**Supplementary Table 2: Summary of studies that have applied bio-receptors and chromogenic substrates for the detection of toxins**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Nanoparticles used** | **Bio-receptors & Chromogenic substrates** | **Target toxins** | **Mechanism of detection** | **Colorimetric output** | **Other Signal transducer** | **Detection limit** | **Main findings** | **Reference** |
| Gold | Aptamer | Cyanobacterial toxin (Microcystin-LR) | Gold-thiolated aptamer was arrested covalently on dual-resonance fiber gratings to sense Microcystin-LR toxin | NA | Atomic force microscopy (AFM) and optical spectrum analyzer | 10 nM | Leveraging on the highly precise spectral interrogation mechanism, the specific MC-LR binding to a DNA aptamer immobilized covalently on the LPFG surface was monitored  As a result of covalent binding between the thiolated DNA aptamer and the gold-coated LPFG surface, no aptamer dissociation was observed during subsequent washes. Hence, sensor measurements obtained was highly stable compared to those of adsorption-based sensors | (Tripathi et al., 2019) |
| Gold | Phospholipid coated AuNP probe incorporated with GM1 | Cholera toxin | Plasmonic nanoparticles with a bilayer phospholipid coating and embedded Raman indicators was designed and functionalized with CT-binding ligands of ganglioside (GM1). Thus, allowing a simplified synthesis of the Plasmonic nanoparticle through two-step self-assembly. There was no chemical immobilization | NA | Surface-Enhanced Raman Scattering (SERS)-(PCERS) | 0.3 pg/mL | The nanobeacon designed provided a modest but ultrasensitive sensor for prompt detection of CT with a large signal-to-background ratio. This is useful for point of-care testing and diagnostic monitoring of cholera because of its superb reproducibility in a comprehensive and dynamic range | (Zhang et al., 2016) |
| Gold | Graphene-chitosan nanocomposite film immobilised BoNT/A antibody | Botulinum neurotoxin A (BoNT/A) | BoNT/A antibody was immobilized on glassy carbon electrode that has already been modified with gold nanoparticles/graphene-chitosan for the amplification of signal | NA | Electrochemical sensor | 0.11 pg/mL | The measurements observed in this study were greatly target-specific and linear with logarithmic BoNT/A concentrations in human serum and milk | (Afkhami et al., 2017) |
| Gold nano-urchins | Reduced graphene oxide (rGO) and gold nano-urchins (AuNUs) incorporated screen printed electrode | Staphylococcal enterotoxin B (SEB) | The ability of the aptamer to detach from the surface of the modified electrode used due to the affinity of the SEB toxin molecule in the direction of its specific aptamer is the mechanism of this study | NA | Differential Pulse Voltammetry (DPV), Cyclic Voltammetry (CV) and Electrochemical Impedance Spectroscopy (EIS) | 0.21 fM | The recovery percentages observed were better and standard deviation of aptasensor was lower when compared with conventional ELISA kit of SEB detection | (Mousavi Nodoushan et al., 2019) |
| Gold | Tetraethylene glycol ferrocene derivative and an anti-AFM1 aptamer | Aflatoxin M1 | The aptamer anti-AFM1 probe was immobilized covalently on the AuNPs/SPCE electrode surface via the ferrocene tetraethylene glycol ligand (FcTGL) | NA | Screen-printed carbon electrode (SPCE) | 7.14 pg/mL | This design has high sensitivity toward AFM1 toxin with a good limit of detection. Based on its selectivity, repeatability, reproducibility and storage stability, the design was applied to determine the AFM1 toxin in real samples like cow milk. | (Hamami et al., 2021) |
