Human Gut Microbes, the Natural Bio Degraders of Allura Red

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ABSTRACT

Introduction: Food additives and preservatives are foreign to the human body and for the natural environment. Artificial colorants, derived from petroleum or crude oil, are xenobiotic in nature and are widely used in the different textile, pharmaceutical, cosmetic, paper, and food industries. Azo dyes are synthetic dyes that are highly stable, water-soluble aromatic compounds, and almost 65% of them are used as food colorants. The Allura Red, a member of this group is commonly used as a food colorant frequently present in candies, ice lollies, soft drinks, fruit juices, cakes, and sweets, attracting persons of all ages especially children due to its attractive bright red color. Apart from food products, it is also used in cosmetic and pharmaceutical industries. Consumption of foods containing synthetic dyes can interact with the intestinal microbial flora. Previous research indicate that intestinal bacteria possess azoreductase enzymes that catalyze the cleavage of azo bonds (-N=N-), converting dyes into colorless aromatic amines. These amines may undergo hydroxylation or acetylation, potentially increasing their carcinogenicity. Extreme use of these dyes has been associated with allergies, gastritis, behavioral problems, and increased hyperactivity in children.

Objective: The main aimed of this research is to evaluate the potential of intestinal bacteria to degrade the food azo dye Allura Red. The objectives included identifying bacterial isolates capable of dye decolorization and determining the degradation products using spectroscopic techniques.

Methodology: Initially intestinal bacterial strains were obtained from the culture bank of Department of Microbiology, Jinnah University for Women. After that isolated cultures were purified and identified through conventional morphological, cultural, and biochemical methods. Molecular characterization was performed using universal 16S rRNA gene sequencing. Screening of bacterial isolates for Allura Red decolorization was carried out under different physicochemical conditions i.e. pH, temperature, glucose concentration, and dye concentration, using UV-Visible spectroscopy. The degraded products were further analyzed using Fourier Transform Infrared (FT-IR) spectroscopy.

Key Findings:

1. The study assessed the capacity of gut microbiota to degrade the azo dye Allura Red.
2. The bacterial isolates *Escherichia coli*, *Pseudomonas aeruginosa*, and *Enterococcus faecalis* were identified and confirmed through both conventional and molecular methods, including 16S rRNA gene analysis.
3. Dye degradation kinetics revealed that all bacterial isolates were capable of degrading Allura Red within 24 hours of incubation. Maximum decolorization occurred at 37°C, pH 7–8, and in the presence of glucose.
4. Higher concentrations of dye negatively affected bacterial growth. The FT-IR analysis of degraded products showed disappearance of characteristic peaks present in undegraded dye, confirming structural breakdown of Allura Red.

Conclusion: Present research highlights the potential of human gut bacteria to interact with and degrade food azo dyes through enzymatic pathways. However, high concentrations of such dyes can be toxic to bacterial species, potentially disrupting gut microbial balance. The persistence of these dyes in the body at elevated concentrations may pose toxicity risks to humans.

Keywords: Allura Red, Toxicity, Gut Bacteria.

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