NATIONAL CENTER FOR AGRICULTURAL UTILIZATION RESEARCH

Microbial Genomics & Bioprocessing Research

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Research

Research in my laboratory focuses on developing new microbial processes for adding functionality groups to plant lipids or their component fatty acids to produce value-added food and industrial products. The goal is to develop new products from surplus soybean oil or its component fatty acids through bioprocesses. Oxygenated fatty acids such as hydroxy-, keto-, epoxy-, and cyclic fatty acids are important industrial chemicals and as materials in national defense. Castor oil and its derivatives (hydroxy fatty acid) are classified by the Department of Defence as strategic and critical materials. Newly discovered hydroxy unsaturated fatty acids were reported to have interesting physiological activity. Several microorganisms and biocatalytic processes have been identified that introduce new functional groups to the inner carbon atoms of fatty acids. These hydroxy fatty acids are classified into three types, namely: monohydroxy, dihydroxy and trihydoxy fatty acids.

DOD and TOD
A microbial culture, *Pseudomonas aeruginosa* PR3, was found to convert oleic acid to a new compound, 7,10-dihydroxy-8(E)-octadecenoic acid (DOD). The absolute configuration of DOD is 7(*S*),10(*S*)-dihydroxy-8(*E*)-octadecenoic acid. An intermediate for the synthesis of DOD was identified as 10S-hydroxy-8(E)-octadecenoic acid. DOD has surface-active properties and has antimicrobial activity against *Bacillus subtilis* and common clinical yeast, *Candida albicans.* Strain PR3 also converts ricinoleic acid to 7,10,12-trihydroxy-8(*E*)-octadecenoic acid (TOD). An intermediate, 10,12-dihydroxy-8*(E)*-octadecenoic acid was also identified for the synthesis of TOD. TOD showed anti-plant pathogenic fungal activities, especially on the rice blast fungus. Strain PR3 also converts linoleic acid to many isomeric 9,10,13 (9,12,13)-trihydroxy-11*E* (10E)-

octadecenoic acids. One kilogram of DOD was produced and several companies are investigating its application, uses include production of polyurethane rigid foam, skin care products and others.

12,13,17-THOA, THFAs, and DEOA
Another microbial culture, *Clavibacter* sp. ALA2 was found to convert linoleic acid to a new product, 12,13,17-trihydroxy-*9(Z)*-octadecenoic acid (12,13,17-THOA). 12,13,17-THOA inhibits the growth of many plant pathogenic fungi. Strain ALA2 also produced the following products from linoleic acid: two tetrahydrofuranyl fatty acids (THFAs), 12-hydroxy-13,16-epoxy-*9(Z)*-octadecenoic acid and 7,12-dihydroxy-13,16-epoxy-*9(Z)*-octadecenoic acid; two diepoxy bicyclic fatty acids, 12,17;13,17-diepoxy-*9(Z)*-octadecenoic acid (DEOA) and 12,17;13,17-diepoxy-7-hydroxy-9(Z)-octadecenoic acid (hDEOA). Tetrahydrofuranyl compounds are known to have anticancer activity. The diepoxy bicyclic fatty acids are complete new chemical entities. With many functionality groups on the molecules, their application in biomedical as well as specialty chemical industries is expected. We are trying to scale up production of these compounds. We are also working on lipases for production of structured lipids and healthy oils.

Selected Publications

Hosokawa, M. **Hou**, C.T., Weisleder, D., and Brown, W. 2003. Biosynthesis of tetrahydrofuranyl fatty acids from linoleic acid by *Clavibacter* sp. ALA2. J. Am. Oil Chem. Soc. 80:145–149.

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Kim, H., Kuo, T.M., and **Hou**, C.T. 2000. Production of 10,12-dihydroxy-8(E)-octadecenoic acid, an intermediate in the conversion of ricinoleic acid to 7,10,12-trihydroxy-8(E)-octadecenoic acid by *Pseudomonas aeruginosa* PR3. J. Ind. Microbiol. Biotechnol. 24:167-172.

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