

Profiling of metabolites and minerals from black ginger and blue turmeric rhizomes by gas chromatography–mass spectrometry analysis and their biopotentials

Abstract

This study focuses on analyzing the rhizomes of two ginger varieties and four turmeric varieties to explore their phytochemical profiles using GC–MS analysis, determine minerals and mineral oxides content by XRD and ICP-OES, identify functional groups using FTIR, and evaluate antioxidant activities. Polarity-based organic solvents were employed to extract major metabolites from rhizomes. A total of 21 and 66 bioactive compounds were detected in ginger and turmeric varieties, respectively, in all three solvents used for extraction. The ICP-OES revealed 5.908 mg/kg of calcium in the rhizomes of black ginger (BG) and blue turmeric (BT) in mineral quantification. Flame photometer analysis indicated high sodium in the BG rhizome and higher potassium content in the BT rhizome. XRD analysis of black turmeric revealed the presence of ciclopirox olamine monohydrate, known for its antifungal activity, while BG showed the presence of a complex containing N-(4-Nitrophenyl)-3-(4-methoxyphenyl)-2-propenimine. FTIR reported the presence of alkyl halides and aromatic functional groups in BG and BT. Higher starch content was quantified in blue turmeric rhizomes. Furthermore, the methanolic extract of rhizomes exhibited the highest antioxidant activity among all assays tested, particularly in black ginger and blue turmeric varieties. Thus, diverse chemical and structural characteristics of rhizomes varieties provide valuable insights on stress-induced metabolite production in medicinal plants, emphasizing that stressors can amplify bioactive compounds synthesis and enhance therapeutic properties.

Keywords

Antioxidant; Black ginger; Blue turmeric; Mineral nutrients; Rhizomes