

## REFERENCES

- A.O.A.C. 1999. Official Methods of Analysis of AOAC International. Vol. II 16<sup>th</sup> Ed. AOAC International. USA.
- Abramic, M., Lescic, I., Korica, T., Vitale, L., Saenger, W. and Pigac, J. 1999. Purification and properties of extracellular lipase from *Streptomyces rimosus*. Enzyme Microb. Technol. 25: 522-529.
- Adlercreutz, P. 1991. Immobilized enzymes. In Food Enzymology vol.2 (Fox, P.F., ed) p. 103-118. Elsevier Applied Science. London.
- Adlerhorst, K., Bjorkling, F., Godtfredsen, S.E. and Kirk, O. 1990. Enzyme catalyzed preparation of 6-O-acylglycopyranoside. Synthesis. 2: 112-115.
- Akoh, C.C. 1996. Enzymatic modification of lipids. In Food Lipids and Health (McDonald, R.E. and Min, D.D., ed) p. 117-134. Marcel Dekker. New York.
- Akoh, C.C. and Swanson, B.G. 1990. Optimized synthesis of sucrose polyester : Comparison of physical properties of sucrose polyester, raffinose polyester and salad oils. J. Food Sci. 55: 236-243.
- Akoh, C.C. 1994. Enzymatic synthesis of acetylated glucose fatty acid esters in organic media. J. Am. Oil Chem. Soc. 71: 319-323.
- Akoh, C.C. and Mutua, L.N. 1993. Synthesis of alkyl glucoside fatty acid ester : Effect of reaction parameters and incorporation of n-3 polyunsaturated fatty acid. Enzyme Microb. Technol. 16: 115-119.
- Arcos, J.A., Bernabe, M. and Otero, C. 1998. Quantitative enzymatic production of 1,6-diacyl fructofuranoses. Enzyme Microb. Technol. 22: 27-35.
- Arcos, J.A., Bernabe, M. and Otero, C. 1998. Quantitative enzymatic production of 6-O-acylglucose esters. Biotechnol. Bioeng. 57: 505-509.
- Arcos, J.A., Bernabe, M. and Otero, C. 1998. Quantitative enzymatic production of 1,6-diacyl sorbitol esters. Biotechnol. Bioeng. 60: 53-60.
- Arcos, J.A., Hill, C.G. and Otero, C. 2001. Kinetic of the lipase-catalyzed synthesis of glucose esters in acetone. Biotechnol. Bioeng. 73: 104-113.
- Balcao, V.M., Paiva, A. and Malcata, F.X. 1996. Bioreactors with immobilized lipases : State of art. Enzyme Microb. Technol. 18: 392-416.
- Basri, M., Ampom,K., Yunus, W.M.Z.W., Razak, C.N.A. and Salleh, A.B. 1995. Enzymatic synthesis of fatty esters by hydrophobic lipase derivatives immobilized on organic polymer beads. J. Am. Oil Chem. Soc. 72: 407-411.

- Becker, P., Abu-Reesh, I., Markossian, S., Antranikian, G. and Mark, H. 1997. Determination of the kinetics parameters during continuous cultivation of the lipase-producing thermostable *Bacillus* sp. [HI-9] on olive oil. *Appl. Microbiol. Biot.* 42: 184–190.
- Benjamin, S. and Pandey, A. 1996. Optimization of liquid media for lipase production by *Candida rugosa*. *Bioresource Technol.* 55: 167–170.
- Bornscheuer, U.T. 2000. Enzymes in Lipid Modification. Wiley–VCH. Weinheim.
- Bornscheuer, U.T. and Kazlauskas, R.J. 1999. Hydrolases in Organic Synthesis: Regio- and Stereo-selective Biotransformation. Wiley–VCH. Weinheim.
- Bousquet, M.P., Willenot, R.M. and Monsan, P. 1999. Enzymatic synthesis of unsaturated fatty acid glucoside esters for dermo-cosmetic applications. *Biotechnol. Bioeng.* 63: 730–736.
- Bradford, M. 1976. A rapid and sensitive method for the quantification of microgram quantities of protein utilizing the principle of protein-dye binding. *Anal. Biochem.* 72: 248–254.
- Cameleyre, X., Bouchu, A., Guibert, A. and Combs, D. 1997. Reverse hydrolysis reaction in aqueous medium without any cosolvents-application to synthesis of glycosidic esters of tyrosine. *Appl. Biochem. Biotech.* 62: 61–69.
- Castro-Ochoa, L.D., Rodriguez-Gomez, C., Valerio-Alfaro, G. And Ros, R.O. 2005. Screening, purification and characterization of thermoalkalophilic lipase produced by *Bacillus thermoleovorans* CCR11. *Enzyme Microb. Technol.* 37: 648–654.
- Cao, L., Bornscheuer., U.T. and Schmid, R.D. 1999. Lipase-catalyzed solid-phase synthesis of sugar esters. Influence of immobilization on productivity and stability of enzyme. *J. Mol. Catal. B: Enzymatic.* 6: 279–285.
- Cao, L., Bornscheuer, U. T. and Schmid, R.D. 1996. Lipase-catalyzed solid phase synthesis of sugar esters. *Fett/Lipid.* 98: 332–335.
- Cao, L., Fischer, A., Bornscheuer, U.T. and Schmid, R.F. 1997. Lipase-catalyzed solid phase synthesis of sugar fatty acid esters. *Biocatal. Biotrans.* 14: 269–283.
- Cardenas, F. Castro, M.S. Sanchez-Motero, J.M. Sinisterra, J.V. Valmaseda, M. Elson, S.W. and Alvarez, E. 2001. Novel microbial lipases : catalytic activity in reaction in organic media. *Enzyme Microb. Technol.* 28: 145–154.
- Castillo, E., Pezzotti, F., Navorro, A. and Lo, A. 2003. Lipase-catalyzed synthesis of xylitol monoesters: solvent engineering approach. *J. Biotechnol.* 102: 251–259.

