SUMMARY:
DEVELOPMENT OF A BIOSENSOR FOR MEASURING ODORANTS IN THE AMBIENT AIR NEAR SOLID WASTE MANAGEMENT FACILITIES

Daniel E. Meeroff (PI)\(^1\)
David M. Binninger (Co-PI)\(^2\)
Sharmily Rahman\(^3\)

In 2017, the Bill Hinkley Center for Solid and Hazardous Waste Management funded FAU Lab.EES to develop a novel biosensor technology that has the potential to objectively and rapidly measure odor concentrations in real-time, transforming how nuisance odors are monitored and regulated. This is a follow up study to a project entitled, "Investigation of effective odor control strategies" that was completed in 2017 that in part studied ways to improve odor detection including development of a novel technology that uses human odorant binding proteins as a biosensor to quantify odors.

Nuisance odor levels produced by solid waste management operations such as landfill facilities are subject to regulatory standards because of their impacts on the quality of life of the residents living within close proximity to the facility. Failure to meet such standards may result in costly fines, litigation, inability to acquire permits, mitigation, and re-siting operations. Since measurement of environmental nuisance odors is currently limited to subjective techniques, monitoring odor levels to meet such standards is often problematic. This is becoming more acute as increasing residential populations begin to encroach on properties adjacent to landfills. Odors can cause relations between the facility and the surrounding population to deteriorate. In order to ensure that nuisance odor issues are minimized, it is necessary to provide an objective measurement. However, until now, we did not have any objective methods of monitoring or recording nuisance odors. Moreover, there are usually a number of odorants that interact with each other, further complicating quantification.

The objective of the current research is to develop a biosensor for providing an objective, standard measurement of odors. Our approach will modify hOBP2A, a human odorant binding protein, isolated using published biomolecular techniques by either fluorescently tagging it with a chromophore functional group or a monoclonal antibody. Then the biosensors will be exposed to selected model odorants (single and mixtures) to determine positive/negative spectrophotometric response and concentration dependence/Beer’s Law quantitation for a specific set of odorants typically encountered at solid waste facilities.

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PROGRESS REPORT
(September 2018)

Project Title: DETECTION OF NUISANCE ODORS USING ODOR BINDING PROTEIN SENSOR
Principal Investigator: Daniel E. Meeroff, Ph.D.
Co-Principal Investigator: David M. Binninger, Ph.D.
Affiliation: FAU
Phone number: (561) 297-2658
Project website: http://labees.civil.fau.edu/leachate.html
Student: Sharmily Rahman, MSCV Candidate

Methodology/Scientific Approach

TASK 1. Conduct literature review. Sharmily Rahman continues to conduct literature review on objective measurement techniques for detecting landfill odors with the main goal 1) identifying specific odor causing compounds in solid waste operations to create a database of odorant candidates for testing; and 2) identifying literature that would improve the efficiency of the analysis technique proposed.

TASK 2. Prepare biosensor molecules. Dr. Binninger, Biology Professor at FAU has already supervised production of the first large batch of purified hOBP2A with the assistance of Yasmeen Amanza Ampuero and Cynthia Raaijmakers (graduate students in his laboratory). The research team is in the process of verifying the purity of the protein.

TASK 3. Develop an experimental exposure chamber. Sharmily Rahman is in the process of updating the prototype reactor. S. Rahman is also scheduled to receive training for laboratory safety, biowaste, and hazardous waste awareness, as well as training on the spectroscopic instruments needed for testing.

TASK 4. Perform protein sensitivity experiments on model compounds. S. Rahman is preparing to replicate the previous protein sensitivity experiments conducted by Julia Roblyer with H2S.

TASK 5. Perform protein sensitivity experiments on mixtures. S. Rahman will compare the results and also check whether the protein shows a binding affinity only towards H2S or whether the same applies to a mixture of “standard landfill gas,” containing H2S, CO2, NH3 and N2 to confirm the Beer’s Law relationship in the presence of other odorants.

