

Synergistic Cytoprotective and Antioxidant Potential of a Probiotic-Prebiotic Formulation Enriched with *Withania somnifera* and *Elaeocarpus ganitrus* Against Oxidative Stress in Intestinal Epithelial Cells: An in Vitro Approach

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Abstract

Oxidative stress is a central driver of gastrointestinal epithelial dysfunction and a key contributor to chronic intestinal disorders. The present in vitro study evaluates the cytoprotective and antioxidant efficacy of a novel formulation combining probiotics (*Lactobacillus acidophilus*, *L. rhamnosus*, *L. plantarum*, *Bifidobacterium longum*), a prebiotic (inulin), Ashwagandha (*Withania somnifera*) root extract, and Rudraksha (*Elaeocarpus ganitrus*) extract against hydrogen peroxide (H₂O₂)-induced oxidative stress in Vero intestinal cell lines. Cell viability was assessed by MTT assay, antioxidant potential by DPPH radical scavenging assay, intracellular reactive oxygen species (ROS) by DCFH-DA fluorescence, and cellular morphology by inverted microscopy. The combined formulation demonstrated significantly superior cell viability ($93.2 \pm 1.7\%$ at 48 hrs), the lowest IC₅₀ ($41.6 \pm 1.0 \mu\text{g/mL}$), and maximum ROS reduction (59.4%) compared to individual components ($p < 0.001$). Microscopic analysis confirmed near-normal cellular morphology in the combined group. These results validate the synergistic interaction among probiotics, prebiotics, and herbal bioactives, providing a scientific foundation for developing integrated nutraceutical formulations targeting intestinal health.

Keywords

Probiotics, *Withania somnifera*, *Elaeocarpus ganitrus*, Oxidative stress, MTT assay, DPPH, ROS, Vero cells, Synergistic effect, Nutraceuticals.