Visual Detection of Skin-Sensitizing Chemicals Using Gold Nanoparticles

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Background

Allergic contact dermatitis (ACD) is a common skin condition caused by exposure to skin-sensitizing chemicals (SSCs). Although traditional animal testing for skin sensitization is reliable, it raises ethical concerns and has been banned in the European Union. Current non-animal testing methods, such as the direct peptide reactivity assay (DPRA), are effective but require expensive equipment and specialized expertise, limiting their widespread use. Gold nanoparticles (AuNPs) have emerged as a promising alternative for simple and cost-effective colorimetric detection of various analytes, utilizing their unique optical properties.

Methods

In this study, we developed a novel platform using AuNPs for the detection of SSCs. This method takes advantage of the electrophilic nature of SSCs and the optical properties of AuNPs. We functionalized AuNPs with cysteine, lysine, and peptides, enabling them to react with SSCs. This reaction causes cross-linking of the AuNPs, resulting in a color change from red to purple, indicating the presence of SSCs. The dispersed 13 nm AuNPs initially appear red, while aggregation due to SSC interaction turns them purple. This platform provides a low-cost, user-friendly alternative for SSC detection, enhancing accessibility and reducing reliance on animal testing.

Results and Discussion

The developed AuNP-based platform successfully detected 8 common SSCs, categorized into 5 levels of sensitizing power: extreme, strong, moderate, weak, and non-sensitizer (Figure 1). The method demonstrated a clear correlation between the degree of color change and the concentration of SSCs, effectively reflecting their sensitizing potential. Notably, more hazardous SSCs induced a visible color change of the AuNPs solution at lower concentrations, highlighting the platform's sensitivity and reliability.

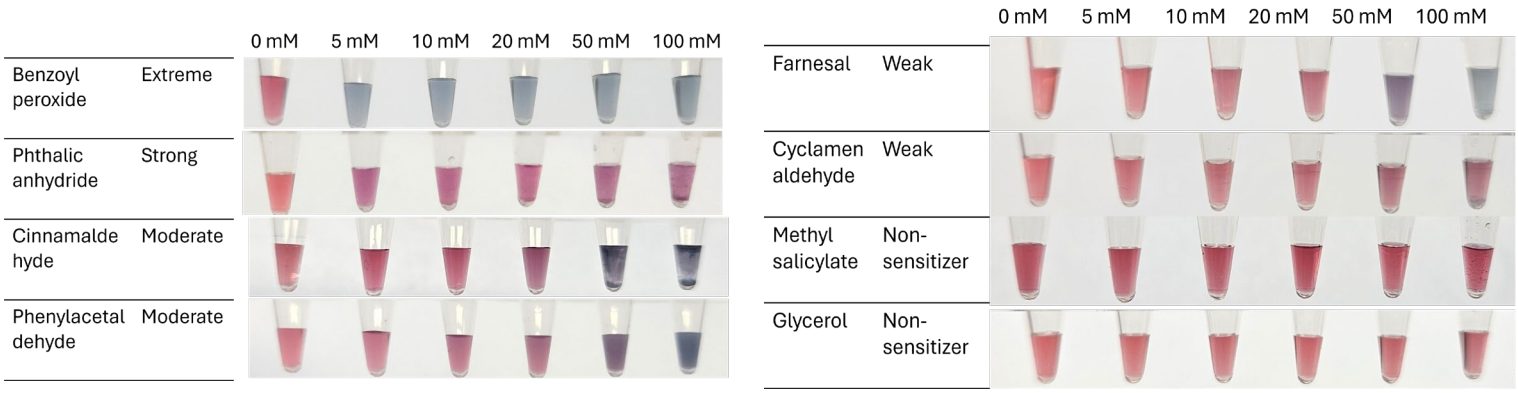

Figure 1. *Detection of 8 sensitizers with 8 nM Cys-AuNPs.*

Conclusion and Impact

The method demonstrated a clear correlation between the degree of color change of AuNPs and the concentration of SSCs, effectively reflecting their sensitizing potential. Notably, more hazardous SSCs induced a visible color change of the AuNPs solution at lower concentrations, highlighting the platform's sensitivity and reliability. This colorimetric response was consistent and easily observable, confirming the method's practicality for ACD risk assessment. By simplifying allergen testing, this approach enhances public accessibility and supports the transition away from animal testing.