The Issue of Biofuels:
A Comparison of Properties of Ethanol and Butanol in Relation to Efficiency, Environmental Impact, and Practicality

Erin Kimsey
Projected Graduation Date: June, 2011

Academic Advisor: Elvira G. Hack
Department of Animal Biology

Mentor: Dr. Charles DeGaul
Office: Chem 314
Department of Chemistry

December 5, 2008
PROJECT DESCRIPTION

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Introduction

Alternative fuel sources are becoming increasingly important to our society. Biofuels are one form of alternative fuel that have gotten significant attention in the scientific community and media. Although there are many different types of biofuels currently being studied, including biodiesel, bioalcohols, and natural gas (sometimes called “biogas”), ethanol is probably the most popular kind. Ethanol is a two-carbon chain molecule attached to an alcohol that is produced from fermentation of plants, usually agricultural plants such as corn. According to Michelle Chang of the University of California, Berkeley, “The major biofuel in use today is ethanol, which can be blended with gasoline for use in conventional automobiles and represents ~2% of transportation fuel usage in the United States” (Chang 2007). Blending ethanol with gasoline allows a slightly cleaner-burning fuel than just gasoline and a more efficient fuel than ethanol alone. It also makes it easier on an engine that has not been converted to withstand ethanol which can corrode plastic tubing.

A lesser-known biofuel is butanol which is very similar in structure to ethanol – composed of a four-carbon chain with an alcohol group – and produced through the same process. The difference between these two fuels, other than the two carbons, is that ethanol has received much greater attention in the media despite the fact that many of my sources indicate that butanol is a more efficient fuel. According to Randall Chase in an article from USA Today entitled “DuPont, BP join to make butanol; they say it outperforms ethanol as a fuel additive,” he states that “[butanol] can be blended at higher concentrations than ethanol without the need to retrofit vehicles, and it offers better fuel economy than gasoline-ethanol blends” (Chase 2006). This is a significant characteristic that can make a great difference in the application of these biofuels.

My project will further investigate associated properties of and issues with biofuels with a focus on the comparison between ethanol and butanol. Properties I will be researching, in particular, are water solubility, boiling point, production methods and efficiency (input vs. output/yield), and more. The main issues that I will also consider will be practicality of application of the fuels to existing technology and media coverage.

I currently have some understanding of ethanol and butanol (from classes as well as personal interest) and this project will allow me to learn more about the actual mechanisms and properties that contribute to the way in which ethanol and butanol are/can be used as a biofuel.

This project is of particular importance to our current issue of fuel and energy sources. The United States and many other countries still rely heavily on fossil fuels for both fuel and energy sources. Gas prices and oil dependency as well as global warming and other evidence of environmental degradation have been highly publicized issues in our country that have made people begin to understand that a change must be made in the way we live and operate our lives. Sustainability and conservation of resources are important components of our growing world and alternative fuels is just one place to start.

Goals

My goal is to gain knowledge about biofuels and understand them as alternative fuel sources, specifically ethanol and butanol. I will be making a direct comparison between butanol and ethanol since they are analogous in structure and production process. I will investigate the practicality of application, energy efficiency, and environmental impact of both butanol and ethanol. My focus will be on the structural differences and how those contribute to property differences. My goal will be to understand the attention to ethanol in the media relative to its actual effectiveness as a fuel. I will
examine public and scientific discourse about biofuels in general and, more specifically, how ethanol has been publicized and how butanol could possibly be more publicized as a valid alternative.

- **Tentative protocol and timetable**
  - Extensive research (library, Internet, interviews, and other sources) to begin spring quarter 2009 and continue through until the end of January 2010 with majority of the research being conducted between September and December 2009.
  - Fall Interviews (time to be determined based on interviewee availability)
    - Professor Michelle Chang (UCB; butanol research; BP funding)
    - Professor Mark Mascal (UCD; alternatives to ethanol; funding from Chevron)
    - Other professors in the field of biofuels
    - Graduate students working with these professors
    - UCD Bio-Energy Research Group (BERG)
  - Collect minimum of 20 resources by October 1\textsuperscript{st}; recheck sources for changes in information on January 1\textsuperscript{st}
  - The research component of the project will be completed by January 31, 2010.
  - Work on the written product will begin in February 2010.
  - A rough draft of the project will be completed by Monday, March 1, 2010.
  - A first draft will be completed by Monday, March 22, 2010.
  - A second draft will be completed by Monday, April 19, 2010.
  - The final draft will be completed by Monday, May 3, 2010.

