NATIONAL CENTER FOR AGRICULTURAL UTILIZATION RESEARCH

Microbial Genomics & Bioprocessing Research

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Research

The goal of my research is to acquire, characterize, and improve new microorganisms as biocatalysts for the production of large volumes of valuable bioproducts from glycerol and lipids as derived from renewable agricultural materials. Research in my laboratory focuses on two major areas for optimal production of targeted bioproducts: (1) the discovery and development of novel microbial bioconversion systems and (2) the enhancement of advanced fermentation technology.

Novel Microbial Bioconversion Systems
The current research emphases in our laboratory that involve the development of novel microbial bioconversion systems are aimed at (1) the effective utilization of glycerol from biodiesel production and (2) the production of novel fatty amides from plant lipids. Glycerol is a major by-product from the production of biodiesel fuels, a fast-growing industry resulting in an annual production of over 1 billion pounds of surplus soybean oil in the U.S. We are producing new microbial systems that produce industrial chemicals and polymer feedstocks, such as 3-hydroxypropionaldehyde (3-HPA), 3-hydroxypropionic acid, 1,3-propanediol, rhamnolipid biosurfactants, etc., from these surplus glycerol stocks. Many of these chemicals can be further modified to produce important industrial compounds. For instance, 3-HPA can be oxidized to 3-hydroxypropionic acid and acrylic acid, important building blocks for paints, synthetic plastics, and other polymers.

Advanced Fermentation Technology
Our research on the development of advanced fermentation technology is aimed at achieving scale-up production of bioproducts in quantities sufficient for testing of new industrial uses. An ongoing project for developing an improved technology is based on a successful reactor process that uses a new aeration mechanism to overcome excessive foaming generated by hydrophobic substrates and surface-active products. The model systems used

for this study involve previously characterized microbes (e.g., *Nocardia cholesterolicum*, *Sphingobacterium thalpophilum, Pseudomonas aeruginosa,* and *Bacillus sphaericus*) that synthesize novel biochemical products from the bioconversion of fatty acids in small shake fermentation flasks. The new knowledge gained from this research is expected to greatly benefit glycerol utilization research.

Selected Publications

Kuo, T. M. and Nakamura, L. K. 2004. Diversity of oleic acid, ricinoleic acid and linoleic acid conversions among Pseudomonas aeruginosa strains.
Curr Microbiol. 49:261-266.

Labeda DP, Jackson MA, **Kuo** TM, Nakamura LK. 2004. Enantioselective hydrolysis of butyl 2-ethylhexanoate by a strain of Nocardia corynebacteroides.
Curr. Microbiol.49:133-135.

Kuo, T. M. and Lanser, A. C. 2003. Factors influencing the production of a novel compound, 7,10-dihydroxy-8(*E*)-octadecenoic acid, by *Pseudomonas aeruginosa* PR3 (NRRL B-18602) in batch cultures. *Curr. Microbiol.* 47:186-191.

Kuo, T. M., Ray, K. J. and Manthey, L. K. 2003. A facile reactor process for producing 7,10-dihydroxy-8(*E*)-octadecenoic acid from oleic acid conversion by *Pseudomonas aeruginosa*. *Biotechnol. Lett.* 25:29-33,

Kuo, T. M., Kaneshiro, T. and Hou, C. T. 2002. Microbiological conversions of fatty acids to value-added products. pp. 605-628. In Kuo, T. M. and Gardner, H. W. (eds.) *Lipid Biotechnology,* Marcel Dekker, New York, NY. 728 pp.

Kuo, T. M., Nakamura, L. K. and Lanser, A. C. 2002, Conversion of fatty acids by *Bacillus sphaericus*-like organisms. *Curr. Microbiol.* 45:265-271,

Kuo, T. M. and Kaneshiro, T. 2001. Selection of saprophytic bacteria and characterization of their fatty acid bioconversions during compost formation. pp. 55-64. In Saha, B. C. and Demirjian, D. C. (eds.) *Applied Biocatalysis in Specialty Chemicals and Pharmaceuticals,* ACS Books, Washington, DC. 292 pp.

Kuo, T. M., Kim, H. and Hou, C. T. 2001. Production of a novel compound, 7,10,12-trihydroxy-8(*E*)-octadecenoic acid from ricinoleic acid by *Pseudomonas aeruginosa* PR3. *Curr. Microbiol.* 43:198-203.

Kuo, T. M., Lanser, A. C., Nakamura, L. K. and T. and Hou, C. T. 2000. Production of 10-ketostearic acid and 10-hydroxystearic acid by strains of *Sphingobacterium thalpophilum* isolated from composted manure. *Curr. Micobiol.* 40:105-109.

Kuo, T. M. and Hou, C. T. 1999. Bioconversions of unsaturated fatty acid by *Pseudomonas aeruginosa* PR3. *Recent Res. Developments in Oil Chem.* 3:1-10.

Kuo, T. M., Lanser, A. C., Kaneshiro, T. and Hou, C. T. 1999. Conversion of oleic acid to 10-ketostearic acid by *Sphingobacterium* sp. strain O22. *J. Am. Oil Chem. Soc.* 76:709-712.

Kuo, T. M., Manthey, L. K. and Hou, C. T. 1998. Fatty acid bioconversions by *Pseudomonas aeruginosa* PR3. *J. Am. Oil Chem. Soc.* 75:875-879.

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