- Chahinian, H., Vanot, G., Ibrik, A., Rugani, N., Sarda, L. and Comeau, L.C. 2000. Production of extracellular lipases by *Penicillium cyclopium* purification and characterization of partial acylglycerol lipase. *Biosic. Biotechnol. Biochem.* 64: 215-222.
- Chamouleau, F., Coulon, D. Girardin, M. and Ghoul, M. 2001. Influence of water activity and water content on sugar esters lipase-catalyzed synthesis in organic media. *J. Mol. Catal. B: Enzymatic.* 11: 949-945.
- Chaplin, M.F. and Bucke, C. 1990. *Enzyme Technology*. Cambridge University Press. Cambridge.
- Chartrain, M., Katz, L., Marcin, C., Thien, M., Smith, S., Fisher, F., Goklen, K., Salmon, P., Brix, T., Price, K. and Greasham, R. 1993. Purification and characterization of a novel bioconverting lipase form *Pseudomonas aeruginosa* MB 5001. *Enzyme Microb. Technol.* 15: 575-580.
- Chen, H.P., Hsiao, K.F., Wu, S.H. and Wang, K.T. 1995. Regioselectivity enhancement by partial purification of lipase from *Aspergillus niger*. *Biotechnol. Lett.* 17: 305-308.
- Chen, J.Y., Wen, C.M. and Chen, T.L. 1999. Effect of oxygen transfer on lipase production by *Acinetobacter radioresistens*, *Biotechnol. Bioeng.* 62: 311-316.
- Choi, Y.J. and Lee, B.H. 2001. Culture conditions for the production of esterase from *Lactobacillus casei* CL96. *Bioproc. Biosyst. Eng.* 24: 59-63.
- Chopineau, J., McCafferty, F.D., Therisod, M. and Klibanov, A.M. 1988. Production of biosurfactants from sugar alcohol and vegetable oils catalyzed by lipases in a nonaqueous medium. *Biotechnol. Bioeng.* 31: 208-214.
- Corzo, G. and Revah, S. 1999. Production and characterization of the lipase from *Yarrowia lipolytica* 681. *Bioresource Technol.* 70: 173-180.
- Costa, M.A. and Peralta, R.M. 1999. Production of lipase by soil fungi and partial characterization of lipase from a selected strain (*Penicillium wortmanii*). *J. Basic Microbiol.* 39: 11-15.
- Coulon, D. Girardin, M., Povel, B. and Bhoul, M. 1995. Comparison of direct esterification and transesterification of fructose by *Candida antarctica* lipase. *Biotechnol. Lett.* 17: 183-186.
- Coulon, D., Ismail, A., Girardin, M., Bovel, B. and Ghoul, M. 1996. Effect of different biochemical parameters on the enzymatic synthesis of fructose oleate. *J. Biotechnol.* 51: 115-121.

- Coulon, D., Girardin, M., Engasser, J.M. and Ghoul, M. 1997. Investigation of keys parameters of fructose oleate enzymatic synthesis catalyzed by an immobilized lipase. Ind. Crop Prod. 6: 375–381.
- Coulon, D., Girardin, M. and Ghoul, M. 1999. Enzymic synthesis of fructose monooleate in a reduced pressure pilot scale reactor using various acyl donors. Process Biochem. 34: 913–918.
- Degn, P., Pedersen, L.H., Duus, J. and Zimmermann, W. 1999. Lipase-catalyzed synthesis of glucose fatty acid esters in *tert*-butanol. Biotechnol. Lett. 21: 275–280.
- Degn, P. 2000. Enzymatic synthesis of carbohydrate fatty acid ester in organic media. Ph.D. Thesis. Aalborg University, Aalborg, Denmark.
- Degn, P. and Zimmermann, W. 2001. Optimization of carbohydrate fatty acid ester synthesis in organic media by lipase from *Candida antarctica*. Biotechnol. Bioeng. 74: 483–491.
- Dharmsthit, S. and Luchai, S. 1999. Production, purification and characterization of thermophilic lipase from *Bacillus* sp. THL027. FEMS Microbiol. Lett. 179: 241–246.
- Dong, H., Gao, S., Han, S.P. and Cao, S.G. 1999. Purification and characterization of a *Pseudomonas* sp. lipase and its properties in non-aqueous media. Biotechnol. Appl. Biochem. 30: 251–256.
- Ducret, A., Giroux, A., Trani, M. and Lortie, R. 1995. Enzymatic preparation of biosurfactants from sugar or sugar alcohols and fatty acids in organic media under reduced pressure. Biotechnol. Bioeng. 48: 214–221.
- Elibo, M. And Ozer, D. 2001. Influence of oxygen transfer on lipase production by *Rhizopus arrhizus*. Process Biochem. 36: 325–329.
- El Khattabi, M., Van Gelder, P., Bitter, W. and Tommassen, J. 2000. Role of the lipase specific fold of *Burkholderia glumae* as a stearic chaperone. J. Biol. Chem. 275: 26885–26891.
- Essamri, M., Deyris, V. and Comeau, L. 1998. Optimization of lipase production by *Rhizopus oryzae* and study on the stability of lipase activity in organic solvents. J. Biotechol. 60: 97–103.
- Ferrer, M., Cruces, M.A., Bernabe, A.B., and Plou, F.J. 1999. Lipase-catalyzed regioselective acylation of sucrose in two-solvent mixture. Biotechnol. Bioeng. 65: 10–16.

