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

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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 (μg/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. © 2026 Elsevier Ltd.

Author keywords

Gold nanoparticles; LSPR; Mycotoxins; Natural ligands; Plasmonic nanosensors

Indexed keywords

MeSH

Biosensing Techniques; Food Contamination; Food Safety; Gold; Humans; Ligands; Metal Nanoparticles; Mycotoxins; Spectrum Analysis, Raman; Surface Plasmon Resonance

Engineering controlled terms

Digital integrated circuits; Error detection; Fiber optic sensors; Food safety; Functional food; Ligands; Metabolites; Metal nanoparticles; Mycotoxins; Nanosensors; Plasmonic nanoparticles; Plasmonics; Raman scattering; Safety engineering; Surface plasmon resonance; Surface scattering

EMTREE drug terms

gold; ligand; metal nanoparticle; mycotoxin

Engineering uncontrolled terms

Detection limits; Food-safety; Gold nanoparticle; Gold Nanoparticles; Localized surface plasmon resonance; Mycotoxin detections; Natural ligands; Plasmonic nanosensor; Plasmonic sensors; Plasmonics

EMTREE medical terms

chemistry; devices; food contamination; food safety; genetic procedures; human; procedures; Raman spectrometry; surface plasmon resonance

Engineering main heading

Gold nanoparticles

Chemicals and CAS Registry Numbers

Unique identifiers assigned by the Chemical Abstracts Service (CAS) to ensure accurate identification and tracking of chemicals across scientific literature.

gold	7440-57-5
Gold	
Ligands	
Mycotoxins	

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