Production of trehalose lipoic acid esters using immobilized novozym 435

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ABSTRACT

Sugar fatty acid esters are new non-ionic surfactants consisting of a sugar and a fatty acid. Due to their amphiphilic nature, biodegradable, non-toxic and renewable function, they are of great interest in the food, cosmetic and pharmaceutical applications. Currently, esterification reactions are carried out by chemical processes in industries. The biosynthesis of such esters by lipase-catalyzed chemical reactions under mild conditions has become of much current commercial interest. According to currently available reference, most of them used lipase to catalyze the synthesis of sugar fatty acid esters from sucrose, fructose and maltose. Production of trehalose fatty acid with the lipase is quite limited in the literature. The aim of the stady was to establish a process for synthesis of trehalose fatty acid. The synthesis of trehalose fatty acid from trehalose and lipoic, was carried out by a esterification reaction catalyzed by immobilized lipase from Candida Antarctica (Novozym 435). The results showed that we had successfully obtained pure trehalose mono-lipoate which had been confirmed by HPLC-MASS. The actual chemical structure will be identified in the near future.

Keywords : Biocatalysis、Carbohydrates、Direct esterification、Ester、Lipase、Lipoic acid、Trehalose

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REFERENCES

1.王浩昱。2002。在超臨界二氧化碳流體中以之解酵素催化合成乙酸乙酯之研究。大葉大學食品工程研究所碩士論文，彰化。 2.田蔚城。1997。生物技術的發展與應用。九州圖書文物有限公司，台北。 3.朱炫威。脂解酵素在有機溶劑中水解棕櫚核仁軟脂之研究。大葉大學食品工程研究所碩士論文，彰化。 4.何國慶和丁立孝。2007。食品酵素學。五南圖書出版股份有限公司，台中。 5.李素菁和華傑。2004。食品產業導入生物科技之效益評估。食品工業發展研究所。 6.高宇。2005。生物化學。鼎茂圖書出版股份有限公司，台北。 7.張淑微。2002。以反應曲面法研究酵素合成以己醇酯類之最優化。大葉大學食品工程研究所碩士論文，彰化。 8.許德發、鄭智交、楊濟華、李仰穿、溫慧萍及許照紅。2002。化妝品概論。第107-120頁。華格那企業有限公司，台中。 9.陳怡臻及蕭斯欣。1998。台灣生物科技術產業1997/1998。財團法人生物科技開發中心，台北。 10.彭志英。2004。食品酵素學。九州圖書文物有限公司，台北。 11.蕭介夫。1996。酵素工技與蛋白質工程研究之新發展。生物產業，第29-35頁。 12.謝雯玲。2001。台灣生物科技產業的發展。淡江大學國際