- Ferrer, M., Cruces, M.A., Plou, F.J., Bernabe, M. and Ballesteros, A. 2000. A simple procedure for the regioselective synthesis of fatty acid ester of maltose, leucrose, maltotriose and *n*-dodecyl maltoside. *Tetrahedron*. 56: 4053–4061.
- Ferrer, M., Soliveri, J., Plou, F.J., Lopes-Cortes, N., Reyes-Duarte, D., Christensen, M., Copa-Patino, J.L. and Ballesteros, A. 2005. Synthesis of sugar esters in solvent mixtures by lipases from *Thermomyces lanuginosus* and *Candida antarctica* B, and their antimicrobial properties. *Enzyme Microb. Technol.* 36: 391–398.
- Flores, M.V., Naraghi, K., Engasser, J.M. and Halling, P.J. 2002. Influence of glucose solubility and dissolution rate on the kinetics of lipase catalyzed synthesis of glucose laurate in 2-methyl-2-butanol. *Biotechnol. Bioeng.* 78(7): 814–820.
- Fregapane, G., Sarney, D.B., Greenber, G., Knight, D.J. and Bulfson, D.N. 1994. Enzymatic synthesis of monosaccharide fatty acid esters and their comparisons with conventional products. *J. Am. Oil Chem. Soc.* 71: 87–91.
- Fullbrook PD. 1996. Practical applied kinetics. In *Industrial Enzymology*. (Godfrey, T. and West, S., ed). p. 483–450. Stockholm Press. New York.
- Ganske, F. and Bornscheuer, W. 2005. Optimization of lipase-catalyzed glucose fatty acid ester synthesis in a two-phase system containing ionic liquids and *t*-BuOH. *J. Mol. Catal. B: Enzymatic.* 36: 40–42.
- Gao, X.G., Cao, S.G. and Zhang, K.C. 2000. Production, properties and application to nonaqueous enzymatic catalysis of lipase from a newly isolated *Pseudomonas* strain. *Enzyme Microb. Technol.* 27: 74–82.
- Ghanem, E.H., Al-Sayed, H.A. and Saleh, K.M. 2000. An alkalophilic thermostable lipase produced by a new isolate of *Bacillus alcalophilus*. *World J. Microbiol. Biotechnol.* 16: 459–464.
- Ghosh, P.K., Saxena, T.K., Gupta, R., Yadav, R.P. and Davidson, S. 1996. Microbial lipases: production and applications. *Sci. Prog.* 79:119–157.
- Godtfredsen, S.E. 1991. Microbial lipases. In *Microbial Enzymes and Biotechnology*. (Fogarty, W.M. and Kelly, C.T., ed). p. 255–270. Elsevier Applied Science. New York.
- Gordillo, M.A., Obradors, N., Montesinos, J.L., Valero, F., Lafuente, J. and Sola, C. 1995. Stability studies and effect of the initial oleic acid concentration on lipase production by *Candida rugosa*, *Appl. Microbiol. Biotechnol.* 43: 38–41.
- Gulati, R., Saxena, R.K., Gupta, R., Yadav, R.P. and Sheba Davidson, W. 1999. Parametric optimization of *Aspergillus terreus* lipase production and its potential in ester synthesis. *Process Biochem.* 35: 459–464.

- Gupta, N., Rathi, P., Singh, R., Goswami, K.V. and Gupta, R. 2005. Single-step purification of lipase from *Burkholderia multivorans* using polypropylene matrix. *Appl. Microbiol. Biotechnol.* 67: 648–653.
- Hau, C.T. 1994. pH dependence and thermostability of lipases from cultures from ARS culture. *J. Ind. Microbiol.* 26: 13–242–248.
- Helisto, P. and Korpela, T. 1998. Effect of detergents on activity of microbial lipases as measured by the nitrophenyl alkonate esters methods. *Enzyme Microb. Technol.* 23: 113–117.
- Hiol, A., Jonzo, M.D., Druet, D. and Comeau, L. 1999. Production, purification and characterization of an extracellular lipase from *Mucor hiemalis* f. *hiemalis*. *Enzyme Microb. Technol.* 25: 80–87.
- Honda, K., Kataoka, M., Ono, H., Sakamoto, K., Kita, S. Shimizu, S. 2002. Purification and characterization of a novel esterase promising for the production of useful compounds from *Microbacterium* sp. 7–1W. *FEMS Microbiol. Lett.* 206: 221–227.
- Humeau, C., Girardin, M., Coulon, D. and Miclo, A. 1995. Synthesis of 6-O-palmitoyl L-ascorbic acid catalyzed by *Candida antarctica* lipase. *Biotechnol. Lett.* 17: 1091–1094.
- Ikeda, I. And Klibanov, A.M. 1993. Lipase-catalyzed acylation of sugars solubilized in hydrophobic solvent by complexation. *Biotechnol. Bioeng.* 42: 788–791.
- Immamura, S. and Kitaura, S. 2000. Purification and characterization of a monoacylglycerol lipase from the moderately thermophilic *Bacillus* sp. H-257. *J. Biochem.* 127: 419–425.
- Iso, M., Chen, B., Eguchi, M., Kudo, T. and Shrestha, S. 2001. Production of biodiesel fuel from triglycerides and alcohol using immobilized lipase. *J. Mol. Catal. B: Enzymatic.* 16: 53–58.
- Iyengar, R. and Gross, A. 1991. Fat substitutes. In *Biotechnology and Food Ingredients*. (Goldberg, I. and Williams, R., ed) p. 287–311. Van Nostrand Reinhold. New York.
- Jaeger, K.E. and Eggert, T. 2002. Lipases for biotechnology. *Curr. Opin. Biotechnol.* 13: 390–397.
- Jaeger, K. E. and Reetz, M. T. 1998. Microbial lipases form versatile tools for biotechnology. *Trends Biotechnol.* 16: 396–403.
- Janssen, A.E.M., Lefferts, A.G. and Fiet, K. 1990. Enzymatic synthesis of carbohydrate esters in aqueous media. *Biotechnol. Lett.* 12: 711–716.

