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A rapid non-invasive capacitive platform for *in vitro* assessment of insecticide-induced skin corrosion

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Abstract

This study introduces a rapid, non-invasive, and highly sensitive method for evaluating skin corrosion. The platform combines a capacitive sensor with a screen-printed electrode coated in a skin-mimetic layer, allowing real-time monitoring of capacitance changes in surrogate skin before and after exposure to corrosive agents such as agricultural insecticides. The biomimetic coating, formulated from hexane, ethanol, and lanolin, reproduces the lipid composition of the human stratum corneum. Across a broad range of insecticide concentrations, the recorded capacitance shifts accurately reflect the progression of corrosion. Thanks to its low cost and high reproducibility, this system offers a practical alternative that could partially replace the animal models still employed in conventional *in vitro* corrosion assays.

Keywords: Capacitive sensing, skin corrosion, biomimetic stratum corneum, agricultural insecticides.

INTRODUCTION

The skin is often exposed to pesticides during agricultural activities, leading to risks of erythema, peeling, and deep tissue injury. Traditional corrosion assessments depend on animal models such as rabbit skin tests, which are costly and ethically problematic (OECD, 2021). Recent advances combine biomimetic skin surrogates with capacitive sensing, providing rapid and non-invasive detection (Cheng et al., 2025). This study develops a lanolin-based artificial skin platform integrated with a capacitive sensor to enable real-time monitoring of pesticide-induced corrosion, offering an ethical and efficient alternative for agrochemical safety evaluation.

MATERIALS AND METHODS

A lanolin-based biomimetic skin solution was prepared using a hexane–ethanol solvent system to reproduce the lipid characteristics of the human stratum corneum. The solution was stored in small vials for experiments. A custom capacitive sensing system with screen-printed electrodes (SPEs) was calibrated before use to ensure stability. During testing, electrodes were first exposed to the biomimetic solution to establish a baseline, after which pesticide samples were applied. Capacitance changes were continuously recorded to assess the corrosive effects of the chemicals on the surrogate skin layer.

RESULTS & DISCUSSION

The results showed that capacitance values increased markedly after pesticide exposure, with higher concentrations producing stronger responses (as Fig. 1 shown). This indicated that pesticides induced clear damage to the biomimetic skin layer and that corrosion severity rose with concentration. Despite some variability, the separation among treatments remained distinct, demonstrating good sensitivity and reproducibility. Overall, the study confirmed that the capacitive sensor combined with a lanolin-based surrogate skin effectively differentiated corrosion levels and provided a rapid and stable platform for pesticide safety evaluation.

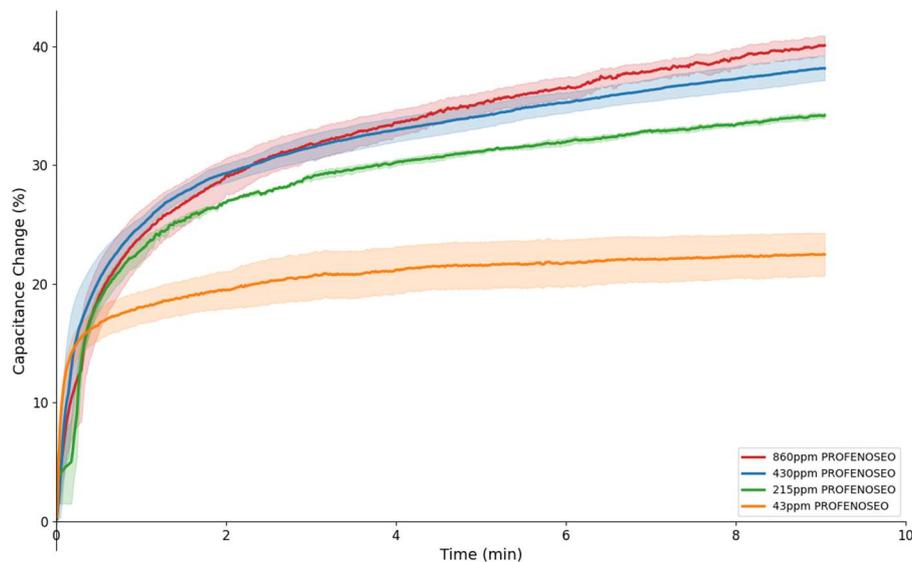


Fig. 1. Capacitance responses of the biomimetic skin platform after pesticide exposure.

CONCLUSIONS

The capacitive sensor combined with a biomimetic skin layer successfully differentiated pesticide-induced corrosion at different concentrations. The method proved rapid, non-invasive, sensitive, and reproducible, offering a practical and ethical alternative to animal-based assays for pesticide safety evaluation.

REFERENCES

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