Upcoming Research Tasks

- TASK 1. Conduct literature review. Continue to update the literature review.
- TASK 2. Prepare biosensor molecules. As soon as the protein is ready, Sharmily Rahman will convert them to the biosensor molecules using the fluorescent tagging markers. The Ocean Optics Spectrometer will be configured for fluoroscopy of fluorescently marked OBP2A as it binds odorants. The software will be acquired and advanced operator training will be conducted.
- TASK 3. Develop an experimental exposure chamber. Based on preliminary experimental results, the exposure chamber will be refined.
- TASK 4. Perform protein sensitivity experiments on model compounds.
- TASK 5. Perform protein sensitivity experiments on mixtures.
- TASK 6. Develop recommendations and preliminary cost analysis.
- TASK 7. Prepare publication materials.
**PROJECT METRICS:**

1. List graduate or postdoctoral researchers funded by THIS Hinkley Center project.

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<thead>
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<th>Last name, first name</th>
<th>Rank</th>
<th>Department</th>
<th>Professor</th>
<th>Institution</th>
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<tbody>
<tr>
<td>Rahman, Sharmily</td>
<td>MSCV Candidate</td>
<td>CEGE</td>
<td>Meeroff</td>
<td>FAU</td>
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<tr>
<td>Ampuero, Yasmeen</td>
<td>MS Biology Candidate</td>
<td>BIO</td>
<td>Meeroff, Binninger</td>
<td>FAU</td>
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<tr>
<td>Raaijmakers, Cynthia</td>
<td>MS Biology Candidate</td>
<td>BIO</td>
<td>Meeroff, Binninger</td>
<td>FAU</td>
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2. List undergraduate researchers working on THIS Hinkley Center project.

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3. List research publications resulting from THIS Hinkley Center project.

None yet

4. List research presentations resulting from THIS Hinkley Center project

None yet

5. List research papers that have cited any publications (or the final report) resulting from this Hinkley Center project (use format for publications as indicated in the Hinkley Center Investigators Guide).

None so far

6. List additional research funding that has been secured due to leveraging the research results from this Hinkley Center project (give project title, funding agency, amount of funding, award date, and award period)

Year two funding from the Hinkley Center for Solid and Hazardous Waste Management was secured. “Development of a biosensor for measuring odorants in the ambient air near solid waste management facilities (this project),” Hinkley Center, $50,487. 12/01/2017 (delayed project start to 08/01/2018) – 05/31/2019.

Additional funding was secured from the Environmental Research and Education Foundation, “Detection of nuisance odors using odor binding protein sensor,” Environmental Research and Education Foundation (EREF), $150,000. 12/01/2017 – 11/30/2019.

7. List submitted proposals which leverage the research results from this Hinkley Center project (give the proposal title, funding agency, requested funding, date submitted)

None yet
8. List new collaborations initiated based on this Hinkley Center project

Deguo Du, Assistant Professor, Chemistry, FAU is allowing us to use his sophisticated fluometry equipment for this project.

9. How have the results from this Hinkley Center funded project been used (not will be used) by the FDEP or other stakeholders in the solid waste field? Please note that the term “other stakeholders” is meant to broadly include any party or practitioner in the solid waste field. This includes county solid waste directors and their staff, municipal solid waste directors and their staff, solid waste facility design engineers, local/county/city solid waste management regulatory staff, federal solid waste regulatory staff, landfill owners and operators, waste haulers, waste to energy plant owners and operators, recyclers, composting plant owners and operators, yard waste operators, construction and demolition debris companies and organizations, county recycling coordinators, citizens and members of the academic community, etc. (1 paragraph maximum)

To date, the results have not been used by stakeholders yet.

**TAG members:**

**TAG meetings:**
October 19, 2018 (Joint TAG meeting held at SWA in conjunction with UM)