- Janssen, P.H., Monk, C.R., Morgan, H.W. 1994. A thermophilic, lipolytic *Bacillus* sp. and continuous assay of its *p*-nitrophenyl-palmitate esterase activity. FEMS Microbiol. Lett. 120: 195–200.
- Kademi, A., Ait-Abdelkader, N., Fakhreddine, L. and Baratti, J.C. 1999. A thermostable esterase activity from newly isolated moderate thermophilic bacterial strains. Enzyme Microb. Technol. 24: 332–338.
- Kademi, A., Ait-Abdelkader, N., Fakhreddine, L. and Baratti, J.C. 2000. Characterization of new thermostable esterase from the moderate thermophilic bacterium *Bacillus circulans*. J. Mol. Catal. B: Enzymatic. 10: 395–401.
- Kaewthong, W. 2003. Continuous production of monoacylglycerols by glycerolysis of palm olein with immobilized lipase. Ph.D. Thesis in Biotechnology. Prince of Songkla University, Hat Yai, Thailand.
- Keawthong, W. and H-Kittikun, A. 2004. Glycerolysis of palm olein by immobilized lipase PS in organic solvents. Enzyme Microb. Technol. 35: 218–222.
- Kambourova, M., Kirilova, N., Mandeva, R. and Derekova, A. 2003. Purification and properties of thermostable lipase from a thermophilic *Bacillus stearothermophilus* MC7. J. Mol. Catal. B:Enzymatic. 22: 307–313.
- Kamini, N.R., Fujii, T., Kurosu, T. and Iefuji, H. 2000. Production, purification and characterization of an extracellular lipase from the yeast, *Cryptococcus* sp. S-2. Process Biochem. 36: 317–324.
- Kaminishi, Y., Tanie, H. and Kimimoto, M. 1999. Purification and characterization of lipase from *Aspergillus repens* and *Eurotium herbariorum* NU-2 used in “Katsuobushi” modeling. Fisheries Sci. 65: 274–278.
- Kanwar, L., Gogoi, B.K. and Goswami, P. 2002. Production of a *Pseudomonas* lipase in n-alkane substrate and its isolation using an improved ammonium sulphate precipitation technique. Bioresource Technol. 84: 207–211.
- Kanwar, S.S., Ghazi, I.A., Chimni, S.S., Joshi, G.K., Rao, G.V., Kaushal, R.K., Gupta, R. and Punj, V. 2006. Purification and properties of a novel extra-cellular thermotolerant metallolipase of *Bacillus coagulans* MTCC-6375 isolate. Protein Express. Purif. 46: 421–428.
- Karadzic, I., Masui, A., Zivkovic, L.I. and Fujiwara, N. 2006. Purification and characterization of an alkaline lipase from *Pseudomonas aeruginosa* isolated from putrid mineral cutting oil as component of metalworking fluid. J. Biosci. Bioeng. 102: 82–89.

- Kenedy, J.F. and Cabral, J.M.S. 1987. Enzyme immobilization. In *Biotechnology*. Vol. 7a *Enzyme Technology* (Kennedy, J.F., ed.) p. 247–404. VCH Publishers. New York.
- Khaled, N., Montet, D., Pina, M., and Graille, J. 1991. Fructose oleate synthesis in a fixed catalyst bed reactor. *Biotechnol. Lett.* 13: 167–172.
- Kim, H.K., Park, S.Y., Lee, J.K. and Oh, T.K. 1998. Gene cloning and characterization of thermostable lipase from *Bacillus stearothermophilus* L1. *Biosci. Biotechnol. Biochem.* 62: 66–71.
- Kim, J.E., Han, J.J., Yoon, J.H. and Rhee, J.S. 1997. Effect of salt hydrate pair on lipase-catalyzed regioselective monoacylation of sucrose. *Biotechnol. Bioeng.* 57: 121–125.
- Kim, J.W., Shim, Y.S. and Yoon, S.S. 1997. Isolation and purification of a lipase from *Pseudomonas* sp. Y0103 isolated from raw milk. *Korean J. Dairy Sci.* 19: 17–24.
- Kimura, Y., Tanaka, A., Sonomoto, K., Nihira, T. and Fukui, S. 1983. Application of immobilized lipase to hydrolysis of triacylglyceride. *Eur. J. Appl. Microb. Biotechnol.* 17: 107–112.
- Klein, R.R., King, G., Moreau, R.A. and Haas, M.J. 1997. Altered acyl chain length specificity of *Rhizopus delemar* lipase through mutagenesis and molecular modeling. *Lipids.* 32: 123–130.
- Kobayashi, T., Adachi, S. and Matsuno, R. 2003. Kinetic analysis of the immobilized-lipase-catalyzed synthesis of octanoyl octyl glucoside in acetonitrile. *Biochem. Eng.* 16: 323–328.
- Kohno, M., Kugimiya, W., Hashimoto, Y. and Morita, Y. 1994. Purification, characterization and crystallization of two types of lipases from *Rhizopus niveus*. *Biosci. Biotechnol. Biochem.* 58: 1007–1012.
- Kojima, Y., yokoe, M. and Mase, T. 1994. Purification and characterization of an alkaline lipase from *Pseudomonas fluorescens* AK102. *Biosci. Biotechnol. Biochem.* 58: 1564–1568.
- Kumar, S., Kikon, K., Upadhyay, A., Kanwar, S.S. and Gupta, R. 2005. Production, purification, and characterization of lipase from thermophilic and alkaliphilic *Bacillus coagulans* BTS-3. *Protein Express. Purif.* 41: 38–44.
- Kuwabara, K., Watanabe, Y., Adachi, S., Nakanishi, K. and Matsuno, R. 2003. Synthesis of 6-O-unsaturated acyl L-ascorbates by immobilized lipase in acetone in the presence of molecular sieves. *Biochem. Eng.* 3718: 1–6.
- Laemmli, U.K. 1970. Cleavage of structure proteins during the assembly of the head of bacteriophage T4. *Nature.* 227: 680–685.

