

Safety Assessment and Health Risk Associated with the Use of Hair Dyes: Chemical Compositions, Toxicities, and Safer Alternatives

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Abstract

Since ancient Egypt, hair coloring has been a common technique. At first, people's usage of hair color was limited to covering up their white and gray hair. The most often used type of dyes is permanent ones, which include ingredients such as hydrogen peroxide, p-phenylenediamine (PPD), and ammonia. Although these chemicals have been connected to several unfavorable health effects, they can penetrate the hair shaft to produce a color that lasts longer. Hair dye allergies, especially those involving PPD, have a well-established history and can manifest as anything from minor skin irritation to life-threatening. The objective of this study is to assess the safety concerns associated with hair dyes and their potential health risks. The review specifically aims to identify the chemical composition of commonly used hair dyes, evaluate their toxicological effects, and suggest safer alternatives. A systematic search of databases including PubMed, Scopus, and Google Scholar was conducted, focusing on peer-reviewed articles. Studies were selected based on their relevance to hair dye safety, toxicology, and regulatory issues. Data on adverse effects, toxicity levels, and safety profiles were extracted and compared. The results indicate significant health risks associated with certain heavy metals in hair dyes, particularly in darker shades, with some products exceeding safe limits. The findings highlight the need for safer formulations and best practices for hair dye application. Limitations include a lack of comprehensive geographical coverage and a need for long-term studies to fully understand chronic exposure risks.

Keywords: *Adverse reactions, Contact dermatitis, Hair colourants, Hair dye, Para-phenylenediamine, Patch test*