**Importance to self, society, and biology**

This concept is especially relevant to the search for a sustainable, efficient, available, and less polluting fuel source which is of great concern in today’s growing world. As an animal biology and environmental biology and management double major, I am especially concerned with issues related to our environment and sustainability. I have significant experience working with environmental groups including Heal the Bay in Santa Monica, CA and Whole Earth Festival here in Davis; both which to promote sustainable living and environmental education. I am originally from Los Angeles, CA and have spent much of my life in a society that revolves around commuting. Therefore, fuel sources are of special relevance to me and my daily life. It is exciting to think about my world of freeways and big, city streets being transformed by a cleaner form of fuel for our vehicles. To think that someday the layer of smog that covers the L.A. skyline could be reduced or eliminated is an incredible thought and something that we should strive for on multiple levels but considering different ways of commuting – whether that be alternative fuels or better public transportation – is a great place to start. Although my project will only be covering a small part of what needs to be done to make the kind of drastic change I imagine, it is a part nonetheless and is still very relevant and special to me.

Another large part of my personal interests relates to scientific communication. It is my goal to have a career that will enable me to communicate scientific thought and developments to the public. I am especially interested in teaching sustainable living as well as appreciation of and respect for the environment. I wish to work in big cities where eco-friendly habits are usually not emphasized and/or the resources are not available. In order to do these things, I will have to have a firm understanding of science and the different methods for effectively communicating science to non-scientists and people who are not educated in scientific (or possibly any other) fields. The health of our environment is one thing that relates to people of all cultures and classes.

The fact is, the world – especially our world in the United States – is in desperate need of a more efficient and cleaner alternative fuel. Science is constantly developing new, cleaner, more sustainable energy sources (such as methane, hydrogen, nuclear, etc.) but I believe it is important to focus on one that will be most practical to apply on a grand scale as soon as possible.
ACADEMIC PLAN

Special Elective Classes:
WINTER 2009
- Environmental and Resource Sciences
  - ERS 120 Global Environmental Interactions (4)
    Lecture – 3 hours; discussion – 1 hour. Prerequisite: Chem 8B. Relationships among the climate, hydrology, biogeochemical cycles, soils and vegetation distribution in diverse landscapes and biomes. Emphasis on physical, chemical, and biological processes affecting ecosystems from the poles to the equator, and human impacts on the environment. Limited enrollment. II. (II.) Southard

  Justification: This class will use organic chemistry which is an important aspect of understanding the reasons ethanol and butanol have different physical properties. It will also provide me with an understanding of environmental interactions that is important for the environmental impact component of my research. Since a large reason I am concerned with biofuels (and alternative fuels in general) has to do with their importance to the environment, this will help me to better understand the different environmental systems that can be affected and how humans impact the environment (especially with fossil fuel use).

WINTER 2010
- Science and Society
  - SAS 42 Earth, Water, Science and Song (3) *
    Lecture – 2 hours; studio – 3 hours. Fusion of water and soil science with performing arts. Creative communication of scientific concepts and facts through exercises in song writing and poetry. Design, discuss, and conduct public performances related to the functioning of the natural world. II. (II.) Silk

  Justification: This class will provide me with skills relevant both to my practicum and my future career goals. It is my goal to work in the field of public education in which I can communicate with people who are either less educated or else otherwise unaware of environmental issues. This class will provide me with more creative methods to effectively communicate with such a broad audience. In relation to the practicum, communication is a crucial component to the issue of biofuels – especially ethanol. A large part of the reason that I chose this topic to investigate has to do with the fact that ethanol has gotten a significant amount of media coverage and yet, through my studies, I have learned that it is not as practical and problem-free of an option as it is made out to be. I am interested in the way media communicates scientific technology and discovery so that I may think of why some things are ignored and how they can be better publicized – specifically butanol. Also, music and other forms of creative media are excellent ways to communicate with children especially but also other large audiences with broad ranges of education levels.

- Plant Sciences
  - PLS 101 Agriculture and the Environment (3)
    Lecture—3 hours. Prerequisite: course 2 or consent of instructor. Interaction between agriculture and the environment. Focus on the interaction between agriculture and the environment to address the principles required to analyze conflict and develop solutions to complex problems facing society. Not open for credit to students who have completed Agricultural Management and Rangeland Resources 101. (Former course Agricultural Management and Rangeland Resources 101.)—II. (II.) Phillips
Justification: This class will be helpful in understanding the environmental impact of biofuels that are produced from agricultural products such as corn. Both ethanol and butanol are produced from the fermentation of plants, usually agricultural plants, thus knowing how agriculture and the environment interact will help me understand the effect of producing these fuels in both the environmental and agricultural aspects.