- Large, K.P. Mirjalili, N., Osborne, M. Peacock, L.M., Zormpaidis, V., Walsh, M., Cavanagh, M.E., Leadlay, P.F. and Ison, A.P. 1999. Lipase activity in *Streptomyces*. Enzyme Microb. Technol. 25: 569-575.
- Lee, C.Y. and Yandolo, J.J. 1986. Losogenic conversion of staphylococcal lipase is caused by insertion of the bacteriophage L54a into the lipase structural gene. J. Bacteriol. 166: 385-391.
- Lee, D., Kok, Y., Kim, K., Kim, B., Choi, H., Kim, D., Suhartona, M.T. and Pyun, Y. 1999. Isolation and characterization of a thermophilic lipase from *Baillus thermoleovorans* ID-1. FEMS Microbiol. Lett. 179: 393-400.
- Lee, H.K., Ahn, M.J., Kwak, S.H., Song, W.H. and Jeong, B.C. 2003. Purification and characterization of cold active lipase from psychrotrophic *Aeromonas* sp. LPB4. J. Microbiol. 41: 22-27.
- Lee, S.Y. and Rhee, J.S. 1993. Production and partial purification of a lipase from *Pseudomoans putida* 3SK. Enzyme Microb. Technol. 15: 617-623.
- Lescic, I., Vukelic, B., Majeric-Elenkov, M., Saenger, W. and Abramic, M. 2001. Substrate specificity and effects of water-miscible solvents on the activity and stability of extracellular lipase from *Streptomyces rimosus*. Enzyme Microb. Technol. 29: 548-553.
- Lessuisse, E., Schanck, K. and Colson, C. 1993. Purification and preliminary characterization of the extracellular lipase of *Bacillus subtilis* 168, an extremely basic pH-tolerant enzyme. Eur. J. Biochem. 216: 155-160.
- Li, C.Y., Cheng, C.Y. and Chen, T.L. 2001. Production of *Acinetobacter radioresistens* lipase using Tween 80 as the carbon source. Enzyme Microb. Technol. 29: 258-263.
- Li, H. and Zhang, X. 2005. Characterization of thermostable lipase from thermophilic *Geobacillus* sp. TW1. Protein Express. Purif. 42: 153-159.
- Lin, S.F., Lee, J.C. and Chiou, C.M. 1996a. Purification and partial characterization of an alkaline lipase from *Pseudomonas pseudoalcaligenes* F-111. Appl. Environ. Microbiol. 62: 1093-1095.
- Ljunger, G., Adlercreutz, P. and Mattiasson, B. 1994. Lipase catalyzed acylation of glucose. Biotechnol. Lett. 16: 1167-1172.
- Long, K., Ghazali, H.M., Ariff, A. Ampon, K. and Bucke, C. 1996. In-situ crosslinking of *Aspergillus flavus* lipase : improvement of activity, stability and properties. Biotechnol Lett. 20: 369-372.

- Lotrakul, P. and Dharmsthit, S. 1997. Lipase production by *Aeromonas sobria* LP004 in a medium containing whey and soybean meal. *World J. Microbiol. Biotechnol.* 13: 163-166.
- Maag, H. and Huls, C.W. 1984. Fatty acid derivatives : Important surfactants for household, cosmetic and industrial purposes. *J. Am. Oil Chem. Soc.* 61: 259-267.
- Macedo, G.A., Park, Y.K. and Postor, G.M. 1997. Partial purification and characterization of an extracellular lipase from a newly isolated strain of *Geotrichum* sp. *Rev. Microbiol.* 28: 90-95.
- Maia, M.M.D., Heasley, A., Camargo, M.M., Melo, E.H.M., Ledingham, W.M. and Lima Filho, J.L. 2001. Effect of culture conditions on lipase production by *Fusarium solani* in batch fermentation. *Bioresource Technol.* 76: 23-27.
- Malcata, F.X., Reyes, H.R., Garcia, H.S., Hill, C.G. and Amundson, C.H. 1992. Kinetics and mechanisms of reaction catalyzed by immobilized lipases. *Enzyme Microb. Technol.* 14: 426-446.
- Mayordoma, I., Randez-Gil, F. and Prieto, J.A. 2000. Isolation, purification and characterization of a cold active lipase from *Aspergillus nidulans*. *J. Agric. Food Chem.* 48: 105-109.
- Meens, J., Herbort, M., Klein, M. And Fredudl, R. 1997. Use of the pre-pro part of *Staphylococcus hyicus* lipase as carrier for secretion of *Escherichia coli* outer membrane protein A prevents proteolytic degradation of Omp A by cell associated proteases in two different Gram positive bacteria. *Appl. Environ. Microbiol.* 63: 2814-2820.
- Mohd Suria Affandi, Y. 1994. Selected readings on palm oil and its uses: In Refining and Downstreaming Processing of Palm and Palm Kernel Oil. p. 35-50. Palm Oil Research Institute of Malaysia, Malaysia.
- Montero, S., Blanco, A., Virto, M.D., Landeta, L.C., Agud, I., Solozabal, R., Lascaray, J.M., Renobales, M., Llama, M.J. and Serra, J.L. 1993. Immobilization of *Candida rugosa* lipase and some properties of the immobilized enzyme. *Enzyme Microb. Technol.* 15: 239-247.
- Mukherjee, K.D. 1998. Lipase-catalyzed reactions for modification of fats and other lipids. *Biocatalysis.* 3: 277-293.
- Mutua, L.N. and Akoh, C.C. 1993. Synthesis of alkyl glycoside fatty acid esters in non-aqueous media by *Candida* sp. Lipase. *J. Am. Oil Chem. Soc.* 70: 43-46.
- Nakashima, T., Fukuda, H., Kyotani, S. and Morikawa, H. 1988. Culture conditions for intracellular lipase production by *Rhizopus chinesis* and its immobilization within biomass support particles. *J. Ferment. Technol.* 66: 441-448.