| Silver | Mesoporous-silica modified reduced  graphene-oxide nanosheets | Uremic toxin  (uric acid) | The homogeneous dispersion of silver nanoparticles was self-assembled on a floating 2D platform of mesoporous silica modified reduced graphene oxide nanosheets, where the advantage of the highly porous structure of mesoporous silica (MPS) and the benefit of Raman enhancement of reduced graphene oxide nanosheets were used as templates | NA | surface-enhanced Raman scattering (SERS) detection | < 10 −6 M (Uric acid) | There SERS intensity increased and the background reduced by using the template of the mrGO which resulted into 6.9 times enhancement of the signal-to-background ratio (S/B ratio). | (Juang et al., 2020) |
| Gold nanocluster | Green-emitting L-arginine@6-aza-2-thiothymine and polyacrylic acid (PAA) | T-2 (trichothecenes A) | A green-emitting L-arginine@6-aza-2-thiothymine coated gold nanocluster (Arg@ATT-AuNCs) was produced through host-guest assemblages and capped with polyacrylic acid (PAA) | NA | Fluorescence resonance  energy transfer (FRET) probe | 0.57 pg/mL | Spiking analysis carried out revealed the robustness and efficiency of this bioassay in real setting using maize and was highly correlated with the standard ELISA method | (Khan et al., 2020) |
| Upconversion nanoparticles (UNCNs) | Carboxyl group modified graphene oxide and Aptamer | Zearalenone (ZEN) | Aptamers, upconversion nanoparticles (UCNPs), and functionalized graphene oxide (FGO) constituted the system. The aptamers were specific molecular recognition elements of Zearalenone for high specificity. The fluorescence of the UCNPs was extinguished when they were brought close to FGO, which led to the fluorescent detection of ZEN at varying concentrations. | NA | Fluorescence resonance energy transfer (FRET) probe | 0.0018 ng/mL | The results indicated that the correlation between the concentration of ZEN and the fluorescence intensity had a high relevance. The detection limit reported was lower than those of the current methods for ZEN detection. | (Li et al., 2021) |
| Griphitic Carbon nitride nanosheets | Thionine (phenothiazine) and Indium tin oxide (ITO) coated glass electrode. | Aflatoxin B1 (AfB1) | Graphitic carbon nitride nanosheets were functionalized with thionine onto an indium tin oxide (ITO) coated glass electrode (Thn/g-C3N4/ITO), which was arrested covalently by EDC-NHS chemistry with anti-aflatoxin  B1 (anti-AfB1) followed by blocking of non-specific sites through the bovine serum albumin molecules | None | Atomic force microscopy and cyclic voltammetry | 0.328 fg/mL | The obtained electrochemical results indicate that the fabricated biosensing electrode has the ability to detect Aflatoxin (AfB1). | (Nirbhaya et al., 2021) |
| Silver nanoparticles | Carbamazepine | Orange II and Rhodamine B | Novel carbamazepine drug was functionalized with silver nanoparticles based electrochemical sensor. | None | Electrochemical impedance spectroscopy | 1.2 nM | This innovative sensor is highly favorable towards the detection of food toxins owing to its low cost, ease of fabrication, high sensitivity and absolute discriminating ability for toxins even in the presence 200 times higher concentration of interfering agents than the analytes. | (Shah et al., 2018) |
| 1.0 nM |
| Magnetic nanoparticle | Silica, silver and gold nanoparticles labeled anti-ricin antibodies | Ricin toxin | MNPs labeled  with anti-ricin A chain antibody 6A6 captured ricin and GNPs labeled with anti-ricin B chain antibody 7G7 were the detectors. The catalytic properties of GNPs were used to promote silver reduction, a sandwich structure  of MNP–capture antibody–ricin–GNP–detection antibody  was formed to enhance the electrical signal | None | Fluke 189 multimeter, interdigitated array microelectrodes (IDAMs) | 10-11 M | The sensitivity of the SEIA for ricin electrical detection was five times higher than that of conventional colorimetric sandwich ELISA. When the antibody was coated on the plates or MNPs, the system was three times more rapid than colorimetric sandwich ELISA. | (Zhuang et al., 2010) |

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