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Toward sustainable food safety: Natural ligand-gold nanoparticle plasmonic sensors for on-site mycotoxin detection

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Volume: 516

DOI: 10.1016/j.foodchem.2026.149295

Article Number 149295

Published JUL 1 2026

Indexed	2026-05-09
Document Type	Review
Abstract	Mycotoxins remain a critical challenge to food safety, with limitations in conventional methods driving demand for rapid, portable alternatives. Gold nanoparticle (AuNP)-based sensors, exploiting localized surface plasmon resonance (LSPR) and surface-enhanced Raman scattering (SERS), offer rapid and highly sensitive detection, typically achieving detection limits in the low ppb ($\mu\text{g/kg}$) to ng/mL range, with performance in food matrices further improved through suitable ligand functionalization and optimized assay design. This review highlights recent advances in the use of natural ligands to design sustainable plasmonic nanosensors for on-site mycotoxin detection. Moreover, natural ligands, such as polyphenols, flavonoids, and organic acids, enable green synthesis while enhancing selectivity and biocompatibility. We discuss structure-function relationships at the ligand-AuNP interface, linking functional groups (hydroxyl, carbonyl, and carboxyl) to stability and specificity. Case studies illustrate improvements in detection limits and applicability in food matrices. Recent trends point toward dual-ligand systems, portable paper-based devices, smartphone integration, and IoT/blockchain-enabled monitoring. Challenges such as reproducibility, standardization, and regulatory approval are considered, alongside opportunities for digital integration and global-scale food safety networks. This review positions metabolite-functionalized plasmonic sensors as a sustainable, next-generation trend in food safety surveillance.
Keywords	Author Keywords: Natural ligands; Plasmonic nanosensors; Gold nanoparticles; Mycotoxins; LSPR Keywords Plus: DRUG-DELIVERY; OPTIMIZATION; AGGREGATION; OCHRATOXIN; RESONANCE
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Categories/Classification

Research Areas: Chemistry; Food Science & Technology; Nutrition & Dietetics

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1.82

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Citation
Indicator™
(2025)

ISSN 0308-8146

eISSN 1873-7072

Current
Publisher ELSEVIER SCI LTD, 125 London Wall, London EC2Y
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