- Nawani, N., Dosanjh, N.S. and Kaur, J. 1998. A novel thermostable lipase from a thermophilic *Bacillus* sp. : characterization and esterification studies. *Biotechnol. Lett.* 20: 997-1000.
- Nawani, N. and Kaur, J. 2000. Purification, characterization and thermostability of lipase from a thermophilic *Bacillus* sp. J33. *Mol. Cell. Biochem.* 206: 91-96.
- Oguntiemein, G.B., Erdmann, H. and Schmid, R.D. 1993. Lipase catalyzed synthesis of sugar ester in organic solvents. *Biotechnol. Lett.* 15: 175-180.
- Ohishi, K., Yoshida, Y., Toita, J. and Sekiguchi, J. 1994. Purification and characterization of a novel lipolytic enzyme from *Aspergillus oryzae*. *J. Ferment. Bioeng.* 78: 413-419.
- Ollis, D.L. Cheah, E., Cygler, M., Dijkstra, B., Frolov, F., Franken, S.M., Harel, M., Remington, S.J., Silman, I., Schrag, J., Sussman, J.L., Verschueren, K.H.G., Goldman, A. 1992. The  $\alpha/\beta$  hydrolase fold. *Protein Eng.* 5: 197-211.
- Oosterom, M.W.V., Fantwijk, F.V. and Sheldon, R.A. 1996. Regioselective acylation of disaccharides in *tert*-butyl alcohol catalyzed by *Candida antarctica* lipase. *Biotechnol. Bioeng.* 49: 328-333.
- Otto, R.T., Bornscheuer, U.T., Syldatk, C. and Schmid, R.D. 1998. Lipase-catalyzed synthesis of arylaliphatic esters of  $\beta$ -D(+)-glucose, n-alkyl- and arylglucosides and characterization of their surfactant properties. *J. Biotechnol.* 64: 231-237.
- Park, O.J., Kim, D.Y. and Dordick, J.S. 2000. Enzyme-catalyzed synthesis of sugar-containing monomer and linear polymers. *Biotechnol. Bioeng.* 70: 209-216.
- Paripatanapairod, W. 2003. Production of methyl esters from palm stearin using immobilized lipase. Master Thesis in Biotechnology. Prince of Songkla University, Hat Yai, Thailand.
- Pedersen, N.R., Wimmer, R., Emmersen, J., Degn, P. and Pedersen, L.H. 2002. Effect of fatty acid chain length on initial reaction rates and regioselectivity of lipase-catalyzed esterification of disaccharides. *Carbohydr. Res.* 337: 1179-1184.
- Petrovic, S.E., Skringar, M., Becarevic, I.F. and Banka, L. 1990. Effect of various carbon sources on microbial lipase biosynthesis. *Biotechnol. Lett.* 12: 299-304.
- Pignede, G., Wang, H., Fudalej, F., Gailardin, C., Seman, M. and Nicaud, J.M. 2000. Characterization of an extracellular lipase encoded by LIP2 in *Yarrowia lipolytica*. *J. Bacteriol.* 182: 2802-2810.
- Plou, F.J., Ferrer, M., Nuero, O.M., Calvo, M.V., Alcalde, M., Reyes, F. and Ballesteros, A. 1998. Analysis of Tween 80 as an esterase/lipase substrate for lipolytic activity assay. *Biotechnol. Tech.* 12: 183-186.

- Rakmi, A. R., Tjahjono, H. and Othman, O. 1997. Preparation of biodegradable and vegetable based surfactant from sugar and palm fatty acid catalyzed by *Mucor miehei* lipase. *Elaeis*. 9: 100–110.
- Rathi, P., Saxena, R.K. and Gupta, R. 2001. A novel alkaline lipase from *Burkholderia cepacia* for detergent formulation. *Process Biochem.* 37: 187–192.
- Rich, J.O., Bedell, B.A. and Dordick, J.S. 1994. Controlling enzyme-catalyzed regioselectivity in sugar ester synthesis. *Biotechnol. Bioeng.* 45: 426–434.
- Rua, M.L., Schmidt-Dannert, C., Wahl, S., Sprauer, A., Schmidt, R.D. 1998. Thermo alkalophilic lipase of *Bacillus thermocatenulatus* large-scale production, purification and properties: aggregation behavior and its effect on activity. *J. Biotechnol.* 56: 89–102.
- Rusnak, M. 2004. Untersuchungen zur enzymatischen enantiomerentrennung von glykolethern und etablierung neuer methoden des synthethischen shufflings. Ph.D. Thesis. Stuttgart University, Germany.
- Rosu, R., Uozaki, Y., Iwasaki, Y. and Yamane, T. 1997. Repeated used of immobilized lipase for monoacylglycerol production by solid-phase glycerolysis of olive oil. *J. Am. Oil Chem. Soc.* 74: 445–450.
- Sakaki, K., Aoyama, A., Nakane, T., Ikegami, T., Negishi, H., Watanabe, K. and Yanagishita., H. 2006. Enzymatic synthesis of sugar esters in organic solvent coupled with pervaporation. *Desalination*. 193: 260–266.
- Salis, A., Pinna, M.C., Murgia, S. and Monduzzi, M. 2004. Novel mannitol based non-ionic surfactants from biocatalysis. *J. Mol. Catal. B: Enzymatic.* 27: 139–146.
- Salis, A., Pinna, M., Monduzzi, M. And Solinas, V. 2005. Biodiesel production form triolein and short chain alcohols through biocatalysis. *J. Biotechnol.* 119: 291–299.
- Salleh, A.B., Musani, R. and Razak, C.N.A. 1993. Extra and intracellular lipases form a thermophilic *Rhizopus oryzae* and factors affecting their production. *Can. J. Microbiol.* 39: 978–981.
- Salunkhe, D.K., Chavan, J.K., Adsule, R.N. and Kadam, S.S. 1992. World Oil Seeds: Chemistry, Technology and Utilization. p. 217–230. Van Nostrand Reinhold. New York.
- Sarney, D.B., Kapeller, H., Fregapane, G., and Bulfson E.N. 1994. Chemo-enzymatic synthesis of disaccharide fatty acid esters. *J. Am. Oil Chem. Soc.* 71: 711–714.
- Sarney, D.B. and Vulfson, E.N. 1995. Application of enzymes to the synthesis of surfactant. *Trends Biotechnol.* 13: 164–172.

