Lactic acid fermentation using dairy manure as the sole carbon and nitrogen source

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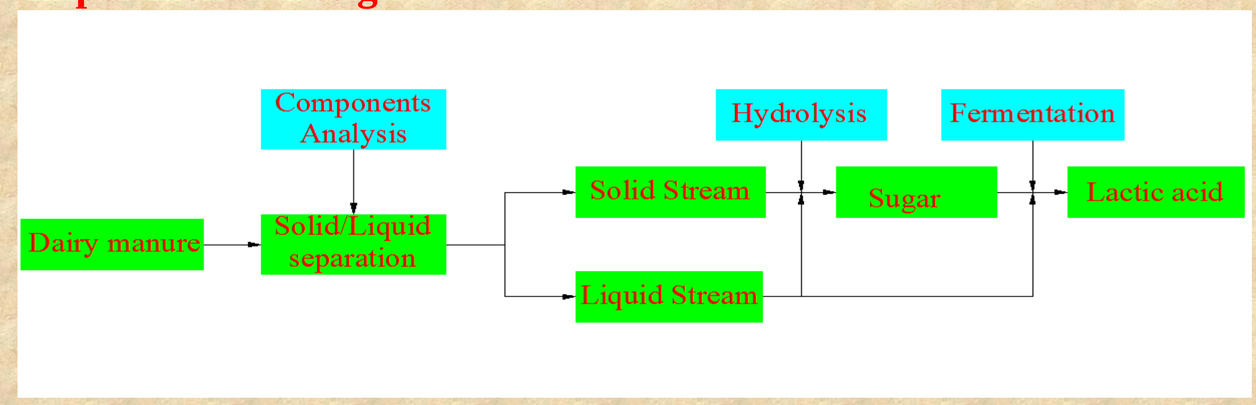
Introduction

L-Lactic acid is one of the most important organic acids utilized in food, pharmaceutical, and chemical industries especially in the production of biodegradable plastics that can replace the fossil-fuel-based non-biodegradable plastic materials widely used in many aspects of life today, leading to the reduction of global consumption of the diminishing petroleum resources. This project is aimed at exploring a novel idea of producing lactic acid from dairy manure, via batch fermentation by microorganisms such as fungi, with emphasis on the feasibility and possibility of microbial use of the nutrients in the manure (carbon and nitrogen source) for lactic acid production. The specific objectives of this project can be summarized as follows: 1) develop effective processes for dairy manure hydrolysis by fungi by determining the most effective microbial culture or flora and the optimal operating parameter values for hydrolysis and 2) investigate the feasibility and techniques of converting the hydrolysates into lactic acid through fermentation without external nutrients and optimize the fermentation conditions to enhance lactic acid production.

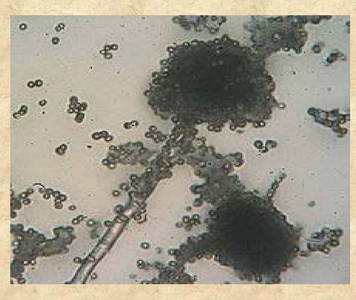
Experimental Design



Enrichment and screening of Cellulose Degradation Fungi:

