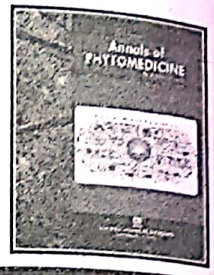
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Review Article : Open Access

The phenylpropanoid network in pearl millet: Antioxidant functions and biological roles of polyphenols

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Abstract

Pearl millet (*Pennisetum glaucum* (L.) R. Br.) is a resilient, nutrient-dense cereal increasingly recognized for its rich polyphenolic composition and potent antioxidant potential, yet current knowledge remains scattered across biochemical, nutritional, and functional studies. This review consolidates advances published between 2010 and 2025, identified through structured searches of Web of Science, Scopus, PubMed, and Google Scholar using targeted keywords related to millet polyphenols, antioxidant activity, and functional foods. It integrates present understanding of composition, biosynthesis, analytical characterization, and biological relevance of pearl millet polyphenols, highlighting their role in oxidative stress modulation and health promotion. The dominant compounds include phenolic acids (ferulic, caffeic, pcoumaric) and flavonoids (tricin, luteolin, quercetin) derived from the phenylpropanoid pathway regulated by PAL, C4H, and CHS enzymes. Ethanol based extraction combined with UPLC QTOF MS profiling enhances recovery and structural identification of these metabolites. Functionally, pearl millet polyphenols operate through hydrogen atom transfer, single electron transfer, and metal chelating mechanisms, activate Nrf2 ARE signalling, and inhibit pro oxidant enzymes, producing strong radical scavenging, DNA protective, and membrane stabilizing effects linked to antidiabetic, cardioprotective, anti-inflammatory, and gut modulatory benefits. By unifying molecular and functional perspectives, this review establishes a framework for standardized research and supports the development of pearl millet as a sustainable nutraceutical and phytomedicine resource.

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