- Saxena, R.K., Davidson, W.S., Sheoran, A. and Giri, B. 2003. Purification and characterization of an alkaline thermostable lipase from *Aspergillus carneus*. Process Biochem. 39: 239–247.
- Saxena, R.K., Sheoran, A., Giri, B. and Sheba Davidson, W. 2003. Purification strategies for microbial lipases. J. Microbiol. Meth. 52: 1–18.
- Schmidt-Dannert, C., Rua, M.L., Atomi, H. and Schmid, R.D. 1996. Thermoalkalophilic lipase of *Bacillus thermocatenulatus*: I Molecular cloning, nucleotide sequence, purification and some properties. Biochim. Biophys. Acta. 1301: 105–114.
- Schrag, J.D., Li, Y., Cygler, M., Lang, D.A., Burgdorf, T., Schmid, H.J. Hecht, R., Schomburg, D., Rydel, T., Oliver, J., Stricklan, L., Dunnaway, M., Larson, S., McPherson, A. 1997. The open conformation of a *Pseudomonas* lipase. Structure. 5: 187–202.
- Scheckermann, C., Schlotterbeck, A., Schmid, M., Wray, V. and Lang S. 1995. Enzymatic monoacylation of fructose by two procedures. Enzyme Microb. Technol. 17: 157–162.
- Schlotterbeck, A., Lang, S., Wray, V. and Wagner, F. 1993. Lipase-catalyzed monoacylation of fructose. Biotechnol. Lett. 15: 61–64.
- Schuepp, C., Kermasha, S., Michalski, M.C. and Morin, A. 1997. Production, partial purification and characterization of lipase from *Pseudomonas fragi* CRDA 037. Process Biochem. 32: 225–232.
- Sebeder, S., Habulin, M. and Knez, Z. 2006. Lipase-catalyzed synthesis of fatty acid fructose ester. J. Food Eng. 77: 880–886.
- Seino, H., Uchibori, T., Nishitani, T. And Inamasu, S. 1984. Enzymatic synthesis of carbohydrate esters of fatty acids (1) esterification of sucrose, glucose, fructose and sorbitol. J. Am. Oil Chem. Soc. 61: 1761–1765.
- Sharma, R., Ghisti, Y. and Banerjee, U.C. 2001. Production, purification, characterization and application of lipases. Biotechnol. Adv. 19: 627–662.
- Sharma, R., Soni, S.K., Vohra, R.M., Gupta, L.K. and Gupta, J.K. 2002. Purification and characterization of a thermostable alkaline lipase form a new thermophilic *Bacillus* sp. RSJ-1. Process Biochem. 37: 1075–1084.
- Sharon, C., Furugoh, S., Yamakido, T., Ogawa, H.I. and Kato, Y. 1998. Purification and characterization of a lipase from *Pseudomonas aeruginosa* KKa-5 and its role in castor oil hydrolysis. J. Ind. Microbiol. Biotechnol. 20: 304–307.
- Shibatani, S., Kitagawa, M. and Tokiwa, Y. 1997. Enzymatic synthesis of vinyl sugar ester in dimethylformamide. Biotechnol. Lett. 19: 511–514.

- Shu, C.H., Xu, C.J. and Lin, G.C. 2006. Purification and partial characterization of a lipase from *Antordia cinnamomea*. *Process Biochem.* 41: 734–738.
- Sierra, G. 1957. A simple method for the detection of lipolytic activity of microorganisms and some observations on the influence of the contact between cells and fatty substrates. *Anton. Leeuw. Int. J. B.* 23: 15–22.
- Simons, J.W., van Kampen, M.D., Riel, S., Gotz, F., Egmond, M.R. and Verhey, H.M. 1998. Cloning, purification and characterization of the lipase from *Staphylococcus epidermidis*—comparison of the substrate selectivity with those of other microbial lipases. *Eur. J. Biochem.* 253: 675–683.
- Sin, Y.M., Cho, K.W. and Lee, H.T. 1998. Synthesis of fructose esters by *Pseudomonas* sp. lipase in anhydrous pyridine. *Biotechnol. Lett.* 20: 91–94.
- Sinchaikul, S., Sookkheo, B., Phuttrakul. And Pan, F.M. 2001. Optimization of a thermostable lipase from *Bacillus stearothermophilus* P1: Overexpression, purification and characterization. *Protein Expres. Purif.* 22: 388–398.
- Snellmann, E., Sullivan, R. and Colwell, R.R. 2002. Purification and properties of the extracellular lipase, LiA, of *Acinetobacter* sp. RAG-1. *Eur. J. Biochem.* 269: 5771–5779.
- Soedjak, H.S. and Spradlin, S.E. 1994. Enzymatic transesterification of sugars in anhydrous pyridine. *Biocatalysis.* 11: 241–248.
- Sommer, P., Bormann, C. and Gotz, F. 1997. Genetic and biochemical characterization of a new extracellular lipase form *Streptomyces cinnamomeus*. *Appl. Environ. Microbiol.* 63: 3553–3560.
- Song, Q.X. and Wei, D.Z. 2002. Study of vitamin C ester synthesis by immobilized lipase from *Candida* sp. *J. Mol. Catal. B: Enzymatic.* 18: 261–266.
- Soultani, S., Engtasser, J.M. and Ghoul, M. 2001. Effect of acyl donor chain length and sugar/acyl donor molar ratio on enzymatic synthesis of fatty acid fructose esters. *J. Mol. Catal. B: Enzymatic.* 11: 725–731.
- Soumanou, M.M., Bornscheuer, U.T., Menge, U. and Schmid, R.D. 1997. Synthesis of structured triglycerides from peanut oil with immobilized lipase. *J. Am. Oil Chem. Soc.* 74: 427–433.
- Sugihara, A., Shimada, Y., Nakamura, M., Nagao, T. and Tominaga, Y. 1994. Positional and fatty acid specificities of *Geotrichum candidum* lipase. *Protein Eng.* 7: 585–588.
- Sugihara, A., Scnoo, T., Enoki, A., Shimada, Y., Nagao, T. and Tominaga, Y. 1995. Purification and characterization of a lipase from *Pichia burtonii*. *Appl. Microbiol. Biotechnol.* 43: 227–281.