SPRING 2010

- **English**
  - **ENL 164 Writing Science (4)**
    Lecture/discussion—3 hours; extensive writing. Prerequisite: course 3 or Science and Technology Studies 1, or equivalent. Texts and writing practices in the production of scientific knowledge. Surveys the literary structure of scientific arguments; history of scientific genres; rhetoric and semiotics in scientific culture; graphical systems in the experimental laboratory; narratives of science, including science fiction. (Same course as Science & Technology Studies 164.) GE Credit: Wrt.—Milburn

  Justification: This class will study scientific writing which is important for me to understand so that I can read my resources critically and write an effective, well-composed final paper. It also relates to scientific communication in a more conventional way.

- **Environmental Science and Policy**
  - **ESP 179 Environmental Impact Assessment (4)**
    Lecture—3 hours; discussion—1 hour. Prerequisite: upper division standing and once course in ESP (course 100, 110, or equivalent). Introduction to the information resources and methods typically used in environmental impact analysis. Emphasis on how environmental regulation, and public policymaking, with case studies from California land use and natural resource policy. III. (III.) Quinn

  Justification: This class will more specifically equip me with the skills to analyze the environmental impact that these biofuels will have based on various aspects of them including processes in creating the fuels, products of burning the fuels, and many more. Its emphasis on policies and policymaking is also an important logistical factor to environmental conservation.

- **Food Science and Technology**
  - **FST 123 (3) Introduction to Enzymology (3) *if course 205 is not offered**
    Lecture—3 hours. Prerequisite: Biological Sciences 103. Principles of physical, chemical and catalytic properties of enzymes and their importance. Purification, characterization, and quantitative evaluation of reaction conditions on activity are stressed. Specificity and mechanism of action illustrated by use of selected enzymes. (Former course Biochemistry and Biophysics 123.)—III. (III.) G. Smith

  - **FST 205 Industrial Microbiology (3) *preferred if it is offered**
    Lecture—3 hours. Prerequisite: Biological Sciences 1A, 102, 103; Microbiology 130A-130B or Biological Sciences 101 recommended. Use of microorganisms for producing substances such as amino acids, peptides, enzymes, antibiotics and organic acids. Emphasis on metabolic regulation of pathways leading to fermentation products, on yeast fermentations, and on genetic manipulations (including recombinant DNA techniques) of industrial microorganisms. Offered in alternate years.
Either of these FST classes will be helpful but course 205 would be best as it has an emphasis on the industry. Fuel production is an industry and it would be important for me to understand it as such. The class will also focus on “pathways leading to fermentation products” and “genetic manipulations” both of which relate to the production of ethanol and butanol as large-scale fuels. Course 123 would provide some important knowledge but with an emphasis on enzymes as catalysts. Enzymes are used for the production of ethanol and butanol so this would be helpful to better understand their production processes as well.

- **Viticulture and Enology**
  - **VEN 186 Fermentation Science (3)**
    Lecture – 3 hours. Prerequisite: Microbiology 102, Biological Sciences 101. Basic principles of fermentation science and biotechnology with emphasis on industrial fermentation processes that generate useful products including fermented food and beverages, pharmaceuticals, fine chemicals, and other gene products.

  *Justification:* Because both of the biofuels on which I will be focusing are produced by fermentation, it is important for me to understand how exactly this process works. A firm understanding of the fermentation process will help me better understand ways in which these fuels can be mass produced and what kind of resources are necessary for their production. All of this will be relevant to the environmental impact of their production and the practicality aspect of my issues paper.

- **Science and Society**
  - **SAS 3 Science, Technology, and Society (4) *alternative to course 42**
    Lecture—4 hours. Impact of developments in science and technology on the individual in society and how economics, politics, culture and values affect technological development. Not open for credit to students who have completed former course Applied Behavioral Sciences 18. GE credit: SciEng or SocSci, Wrt.—(III.)

    *In the event that I cannot take course 42 either for the sake of units or if it is not approved, course 3 may be taken to investigate the way different groups in society accept and understand science and technology. This is important for determining the practicality of application for biofuels or any alternative fuel technology since the people using it must be the ones to determine whether such a conversion of technology is acceptable/desirable.