貿易研究所碩士論文，台北。 13.鐵翠娟、寇秀芬、徐家立。2002。固定化脂肪酵素催化合成6,6 ’-海藻糖月桂酸酯。催化學報，第一期。 14.Addo, K., Slepak, M. and Akoh, C.C. 1995. Effects of sucrose fatty acid ester and blends on alveograph characteristics of wheat flour doughs. Journal of Cereal Science. 22: 123-127. 15.Aloksey, Z., Alexander, M. and Klibanov. 1984. Enzymatic catalysis in organic media at 100 °C. Science., 24: 1249-1251. 16.Brich, G.G., Wolfrom, M.L. and Tyson, R.S. 1963. Advances in carbohydrate chemistry. Academic Press New York., 18: 201-225. 17.Chakraborty, S., Sahoo, B., Teraoka, I., Miller, L. M. and Gross, R. A. 2005. Enzyme-catalyzed regioselective modification of starch nanoparticles. Macromolecules., 38: 61-68. 18.Chen, J., Kimura, Y., and Adachi, S. 2005. Synthesis of linoleoy disaccharides through lipase-catalyzed condensation and their surface activities. Journal of Bioscience and Bioengineering. 100: 274-279. 19.Degn, B. and Zimmermann, W. 2001. Optimization of carbohydrate fatty acid ester synthesis in organic media by a lipase from Candida antarctica. Biotechnology and Bioengineering. 74: 483-491. 20.Devulapalle, K.S., Segura, A.G., Ferrer, M., Alcalde, Miguel., Mooser, G. and Plouim, F.J. 2004. Effect of carbohydrate fatty acid esters on Strptococcus sobrinus and glucosyltransferase activity. Carbohydrate Research, 339: 1029-1034. 21.Elbein, A.D.,Tipson, R.S. and Horton, D. 1974. Advances in Carbohydrate Chemistry and Biochemistry. Academic Press, New York. 30: 227-256. 22.Ferrer, M., Cruces, M. A., Plou, F. J., Bernabe, M. and Ballesteros, A. 2000. A simple procedure for the regioselectivs synthesis of fatty acid esters of maltose, leucrose, maltoriose and n-dodecyl maltosides. Tetrahedron.,56: 4053-4061. 23.Ferrer, M., Soliveri, J., Plou, F.J., Lopez-Cortes, N., Reyes-Duarte, D., Christensen, M., Copa-Patino, J.L. and Ballesteros, A. 2005. Synthesis of sugar ester in solvent mixtures by lipases from Thermomyces lanuginosus and Candida antarctica B, and their antimicrobial properties. Enzyme and Microbial Technology. 36: 391-398. 24.Garti, N., Aserin, A. and Fanun, M. 2000. Non-ionic sucrose esters microemulsions for food applications. Colloids and Surfaces A : Physicochemical and Engineering Aspects. 164: 27-38. 25.Harding, T.S. 1997. History of trehalose: its discovery and methods of prepartion. Sugar., 25: 476-478. 26.Ishimoto, R., Sugimoto, M. and Kawai, F. 2001. Screening and characterization of trehalose-oleate hydrolyzing lipase. FEMS Microbiology. 195: 231-235. 27.Khaled, N., Montet, D., Pina, M. and Graille, J. 1991. Fructose oleate synthesis in a fixed catalyst bed reactor. Biotechnology Letters. 13: 167-172. 28.Kou, X. and Xu, J. 2000. Enzymatic synthesis of saccharide and saccharide alcohol fatty acid esters. Wei Sheng Wu Xue Bao. 40:193-197. 29.Ku, M.A. and Hang, Y.D. 1995. Enzymatic synthesis of esters in organic medium with lipase from Byssochlamys fulva. Biotechnology Letters. 17: 1081-1084. 30.Marangon, K., Devaraj, S., Tirosh, O., Packer, L. and Jialal, I. 1999. Comparison of the effect of alpha-lipoic acid and alpha – tocopherol supplementation on measures of oxidative stress. Free Radical Biology & Medicine. 27: 1114-21. 31.Muller, A.S., Gagnaire, j., Queneau, Y., Karaoglanian, M., Maitre, J.P. and Bouchu, A. 2002. Winsor behaviour of sucrose fatty acid esters : choice of the cosurfactant and effect of the surfactant composition. Colloids and Surfaces A : Physicochemical and Engineering Aspects. 203: 55-66. 32.Oosterom, M.W., Rantwijk, F. and Sheldon, R.A. 1996. Regioselective acylation of disaccharides in tert-butyl alcohol catalyzed by Candida antarctica lipase. Biotechnology and Bioengineering. 49: 328-333. 33.Osipow, L., Snell, F. D., York, W.C. and Finchler, A. 1956. Methods of preparation fatty acid esters of sucrose. Industrial and Engineering Chemistry. 48: 1459-1462. 34.Packer, L., Witt, E.H. and Tritschler, H.J.1995.Alpha-Liopic acid as a biological antioxidant. Free Radical Biology & Medicine., 19: 2278-50. 35.Pavia, D.L., Lampman, G.M. and Kriz, G.S. 2000. Introduction to spectroscopy: A guide for students of organic chemistry. (third ed) p168. Thomson Learning. USA. 36.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-catalysed esterification of disaccharides. Carbohydrate Research. 337: 1179-1184. 37.Podda, M., Zollner, TM., Grundmann-Kollmann, M., Thiele, JJ., Packer, L. and Kaufmann, R. 2001. Activity of alpha-lipoic acid in the protection against oxidative strees in slin. Current Problems in Dermatology., 204: 98-104. 38.Pouchert, C. J. and Behnke, J. 1992. The Aldrich library of 1H and 13C FT NMR spectra, Aldrich Chemical, Milwaukee, MI, USA, p819. 39.Quan, J., Xu, J.M., Liu, B.K., Zheng, C.Z. and Lin, X.F. 2007. Synthesis and characterization of drug-saccharide conjugates by enzymatic strategy in organic media. Ezyme and Microbial Technology. 41:756-763. 40.Raku, T., Kitagawa, M., Shimakawa. and Tokiwa, Y. 2003. Enzymatic synthesis of hydrophilic undecylenic acid sugar esters and their biodegradability. Biotechnology Letters, 25:161-166. 41.Raku, T., Kitagawa, M., Shimalawa, H. and Tokiwa, Y. 2003. Enzymatic synthesis of trehalose esters having lipophilicity. Journal of Biotechnology. 100: 230-208. 42.Richards, A.B., Krakowka, S. Dexter, L.B., Schmid, H. Wolterbeek, A.P.M., Waalkens-Berendsen, D.H. Shigoyuki, A. and Kurimoto, M. 2002. Trehalose: a review of properties, history of use and human tolerance, and results of multiple safety studies. Food and Chemical Toxicologs., 40: 871-898. 43.Sabeder, S., Habulin, M. and Knez, Z. 2006. Lipase-catalyzed synthesis of fatty acid fructose esters. Journal of Food Engineering. 77: 880-886. 44.Sadtler, V.M., Guely, M. Marchal, P. and Choplin, L. 2004. Shear-induced phase transitions in sucrose ester surfactant. Journal of Colloid and Interface Science. 270: 270-275. 45.Scheckermann, C., Schlotterbeck, A. Schmidt, M., Wray, V. and Lang, Siegmund. 1995. Enzymatic monoacylation of fructose by two procedures. Enzyme and Microbial Technology. 17: 157-162. 46.Schiraldi, C., Di Lemia, I. and De Rose, M. 2002. Trehalose producition :exploiting novel approaches. Trends in Biotechnology. 20: 420-425. 47.Schmid, R.D. and Verger, R. 1998. Lipases: Interfacial enzymes with attractive applications. Angewandte Chemie International edition. 37: 1608-1633. 48.Shieh, C.J. and Lou, Y.H. 2000. Five-factor response surface optimization of enzymatic synthesis of citronellyl butyrate by lipase IM77 from Mucor miehei. Journal of the American Oil Chemists ’ Society. 77: 521-525. 49.Tchinda, A.T., Tane, P., Ayafor, J.F. and Connlly, J.D. 2003. Stigmastane derivatives and isovaleryl sucrose esters from Vernonia guineensis (Asteraceae). Phytochemistry. 63: 841-864. 50.Thormar, H. and Hilmarsson, H. 2007. The role of microbicidal lipids in host defense aganinst pathogens and their potential as therapeutic agents. Chemistry and Physics of Lipids., 150: 1-11. 51.Tsizuki, W., Kitamura, Y., Suzuki, T. and Kobayashi, S. 1999. Synthesis of Sugar fatty acid esters by modified lipase. Biotechnology and Bioengineering . 64: 267-271. 52.Tsuchido, T., Yokosuka, M. and Takano, M. 1993. Isolation and characteristics of a Bacillus subtilis mutant tolerant to the lytic action of sucrose esters of long-chain fatty acids. Joumal of Fermentation and Bioengineering. 75:

191-195. 53.Tsuzuki, W., Kitamura, Y., Suzuki, T. and Kobayashi, S. 2008. Synthesis of sugar fatty acid esters by modified lipase. Biotechnology and Bioengineering. 64: 267-271. 54.Vijayakumar, G. R., Lohith, K., Somasheker, B.R. and Divakar, S. 2004. Lipase catalyzed synthesis of l-alanyl, l-leucyl and l-phenylalanyl esters of d-glucose using unprotected amino acids. Biotechnology Letters. 26: 1323-1328. 55.Ward, O.P., Fang, J. and Li, Zuyi. 1997. Lipase-catalyzed synthesis of a sugar ester containing arachidonic acid. Enzyme and Microbial Technology. 20: 52-56. 56.Watanabe, Y., Miyawaki, Y., Adachi, S., Nakanishi, K. and Matsunno, R. 2000. Synthesis of lauroyl saccharides through lipase-catalyzed condensation in microaqueous water-miscible solvents. Journal of Molecular Catalysis. 10: 241-247. 57.Xie, J. and Hsieh, Y. L. 2001. Enzyme-catalyzed transesteritication of vinyl esters on cellulose solids. Biocmica Biophysica et Acta., 39:1931-1923. 58.Zhao, H., Baker, G.A., Song, Z., Olubajo, O., Grittle, T., and Peters, D. 2008. Designing enzyme-compatibe ionic liquids that can dissolve carbohydarate. Green Chemistry. 10: 696-705.