Detection of Patulin Mycotoxin using Molecular Imprinted Polypyrrole Modified Electrodes

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Project Scope: Patulin is a polyketide lactone mycotoxin that is produced by *Aspergillus*, amongst other fungi, which is commonly associated with apple juice derived from contaminated fruit. The mycotoxin is very stable and can accumulate within the body causing acute or chronic illness when ingested. Due to the stability of patulin there is a strong reliance on screening products so that contaminated batches can be removed from the food chain. On-site assays based on ELISA are available but are costly and require significant user input. The following reports on the fabrication of a patulin sensor based on molecular imprinted polypyrrole. Molecular imprinted (MI) films are artificial antibodies which are produced by forming a polymer around the analyte (or analog) template. Upon completion of the polymerization the template is removed leaving voids which exhibit high affinity towards the analyte. Unlike biological agents such as antibodies, MI's are robust, stable, cheap and conducive to mass manufacturing. Polypyrrole is a semi-conductor that can switch between conducting and insulating states under the influence of external stimuli. The main advantage of using polypyrrole for MI fabrication is that the binding of target analyte and be instantly transduced into an electrical signal thereby enabling reagentless sensing.

Recent Progress: Imprinted films were prepared by electropolymerization of pyrrole onto a glassy carbon electrode in the presence of patulin. AC impedance spectroscopy was used to monitor changes in the polypyrrole layer during interaction with patulin. From the impedance spectra it was observed that the change in Y" (susceptance) correlated to patulin concentration with a lower detection limit of 20ppb. In comparison, non-imprinted films showed negligible responses to patulin. Equivalent circuit analysis illustrated that the interaction of patulin resulted in a decrease in polymer resistance (Rp) and increase in capacitance (CPE-P). From the results obtained it is hypothesized that the charge carrying polarons/bipolarons on the polypyrrole chains undergo nucleophilic attack by patulin resulting in the formation of a covalent bond with the pyrrole units. The neutralization of patulin via interaction with polypyrrole was unexpected finding and could be exploited in developing intelligent materials for removing the mycotoxin from foods and environment.

Future Plans: Further research is need to elucidate the interaction of patulin with polypyrrole. In addition, structural analogues for patulin need to be identified for preparing MIP imprinted films given the cost and hazards of handling mycotoxins.

Relevance to listed research areas: The work has demonstrated proof-of-principle of fabricating reagentless sensors for detection of toxins in the field. The patulin sequestering property of polypyrrole could find utility in developing smart materials for detection and bioremediation applications.

Publications: Keith Warriner, Edward P.C. Lai, Azadeh Namvar, Daniel M. Hawkins and Subrayal M. Reddy. Molecular Imprinted Polymers for Biorecognition of Bioagents. In:

Handbook of Bacterial detection: Biosensors, recognition receptors and microsystems.Ed:. Mohammed Zourob and Antony Turner. Springer Scientific (*In Press*).