinal plant cultivation as well as the requirement for quality checks for heavy metals for their medicinal use.

Keywords: *Salvia officinalis, Stevia rebaudiana, heavy metal stress, stevioside, rosmarinic acid, secondary metabolites*

Publications:

1. **R. Ramakrishnan** and P. Nagella, “Salvia officinalis L. resilience under chromium stress: An integrated study of growth, physiology, biochemical changes and rosmarinic acid production,” Plant Sci. Today, vol. 11, no. 4, 2024. Doi: 10.14719/pst.3258.
2. **R. Ramakrishnan** and P. Nagella, “The accumulation, antioxidant defences, and secondary metabolite production in common sage (Salvia officinalis L.) under lead toxicity,” Med. Plants, vol. 16, no. 3, pp. 519–532, 2024. https://doi.org/10.5958/0975-6892.2024.00053.9.