**TOTAL NUMBER OF UNITS: 24***

I would like to propose for the missing unit in this academic plan, that I search for an internship or other one-unit course related to my research topic. I have also spoken with my mentor, Dr. Franz, about possibly working in her laboratory where she is doing work on biodiesel and that is an option yet to be decided. I request that, until I can find a source for that one missing specialty elective unit, I be approved with the plan that I have currently. Ultimately, I am aware of the unit shortage and will be in the process of finding something with which to fill it – hopefully without substituting a less desirable class for another preferred class.

*total number with SAS 3 in substitution for SAS 42 is 25 units.*
PERSONAL INFORMATION
Name: Erin Kimsey
Birthdate: March 11, 1988
Contact Information:
  e-mail – Erin@ucdavis.edu
  phone – (212) 809-1600
  address – 1000 Tenth St. Apt. #451
  Davis, CA 95618

EDUCATION
University: University of California, Davis
Major(s): 1) Animal Biology
           2) Environmental Biology and Management – Conservation Biology emphasis
Expected Graduation Date: June 2011
Current GPA: 3.17

CAREER GOALS
It is my goal to graduate from UC Davis with a Bachelor's Degree of Science in these two majors and pursue a career in public education about conservation, biology, and sustainable living. In this way, I can combine my experiences in such fields and work to help people to make the small changes in their daily lives that make such a difference to our world and environment. I would much prefer to work in big cities that need the most help in reforming their environmental policies and eco-friendliness. My majors help to provide me with the knowledge necessary to help others in understanding the importance of sustainable practices and how that relates to all life.

PREVIOUS EMPLOYMENT/EXPERIENCE
Tour Guide – UC Davis Campus Events and Visitors Services
  February 2008 – present
  Responsibilities: showing prospective students the UC Davis campus while providing important information about the campus and university
  Skills: advanced public speaking (extemporaneous speech-giving), answering questions in a
pressured situation, memorization of statistics and other important information, working with public

Whole Earth Festival – SOULar Dance Stage Coordinator
November 2007 – present
Responsibilities: coordinating, scheduling, and booking cultural performances on a solar-powered dance stage at the UC Davis Whole Earth Festival 2008 and 2009
Skills: writing application forms and acceptance packets, reviewing said forms, selecting performers that meet the values of the festival, sending out acceptance packets, communicating with performers, making a schedule of performances, recruiting volunteers, communicating with solar power providers, communicating with sound providers, operating sound systems, assembling stage, decorating stage, directing performers on and off stage, emcee work, crowd control

Lab Assistant – VDx Veterinary Pathology Services
November 2006 – June 2007
Responsibilities: transcribing pathology reports, making tissue and cytology slides of samples sent from veterinary clinics for diagnostic purposes, filing, answering phones
Skills: typing, brief understanding of pathological diseases, office work, working with and accommodating clients, tissue-trimming, making slides, filing

Aquarist Volunteer – Santa Monica Pier Aquarium
June 2003 – August 2006
Responsibilities: preparing daily food for aquarium life; feeding aquarium animals; cleaning tanks and filtration systems; checking water chemistry for pH, nitrate, and other chemical levels in tanks; educating the public on pollution, aquarium life (esp. shark conservation and biology)
Skills: public speaking, water chemistry, understanding and communication of conservation and biology of marine ecosystems/animals, working with public

REFERENCES
Jody Dorroh – UC Davis Campus Events and Visitors Services Administrative Assistant
*Can be contacted for testimony to my public speaking skills, punctuality, responsibility and accountability levels, and work ethic
Contact information:
  jdydoroh@ucdavis.edu
  Campus Events & Visitor Services
Amanda Marchand – former Whole Earth Festival SOULar Dance Stage Coordinator and staff member
*Can be contacted for testimony to my ability to coordinate a large event and work with clients
Contact information:
    
    mandaflower@gmail.com
    
    (530) 574-6304

John Peauroi DVM – founder of Vdx
*Can be contacted for testimony to my lab skills and work ethic
Contact information
    
    jpeauroi@vdxpathology.com
    
    2019 Anderson Road, Suite C
    
    Davis, CA 95616
    
    (530) 753-4285

Tara Crow – Santa Monica Pier Aquarium Public Programs Manager
*Can be contacted for testimony to my enthusiasm for biology and conservation sciences, work ethic, public speaking skills, marine knowledge, ability to learn new skills quickly, commitment to work
Contact information:
    
    tcrow@healthebay.org
    
    1600 Ocean Front Walk
    
    Santa Monica, CA 90401
    
    (310) 393-6149 ext. 102