- Sztajer, H., Maliszewska, I. and Wieczorek, J. 1988. Production of exogenous lipase by bacteria, fungi and actinomycetes. *Enzyme Microb. Technol.* 10: 492-497.
- Tanaka, K., Yoshida, K., Sasaki, C. and Osano Y.T. 2002. Practical asymmetric synthesis of the herbicide (S)-indanofan via lipase-catalyzed kinetic resolution of a diol and stereoselective acid-catalyzed hydrolysis of a chiral epoxide. *J. Org. Chem.* 67: 3131-3133.
- Terstappen, G.C., Geerts, A.J. and Kula, M.R. 1992. The use of detergent-based aqueous two-phase systems for the isolation of extracellular proteins: purification of a lipase from *Pseudomonas cepacia*. *Biotechnol. Appl. Biochem.* 16: 228-235.
- Tsitsimpikou, H., Daflos, H. and Kolisis F.N. 1997. Comparative studies on the sugar ester synthesis catalyzed by *Candida antarctica* and *Candida rugosa* lipases in hexane. *J. Mol. Catal. B: Enzymatic.* 3: 189-192.
- Tsuzuki, W., Kitamura, Y., Suzuki, T. and Kobayashi, S. 1999. Synthesis of sugar fatty acid esters by modified lipase. *Biotechnol. Bioeng.* 64 : 267-271.
- Wang, Y., Srivastava, K.C, Shen, G.J., Wang, H.Y. 1995. Thermostable alkaline lipase from a newly isolated thermophilic *Bacillus* strain A30-1 (ATCC 53841). *J. Ferment. Bioeng.* 79: 433-438.
- Ward, O.P., Fang, J. and Li, Z. 1997. Lipase-catalyzed synthesis of a sugar ester containing arachidonic acid. *Enzyme Microb. Technol.* 20: 52-56.
- Watanabe, Y., Miyawaki, Y., Adachi, S., Nakanishi, K. and Matsuno, R. 2000. Synthesis of lauroyl saccharide through lipase-catalyzed condensation in microaqueous water-miscible solvents. *J. Mol. Catal. B: Enzymatic.* 10: 241-247.
- Watanabe, Y., Miyawaki, Y., Adachi, S., Nakanishi, K. and Matsuno, R. 2001. Equilibrium constant for lipase-catalyzed condensation of mannose and lauric acid in water-miscible organic solvents. *Enzyme Microb. Technol.* 29: 494-498.
- Wong, D.W.S. 1995. Food enzymes. In Structure and Mechanism. p. 170-200. Chapman&Hall. New York.
- Yadav, R.P., Saxena, R.K., Gupta, R. and Sheba Davison, W. 1998. Purification and characterization of a regiospecific lipase from *Aspergillus terreus*. *Biotechnol. Appl. Biochem.* 28: 243-249.
- Yahya, A.R.M. Anderson, W.A. and Moo-Young, M. 1998. Ester synthesis in lipase catalyzed reactions. *Enzyme Microb. Technol.* 23 : 438-450.
- Yamane, T. Enzyme technology for the lipids industry: an engineering overview. 1987. *J. Am. Oil Chem. Soc.* 64: 1657-1662.

- Yan, Y., Bornscheuer, U.T., Cao, L. and Schmid, R.D. 1999a. Lipase-catalyzed solid-phase synthesis of sugar fatty acid esters. Removal of byproducts by azeotropic distillation. Enzyme Microb. Technol. 25: 725-728.
- Yan, Y., Bornscheuer, U.T., Stadler, G., Lutz-Wahl. S., Otto, R.T., Reuss, M. and Schmid, R.D. 2001. Regioselective lipase-catalyzed synthesis of glucose ester on a preparative scale. Eur. J. Lipid. Sci. Technol. 103: 583-587.
- Yang, J., Kobayashi, K., Iwasaki, Y., Nakano, H. and Yamane, T. 2000. In vitro analysis of roles of a disulfide bridge and a calcium binding site in activation of *Pseudomonas* sp. strain KWI 56 lipase. J. Bacteriol. 182: 295-302.
- Yankah, V.V. and Akoh, C.C. 2001. Zero energy fat-like substances. In Olestra. Structured and Modified Lipids (Gunstone, F.D. ed.) p. 511-536. Marcel Dekker. New York.
- Yeo, S.H., Nihira, T. and Yamada, Y. 1998. Purification and characterization of *tert*-butyl ester-hydrolyzing lipase from *Burkholderia* sp. YY62. Biosci. Biotechnol. Biochem. 62: 2312-2317.
- Zhu, K., Jutila, A., Tuominen, E.K.J., Patkar, S.A., Svendsen, A. and Kinnunen, P.K. 2001. Impact of the tryptophan residues of *Humicola lanuginose* lipase on its thermal stability. Biochim. Biophys. Acta. 1547: 329-338.
- American University, Washington D.C., USA. 2007. (Online). Available  
<http://www.american.edu/TED/images3/fig12.gif> (20 December 2006)