Project No. RU-7__

ANNUAL REPORT
COMPREHENSIVE RESEARCH ON RICE
January 1, 2009 - December 31, 2009

PROJECT TITLE: Beer and Rice Waste Conversion to Biodegradable Plastics via Bacterial Transformation

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COOPERATORS:

LEVEL OF 2009 FUNDING: $10,000.

OBJECTIVES AND EXPERIMENTS CONDUCTED, BY LOCATION, TO ACCOMPLISH OBJECTIVES:
The objective of the research of second year of the project was to increase the conversion rate of rice bran and rice hulls to lactic acid via bacteria fermentation. The experiments were conducted at Chico State University in the Biology and Chemistry departments and included bacterial conversion with four homolactic fermenting bacteria from the genera *Lactobacillus* and *Lactococcus*. Other experiments utilized rice bran and rice hulls as sources of glucose and beer yeast cells as a source of nitrogen. Conditioning experiments were used to increase the yield of lactic acid with the use of carbon black, acid treatments, base treatments, and autoclave treatments.

SUMMARY OF 2009 RESEARCH (major accomplishments), BY OBJECTIVE:
The major accomplishments include the following for the objective of converting rice bran and hulls to lactic acid:

1. Denaturing rice bran and hulls from lignin with acid pretreatments to increase the release of glucose and lactic acid production.
2. Rice hulls and rice bran are an acceptable carbohydrate source for lactic acid production if they are pretreated with acid, steam in an autoclave, then followed by exposure to an enzyme.
3. Rice bran can be converted to lactic acid with a maximum yield of 40%.
4. Rice hulls can be converted to lactic acid with a maximum yield of 20%.
5. The cellulose in rice hulls and rice bran is converted to glucose through a hydrolysis step and then the glucose is fermented to lactic acid from the bacterium in the nitrogen rich media.
6. Steam explosion pretreatment followed by acid wash and enzyme treatment increased the conversion yields of rice hulls to lactic acid but was not needed with rice bran.
7. Lactic acid can be polymerized into PLA plastic with reasonable thermal properties.

PUBLICATIONS OR REPORTS:

The research was published in the SPE Global Plastics Environmental Conference 2009, Orlando Florida, (March 2009), Center for Undergraduate Research (CUR) Poster Session Presentation on Capitol Hill, Washington D.C. (May, 2009), Biopolymers Symposium, Chicago, IL, (September 2009)

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

Lactic acid can be produced from rice and beer waste materials via bacterial fermentation. The overall goal of the research is to produce lactic acid from 100% waste products from beer and rice manufacturing processes. The research project was a continuation of a previous year's research that established the technical feasibility of converting rice and beer waste into sugars and then lactic acid. The current research optimized the process to increase conversion of rice waste into sugars and then lactic acid.

Experimental research included isolating the rice bran and rice hulls with acid treatments, heating the waste materials in an autoclave, and then treating the effluent with enzymes. The pretreatment conditions were optimized for increased conversion of waste rice to glucose and production of lactic acid using one bacterium. The first step in the conversion process is to expose the rice hulls and rice bran to acids and then enzymes to convert the rice waste to glucose. The optimized pretreatment process included grinding the rice bran and hulls in a blender, mixing the rice powder with 0.1 M sulfuric acid, and then heating the buffered mixture in an autoclave for 50 minutes at 120°C and 1 atmosphere pressure. The optimized pretreatment process converted between 40 and 50% of the rice bran to glucose and 20 to 30% of the rice hulls to glucose. The second step is to convert the glucose to lactic acid through an inoculation process. The optimized inoculation process included exposing the rice glucose solution to *Lactobacillus* bacterium for 5 days with yeast as a nitrogen nutrient at 34°C in an incubator. The optimized inoculation process converted between 90 and 100% of the glucose from rice bran and 40 to 50% of glucose from rice hulls to lactic acid. The lactic acid was polymerized to polylactic acid powder plastic. The PLA plastic was molded into flat plates, though in limited quantities. A preliminary business case study found that pretreatment and inoculation processes can be expanded to larger scale manufacturing to produce more amounts of lactic acid and PLA.