HE04

MIC-ATR

Development of a new regenerable and low-cost biosensor to indoor microbial compounds detection

DURATION OF THE PROJECT
Phase 1: 01/01/2007 – 31/01/2009
Phase 2: 01/02/2009 – 31/01/2011

BUDGET
721.413 €

KEYWORDS
Indoor pollution, health problems, trichothecenes, optical biosensor, monoclonal antibodies, FTIR/ATR spectroscopy.

CONTEXT

There is crucial concern about the presence of molds in indoor environments and their adverse effects on human health. The indoor molds, omnipresent in 60% of the dwellings, have indeed the potential to produce extremely dangerous toxins called mycotoxins. Exposure to these factors has been associated to several severe human health problems like allergic hypersensitivity responses, symptoms of asthma, pulmonary haemorrhage, potentially mortal. The most dangerous mycotoxins responsible for these concerned results belong to the family of trichothecenes. To date, studies have mostly focused on detecting these mycotoxins on bulk materials or in settle dust but there is an urgent need, driven by the guidelines of Public Health policy, to develop specific and sensitive tests to measure airborne macrocyclic trichothecenes mycotoxins in indoor environments, for which no specific nor enough sensitive detection method exists.

PROJECT DESCRIPTION

Objectives

The indoor molds have the potential to produce extremely dangerous toxins belonging to the family of trichothecenes, a very large family of chemically related toxins produced by various species of Fusarium, Myrotecium, Trichoderma, Cephalosporium, Verticimonosporium and Stachybotrys. They are markedly stable under different environmental conditions. The distinguishing chemical feature of trichothecenes is the presence of a trichothecene ring, which contains an olefinic bond at C-9, 10; and an epoxide group at C-12, 13. They can be divided into four categories, types A, B, C and D. Type D presents a macrocyclic ring system between C4 and C15 with two ester linkage and constitutes the trichothecenes found in indoor environment while the other forms are studied in the context of food safety.

There is an urgent need, driven by the guidelines of Public Health policy, to develop specific and sensitive tests to measure airborne macrocyclic trichothecenes mycotoxins in indoor environments, for which no specific nor enough sensitive detection method exists. The aim of the research is double : the network proposes to develop a regenerable low-cost biosensor of high sensitivity and selectivity based on FTIR/ATR spectroscopy and to use it to monitor the ligand/receptor interactions of these molecules. The biosensor will use optical elements, transparent in the IR spectral domain, modified by wet chemistry to allow the coupling of molecular receptors, in particular mouse or rat monoclonal antibodies directed against macrocyclic trichothecenes.

Besides the quantitative determination of the trichothecenes toxins concentration, the research partners will help in the initiation of actions on standardisation and normalisation by defining detection limits and providing reliable sampling methods for indoor environment.
Methodology

The MIC-ATR project has been divided in 4 work packages (WP1 to WP4).

WP1: Biodetection of dinitrophenol (DNP)– The purpose of WP1 is test the biosensor technology on a toxin-like detection problem. This system will constitute a model-system for the whole research project. It will help to validating the detection technology in an antigene/antibody context.

WP2: Biodetection of aflatoxins– This WP is devoted to the quantitative determination of aflatoxins (more specifically : aflatoxin B1) using a commercially available antibody. Extending the results of WP1, WP2 will be the first functional application of the technology to the detection of a toxin.

WP3: Biodetection of trichothecenes with (monoclonal) antibodies – The aim of this WP is to develop the biosensors tested in WP2 using the (monoclonal) antibodies produced at IPB against macrocyclic trichothecenes, including competition tests for specific recognition of the toxins and comparison with commercially available ELISA tests. Additionally, research activities will be carried out at IPB to product anti-ergosterol (monoclonal) antibodies. This molecule serves as a parameter for the total fungal bio-mass.

WP4: Consortium management – The objectives of WP4 are the project management and the work progress co-ordination

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INTERACTION BETWEEN PARTNERS

Some of the research partners (UMH, UCL and ULB) already collaborated in the field of bio-detection. Their competences will be integrated, from environmental sampling to the bio-detection and characterisation of the biological interactions between the ligand (the trichothecene molecule) and the receptor (the antibody) as follows :

- Environmental sampling (HPH, in collaboration with Prof. D. Charpin, Faculty of Medicine, Marseille and subcontractor for the project, (SC3))
- Molecular receptors production and characterisation (IPB)
- Biosensing devices and BIA-ATR technology (UMH in collaboration with Prof. J. Marchand-Brynaert, Unité de Chimie Organique et Médicinale (CHOM) – UCL - subcontractor for the project (SC1) -, and Prof. E. Goormaghtigh, Structure and Function of Biological Membranes (SFMB) – ULB - subcontractor for the project (SC2)

EXPECTED RESEARCH RESULTS

D1 : Capability of detecting DNP using a functionalized germanium ATR
D2 : Capability of chemically synthesising spacers arms to bind the (monoclonal) antibodies
D3 : Capability of detecting AFLATOXINS using a functionalized germanium ATR element coated with COMMERCIAL ANTIBODIES.
D4 : Capability of producing POLYCLONAL and MONOCLONAL ANTIBODIES against MACROCYCLIC trichothecene mycotoxins and ERGOSTEROL
D5: Method for ENVIRONMENTAL SAMPLING of TRICHOTHECENES MYCOTOXINS
D6: Capability of binding MONOCLONAL antibodies against trichothecene mycotoxins
D7: Capability of detecting TRICHOTHECENES MYCOTOXINS using a functionalized germanium ATR element coated with MONOCLONAL ANTIBODIES
D8: Characterisation of the MONOCLONAL ANTIBODIES
D9: Dissemination activities related to WP3 (scientific publications, …)

PARTNERS - ACTIVITIES

Background and expertise
C1 (Coordinator): HPH is involved in indoor pollution through the different activities developed during the past few years in its “Laboratory of Indoor Pollution” (LPI).
P2 : CRMM – UMH has developed an strong expertise at the international level in the study of solid-liquid interactions and, more specifically, in the modification of surfaces properties with auto-assembled monolayers.
P3 : IPB has focused one of its main research topics on the analysis of allergic immune responses in the context of mold allergy.

SC1 : CHOM – UCL has an expertise in organic chemistry which strongly supports several interdisciplinary projects devoted to the design, synthesis and evaluation of biologically active compounds as new leads for therapeutic applications.
SC2 : SFMB- ULB has a strong expertise in the FTIR-ATR technology, in its practical as well as theoretical aspects.
SC3: is a pneumo-allergologue involved in indoor pollution through the “Maison de l’Allergie et de l’Environnement” in Marseille.

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Follow-up Committee

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