Trichoderma reesei

White rot fungi

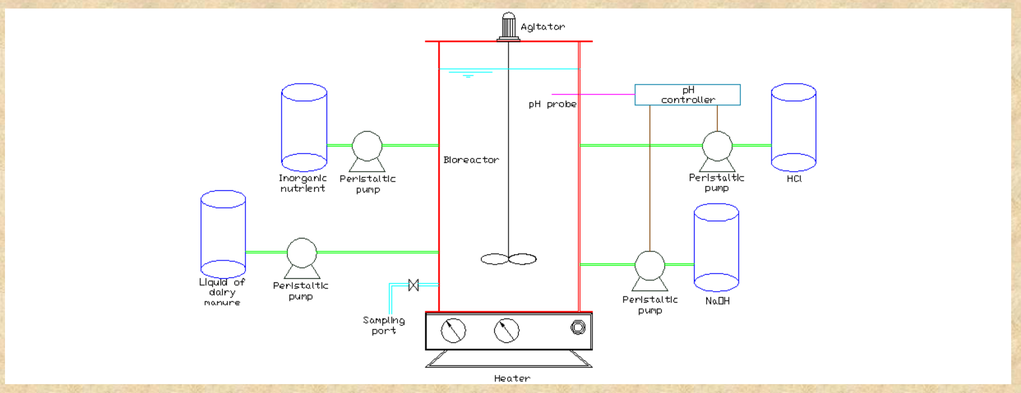


Rhizopus oryzae

Hydrolysis experiment:

The three types of reaction catalyzed by cellulases:1. Breakage of the non-covalent interactions present in the crystalline structure of cellulose (endo-cellulase) 2. Hydrolysis of the individual cellulose fibers to break it into smaller sugars (exo-cellulase) 3. Hydrolysis of disaccharides and tetrasaccharides into glucose (beta-glucosidase).

Fermentation experiment:

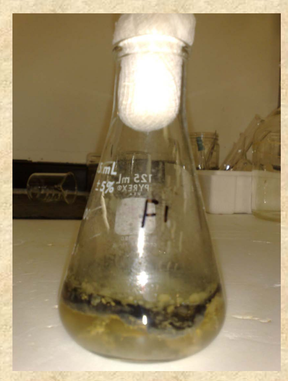


Experimental Progress

Optical condition for nutrient release

Various physical factors including particle size, temperature, pH, and so on may influence the release of organic materials from dry dairy manure. The effect of these factors on release of protein and carbohydrate was investigated in this study using orthogonal experiments with three factors (particle size, temperature and pH) at three levels. Test results suggested that particle size of 1.0-1.4 mm accounted for almost half of the dry manure particles and the optimum condition for release of protein and carbohydrate for this particle size category were pH 13 under reaction temperature of 90^{o}C, under which the protein and carbohydrate release rates could reach 233.36% and 373.36%, respectively. The degree to which these factors affected organics release was in the order from high to low of temperature > pH > particle size.

Six fungi screened form soil



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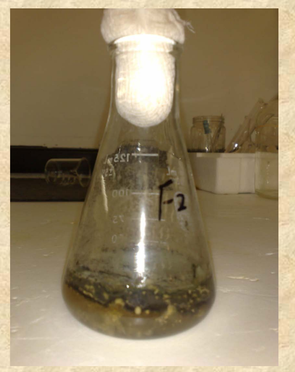

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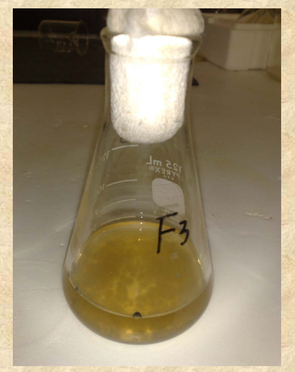

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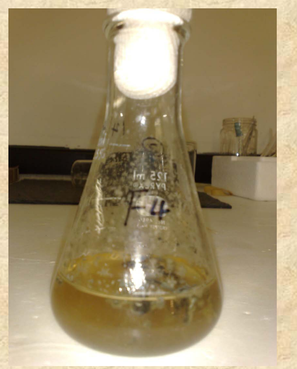

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Future works

Future works will be mainly focused on 1) choosing the most effective microbial species for hydrolyzing cellulosic materials, such as dairy manure and corn stover; 2) determining the optical condition of cellulose hydrolysis by biological method; 3) obtaining the highest fractional conversion from reducing sugar to lactic acid by biological technologies through adjusting the reaction condition.

Summary

The project started from May 2010 and will be ended in May 2011. At present, the project is being carried out step by step according to the proposal. Upon completion of the project, the knowledge will be gained in the following areas: 1) the effective processes for dairy manure or other agricultural residues hydrolysis by the most effective microbial culture 2) the feasibility and techniques of converting the hydrolysates from dairy manure into lactic acid by fermentation without external nutrients.

Acknowledgement

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