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Editorial

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Aptasensors Technologies for Aflatoxins B1 Application

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Editorial

Mycotoxins, highly toxic metabolites occurred by various molds, can contaminate foods and agricultural products, which mainly includes maize, cereals, nuts, meat, milk, wine, and fruits. Aflatoxin B1 (AFB1), one of the most important and toxic mycotoxins, has been classified as group 1 carcinogen by the International Agency for Research on Cancer (IARC) of the World Health Organization (WHO) [1]. The toxicity of AFB1 is over than KCN, arsenic and melamine by 10, 68, and 416 times, respectively. The maximum tolerated level of AFB1 was established at 2 μg kg^{-1} for all cereals and cereal-derived products by European Commission [2]. Traditional AFB1 detection methods are instrumental approaches (like High-Performance Liquid Chromatography (HPLC)) and antibody-based immunoassays (like Enzyme-Linked Immune Sorbent Assay (ELISA)). Aptamers, considered as "chemical antibodies", were obtained and selected by systematic evolution of the ligand by the exponential enrichment process (SELEX) *in vitro*. They can specifically recognize various target with high affinity like or even superior to antibodies [3]. Aptamer-based biosensors have been widely applied for the detection of AFB1 in recent years. More importantly, in order to achieve the performance of simple and rapid detection, low cost, high sensitivity and specificity, current technologies were employed to construct aptasensors for AFB1 determination.

Quantum Dots (QDs) play an important role to construct fluorescent aptasensors. QDs are regarded as new fluorophores, which takes the advantages of long fluorescent lifetime, wide absorption spectra, and narrow emission spectra. First, Lu et al. introduced a CdTe QDs-based aptasensor for fluorescent detection of AFB1. Graphene Oxide (GO) was adopted to quench the fluorescence produced by QDs. With AFB1 addition, the fluorescence signal was recovered, and its detection limit was established at 1.0 nM [4]. Compared with CdTe QDs, higher fluorescent intensity was achieved by using nitrogen-doped C-dots (N, C-dots). The aptamer was modified to the surface of gold nanoparticles (AuNPs) and was assembled with N,C-dots. By this design, the fluorescence signal was recovered when AFB1 presence. A low detection limit (5 pg mL^{-1}) was obtained [5].

In order to improve detection sensitivity, real-time quantitative polymerase chain reaction (RT-qPCR) was employed as a very precise and sensitive strategy. DNA sequences could be used for the template of RT-qPCR with exponential signal amplification. Guo et al. reported an ultrasensitive aptasensor for AFB1 detection base on RT-qPCR technique (LOD=25 fg mL^{-1}). The aptamer was adopted for specific recognition with target AFB1, while the complementary DNA of aptamer was amplified as the template of RT-qPCR. This

proposed aptasensor was the most sensitive approach for AFB1 analysis until today [6].

Surface Enhance Raman Scattering (SERS), regarded as unique fingerprint analytical technology, was widely applied to develop biosensors for contaminates detection. Chen et al. introduced another ultrasensitive aptasensor for the detection of AFB1 based on SERS and CS-Fe_3O_4 nano-beads signal enhancement strategy [7]. The competitively recognition performance was produced between the target and DNA1 modified CS-Fe_3O_4 when AFB1 existed. A wide linear response was achieved with AFB1 levels from 0.01 to 100 ng mL^{-1}, and its detection limit was 3.6 pg mL^{-1}.

In addition, nuclease-induced signal enhancement was a simple and important strategy for amplified detection of mycotoxins. Zhang et al. [8] developed an amplified and rapid aptasensor for AFB1 determination based on nuclease-assisted signal amplification [8]. When AFB1 existed, the conformational change of the aptamer was formed, leading to the separation from the surface of GO. Then, the aptamer was digested by the nuclease as a result that the target AFB1 was released for the cycle signal enhancement. The low detection limit of this aptasensor was established at 0.35 ng mL^{-1}. Recently, as another signal amplification approach, hybridization chain reaction (HCR) attracted more and more attentions from researches for contaminates determination since polymerase and other polymerization was not required in this technique, which is an isothermal amplification process induced by the target. In 2019, Yao et al. [9] reported a chemiluminescent aptasensor for AFB1 analysis by using HCR strategy [9]. With the presence of target AFB1, the competitive binding between the probe DNA and the target for the aptamer caused the the release of the probe from magnetic beads. Then, HCR signal enhancement was achieved for high sensitivity (0.2 ng mL^{-1}).

In order to improve the time-consuming process of aptasensors, Xia et al. [10] developed a signal amplification aptasensor for ultrafast analysis of AFB1 without enzyme catalysis. The aptamer was designed to modify two fluorophores in its terminals and the dual-terminal proximity structures was formed. When the target AFB1 existed, the specific binding between the aptamer and one molecule AFB1 led to the two fluorophores lighted up. More importantly, only 1 min was required in this aptasensor process, which was the fastest analytic platform against AFB1 determination [10].

The application of aptasensors for AFB1 analysis was increased dramatically in recent years, the researchers can select the desirable approach according to their aim and consideration, which mainly included QDs-aptasensor, PCR-aptasensor, SERS-aptasensor, nuclease-aptasensor, HCR-aptasensor and enzyme-free aptasensor. The limitations of many proposed aptasensors include time-consuming process, special equipments, and professional personnel, as well as the quality of aptasensors system. Future research will focus on the development of rapid and sensitive aptasensors, such as simplify the sensing strategy, improve the detection performance, and develop commercial kits for market practicality.

Author Contributions

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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