Kinetic Study of Biomass Upgrading of Polysaccharides from Algae into Furanic Platform Molecules

Jade A. Minzlaff

Introduction:

Algae biofuels present a far more sustainable alternative to both fossil fuels and other proposed biofuels for several reasons. Unlike ethanol production, which is derived from corn and competes with both land use and corn production for food sources, algae production requires far less energy and space than corn, and its production could utilize space in oceans that would require much less infrastructure to grow than other plants. Efficient and cost-effective renewable energy from algae could potentially help reduce global dependence on fossil fuels, production of which is currently endangering the fate of humankind due to their exacerbation of climate change. This research project will study the upgrade of algal biomass to produce 5-HMF and furfural, two platform molecules for the production of biomass derived fuels and chemicals.

Thesis Statement or Hypothesis:

The purpose of my research project is to study the reaction conditions that maximize the percent yield of platform molecules from algae, including temperature, reaction time, and use of catalysts. My stretch goal is to study the production of fuel and commodity molecules from these platform molecules, including oleofurans and 2,5-DMF.

Approach or Methodology:

Working in the lab of Dr. Konstantinos Goulas in Johnson Hall, I will run a series of reactions to generate furfural and 5-HMF from biomass-derived polysaccharides (xylan and glucan, respectively) in small pressure tubes using homogeneous acid catalysts and two-phase reaction systems. Reaction products can then be analyzed using gas chromatography to determine relative the yields of 5-HMF and furfural in each reaction. I will vary temperature, reaction time, and use of catalysts, to determine the conditions that maximize percent yield, building on previous research.

Approach Subsection (Required For All Theses): Does your thesis project involve any research activity that requires compliance procedures (e.g., human subject research requiring Institutional Review Board approval)?

I have taken all necessary laboratory training for both OSU and Johnson Hall.

Expected Results and Anticipated Outcome and Significance:

I expect that my research will produce an increased understanding of the kinetics of the one-pot reaction of algal biomass to platform molecules. I will determine optimal conditions for the production of furfural and 5-HMF from algal biomass, a necessary step for the production of fuels and chemicals in an environmentally friendly way.

Signature Line: _____

Mentor: Dr. Konstantinos Goulas, Chemical Engineering Date

By signing, the mentor gives his/her assurance that they have read the proposal, sees it as a legitimate HC research project, and is willing to serve as your thesis advisor for the proposed project. If this project requires IRB approval, the mentor confirms eligibility as a Principal Investigator according to IRB criteria.

Honors College Thesis Expectations Agreement

Student Responsibilities:

- Work 3 hours each week per research credit
- Maintain a notebook/journal/lab record to verify accomplishments, protocols, problems, questions, dates, number of hours worked and results.
- Mid-way through the research, student will select committee members (the committee will include the mentor, and two others) to review the thesis. Selection of committee members is in consultation with and approved by the thesis mentor.
- Submit a final draft copy of the thesis to their thesis committee no later than ten business days prior to their scheduled thesis defense date
- Present their thesis in front of their thesis committee, discuss and defend their thesis by answering questions about their research and related topics such as theoretical background, rationale, results, experimental design and overall significance
- Revise, edit, and complete the final thesis and submit to OSU Scholar Archive no later than Friday of week 10 of their graduation term.
- Gather signatures for thesis submission form and submit to the Honors College no later than Friday of week 10 of their graduation term.

Signature Line: _____

Student: Jade A. Minzlaff Date

By signing, the student gives their assurance that they agree to the ‘Student Responsibilities’ outlined for the proposed project.

Mentor Responsibilities

- Provide guidance on the development and direction of the research project. The project, including background reading and real-time research, should take about 18-30 total hours (6 credits at 3-5 hours per credit).
- Explain and demonstrate how records should be kept, including notebooks or data organization and storage.
- Identify the publishing or style guide to be used for the thesis: American Chemical Society Style Guide
- Recommend a secondary person for the student to utilize in case of questions: Kyle Reem

- Assist in preparing and reviewing:
    - project timeline
    - project reference materials
    - drafts of the written thesis
- Assist in selecting and approving fellow committee members.
- Provide grades for research credits in terms student enrolls.
- Provide guidance as the student designs the poster and prepares for the thesis defense.
- Chair the student's thesis defense.

Mentor: _____

Mentor: Dr. Konstantinos Goulas, Chemical Engineering Date

By signing, the mentor gives their assurance that they agree to the 'Mentor Responsibilities' outlined for the proposed project.

Honors College Thesis Proposed Timeline

Suggested Submit Date:		Submit to:
March 2021	Read and summarize past literature on topic	Dr. Goulas
Winter 2021- Spring 2022	Gather questions / research / data / themes	Dr. Goulas
Spring 2021-Spring 2022	Analyze thesis questions / data / research / themes	Dr. Goulas
January 2022	Select committee members	Dr. Goulas/HC Office
June 2022	Write and format thesis	Dr. Goulas
July 2022	Revise thesis draft #1, #2, #3	Dr. Goulas
August 2022	Finalized draft to the thesis committee	Dr. Goulas
August 2022	Schedule the thesis defense	Dr. Goulas
August 2022	Design and print the thesis poster	Dr. Goulas
August 2022	Create a presentation on your project	Dr. Goulas
September 2022	Defend the thesis project	HC Office
October 2022	Make revisions to the thesis and format it	HC Office
October 2022	Upload thesis to the OSU Scholars Archive	HC Office

October 2022	Gather approval signatures	HC Office
October 2022	Submit the thesis	HC Office