

Proposal No: 2012-005-TC

The Andersons Research Grants Program

Project Title:

Multiplexed Electrochemical Biosensor for Rapid and Sensitive Detection of Mycotoxins

Principal Investigators:

Name	Institution/Agency/Other
Sundaram Gunasekaran	University of Wisconsin-Madison
Senay Simsek	North Dakota State University

Project Contact (list one person to act as the primary contact):

Name:	Sundaram Gunasekaran
Address:	460 Henry Mall
	Madison, WI 53706
Phone:	(608) 262-1019
Fax:	(608) 262-1228
Email:	guna@wisc.edu

Period of Proposed Project Dates:

Beginning: January 1, 2013 **Ending:** December 31, 2014

Amount Requested (maximum \$75,000 per year for two years):

Year 1: \$75,000 **Year 2:** \$75,000

I. PROBLEM IDENTIFICATION AND RELATED RESEARCH

Fungi constitute major pathogenic organisms of plants and cause extensive crop damage due to disease in the field and post-harvest food spoilage that is often accompanied by production of mycotoxins. Mycotoxins are toxic, low molecular weight (usually < 1 kDa) secondary metabolites that occur naturally. They can enter our food chain directly from the use of mycotoxins-contaminated foods or indirectly from the growth of toxigenic fungi on food¹. Intake of mycotoxins causes acute or chronic mycotoxicoses to human and animals. However, only few of the over 300 mycotoxins are regularly found in foods and feedstuffs such as grains and seeds. They are: aflatoxins (AF), trichothecenes (deoxynivalenol (DON)/nivalenol/T-2 toxins), fumonisins (FUM), zearalenone (ZEA), ochratoxins (OT), and patulin. Mycotoxins-contamination of grains lowers the quality, value, and safety of foods and feeds, resulting in profound economic losses and health risks. The economic costs of mycotoxins are impossible to accurately measure, but the mean annual cost of crop losses in the United States due to three major mycotoxins (AF, FUM, and DON) is estimated over \$900 million².

Members of three genera of fungi, *Aspergillus*, *Fusarium*, and *Penicillium*, are the major mycotoxin producers³. These fungi exist as saprophytes, plant pathogens of major crop plants and/or rarely human pathogens (certain species of *Aspergillus*)⁴. *Aspergillus* and *Penicillium* species contaminate foods and feeds stored under high humidity and temperature conditions. *Fusarium* species are distributed worldwide as saprophytes and plant pathogens, and have wide range of hosts and infect crops growing in the field. When pathogenic *Fusarium* species infect crops such as corn, wheat, and barley, they propagate in plant tissues and produce mycotoxins⁵.

Unlike bacterial, viral or other toxic foodborne contaminants, mycotoxins can easily withstand digestion or temperature treatments like cooking and freezing, and retain toxicity in foods⁶. Many mycotoxins are dangerous even in trace amounts (for example, <0.5 parts per billion (ppb) for aflatoxin M1 (AFM1)). Biotic factors, such as grain type and ripeness, coupled with the prevailing abiotic factors, such as water content and temperature, and also preservative concentration will influence the safe storage life and the level of contamination with mycotoxins such DON produced pre-harvest and ZEA produced post-harvest by *Fusarium graminearum* and *Fusarium poae*, respectively, ochratoxin A (OTA) produced by *Penicillium verrucosum* post-harvest in cool damp climates, and perhaps T-2 and HT-2 toxins produced by *Fusarium langsethiae*. Poor post-harvest drying and storage management may exacerbate DON contamination already present pre-harvest. It is clear that proper post-harvest conditions are necessary to minimize DON and OTA in moist wheat grain⁷.

Some fungi produce more than one toxins and more than one fungal species can infest plants with synergistic effects, variable patterns of contamination have been observed, and when contamination occurs, often multiple toxins are detectable⁸. For example, AF and FUM are co-contaminants often found in corn⁹⁻¹² and milled corn fractions^{9,13,14} and rice and wheat flour¹², and malted barley¹³; DON, ZEA, and nivalenol in wheat¹⁵; patulin, cyclopiazonic acid, penicillic acid, diacetoxyscirpenol¹⁶ and AF¹⁷ in cassava; and AF, FUM, OTA, and ZEA in sows/sow feeds¹⁸. DON and OTA are also common cocontamiants in wheat^{19 20 21. 22}. In a study, when the occurrence of mycotoxins in agricultural commodities, including corn, compound animal feeds, silage, cornmeal, puffed corn, wheat, bran, soybean meal, rapeseed meal, distillers dried grains with solubles, total mixed ration, concentrate supplement, cottonseed meal and whole cottonseed