Guidelines for MAFMA Final Report

Final Reports due 3 months after completion of project
(4-5 pages)

Project Title **A Fermentation-Ultrafiltration Process for Xanthan Gum Production from Waste Sugars**

PI (s) Shang-Tian Yang

Co-PI (s)

Academic Institution The Ohio State University

Award Date 07/15/2006 - 10/31/2008

Please complete all questions below and attached form

1. Objective Summary (1-2 sentence summary)

The goal of this project was to develop a fermentation-ultrafiltration process for the production of high-quality cell-free xanthan gum from glucose and galactose derived from lactose in cheese whey. The optimized process will be scaled up for commercial use to benefit the dairy industry by providing a high-value food product from their wastes.

2. Objective Accomplishments
   (If objectives were not met, what extenuating circumstances contributed to that factor?)
   Convey all of your progress on this project including that obtained with the industry and other matching funds.

A novel, rotating fibrous bed (RFB) bioreactor was developed for cell immobilization to produce cell-free xanthan broth. The centrifugal force generated from rotating the fibrous matrix separates the xanthan polymer from the immobilized cells, thus producing a cell-free xanthan broth. Ultrafiltration was used as an energy-efficient process to concentrate the cell-free xanthan broth before further purification with alcohol precipitation. The permeate from ultrafiltration can be recycled and reused in the fermentation, saving the raw material costs and reducing the amount of spent medium. The feasibility of scaling up the integrated fermentation and ultrafiltration process for xanthan gum production from glucose and galactose derived from lactose in cheese whey was also demonstrated. However, more engineering work will be needed in order to scale up the RFB bioreactor for industrial applications.

3. Unexpected findings, if any

We encountered some difficulties in operating the RFB bioreactor due to poor durability of the tubing used in the laboratory scale system. The tubing usually would break down after one week of continuously pumping with the peristaltic pump, and thus must be replaced in the middle of a fermentation run, which increased the risk of contamination and process failure. This is mainly because of the high viscosity of xanthan gum broth which increased with time as the fermentation proceeded. A gear pump, which replaced the peristaltic pump, was also used but failed to pump the viscous xanthan solution after a few days due to cavitation caused by air bubbles. Careful selection of an appropriate type of pump is thus critical in scaling up the process.

4. Practical impacts of research efforts. Include: implementation of accomplishments by industry partners (if any), identification of economic impacts, and any further pursuit by PI of research in area of this project whether MAFMA or not.

a. Short Term Impacts

We demonstrated the feasibility of the proposed technology and process for converting whey lactose to xanthan gum with improved process economics and product quality. We continue to work with our industrial partner, Bioprocessing Innovative Company, in further optimizing the process and working on its scale up. The company is currently working on a USDA SBIR Phase II project on the related technology.

b. Long Term Impacts

Xanthan gum is a microbial polysaccharide widely used as a suspending, stabilizing, and thickening agent in the food industry. It is also used as a lubricant, emulsifier, or mobility-control agent in pharmaceutical and oil-recovery industries. The worldwide market for xanthan gum is more than 75,000 tons per year and continues to grow at an annual rate of 5-10%. The market for xanthan gum will increase even more with the expanding market of "healthy food," in which xanthan gum plays a major role in creating rich texture with little calories. Xanthan gum is commercially produced by fermentation of glucose. The product is then recovered and purified using alcohol precipitation. The present process is energy-intensive and costly because the highly viscous xanthan broth causes agitation and aeration to be difficult in conventional stirred-tank fermentors. Consequently, conventional xanthan gum fermentation has low xanthan concentration and low productivity. The rotating fibrous bed (RFB) bioreactor (US Patent No. 6787340) developed in this project can produce a cell-free xanthan gum broth at a high concentration (>7.5%) and high productivity (>1 g/L·h) without any difficulty for further concentration by ultrafiltration to greater than 15% (w/v). The new process using RFB bioreactor for fermentation followed by ultrafiltration can produce a much better quality xanthan gum product at a fraction of the current production cost.

This project also demonstrated the feasibility of producing xanthan gum from glucose and galactose derived from lactose in cheese whey. There are ~80 billion lbs of cheese whey generated annually in the dairy industry and much of this byproduct has no economical use at the present time and requires costly disposal because of its high biological oxygen demand (BOD). By converting the whey lactose (and the monosaccharides from lactose hydrolysis) to xanthan gum, we can produce a high-value product for various industrial applicatioins while also solve the whey disposal problem facing the dairy industry.

5. If you are also making reports to other funding agencies in the course of this research work, please include a copy of that report.

6. a. If any publications resulted from the research, a copy must be included. Please note we were notified by the USDA/CSREES National Program Leader for the Midwest Advance Food Manufacturing Alliance (MAFMA) that all publications resulting from research that was funded by MAFMA must include the following wording **"The project was supported by the USDA Cooperative State Research, Education and Extension Service, special research grant number 200X-34328-xxxxx.**

b. If any patents (pending or granted) resulted from the research, please include the patent information.