STUDY ON THE ENZYMATIC SYNTHESIS OF STRUCTURED LIPIDS BY LIPASE

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ABSTRACT

STRUCTURED LIPIDS (SL) ARE DESIGNER TRIGLYCERIDES WITH DESIRED FATTY ACIDS AT SPECIFIC POSITION IN ONE TRIGLYCERIDE MOLECULES AS "NUTRACEUTICALS, FUNCTIONAL FOODS, AND MEDICAL OR PHARMAFOODS" TO TARGET SPECIFIC DISEASES, METABOLIC CONDITIONS AND FOR OPTIMAL NUTRITION. AT PRESENT, ALL THE COMMERCIAL SL PRODUCTS ARE PRODUCED BY CHEMICAL SYNTHESIS. HOWEVER, THE PROCESS REQUIRES HIGH TEMPERATURE AND LONG TIME. IT MAY CAUSE LIPIDS DETERIORATION AND OBTAIN UNWANTED PRODUCTS. LIPASE CAN SYNTHESIZE SL UNDER MILD REACTION CONDITIONS, AND SPECIFITY OF THE LIPASE CAN OBTAIN DESIRED PRODUCTS. SL IS SYNTHESIZED BY COMMERCIALLY IMMOBILIZED LIPASES IN ORGANIC SOLVENTS. HOWEVER, THE DIRECT CONTACT WITH THE SOLVENT AND FATTY ACIDS MAY CAUSE LIPASE INACTIVITY. REVERSE MICELLES CAN PROTECT LIPASE FROM DIRECT CONTACT WITH THE SOLVENT AND FATTY ACIDS. IN THIS STUDY, THE ABILITY OF AN IMMOBILIZED LIPOZYME IM77 TO MODIFY TRIOLEIN BY INCORPORATION OF CAPRYLIC ACID (C8) TO FORM SL IN HEXANE OR REVERSE MICELLAR SYSTEM WAS STUDIED. RESPONSE SURFACE METHODOLOGY (RSM) WAS USED TO EVALUATE THE EFFECTS OF SYNTHESIS VARIABLES ON PERCENT MOLAR CONVERSION OF SL BY TRANSESTERIFICATION AND EXPECT THE OPTIMUM CONDITIONS. THE RESULT WAS THAT ENZYMATIC SYNTHESIS OF SL BY LIPASE IM77 WOULD REACH HIGHER YIELD UNDER LESS WATER CONDITION. THE ABILITY OF LIPASE IM77 WOULD BE INHIBITED BY WATER. THE REACTION OF HIGH TEMPERATURE AND SHORT TIME OR LOW TEMPERATURE AND LONG TIME COULD INCREASE THE YIELD OF SL. FURTHERMORE LIPASE IM77 WAS MORE ACTIVE IN ORGANIC SYSTEM THAN REVERSE MICELLAR SYSTEM. BASED ON CONTOUR PLOTS, OPTIMUM SYNTHESIS CONDITIONS WERE: REACTION TIME, 15 H; TEMPERATURE, 25 ℃; ENZYME AMOUNT, 20%; SUBSTRATE MOLAR RATIO, 1:4; AND ADDED WATER, 0%.

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REFERENCES

1.田蔚城。1997。生物技術導論。生物技術的發展與應用。1:2。 2.朱燕華。2000。構造脂質。食品工業月刊。32:1-6。 3.江文德。1999。脂肪?在油脂加工的應用。食品工業月刊。31:10-19。 4.張曉莉。1996。酵素在有機溶劑中受界面活性劑保護下之逆微胞萃取操作策略及催化反應之增進。 台灣大學博士論文。 5.張曉莉及黃世佑。1997。生物轉換法-有機溶劑中維持酵素活性之研究。化工。44:71-84。 6.許美珠。1996。MORTIERELLA ALPINA H4-ISOLATE中富含花生四烯酸油脂之萃取、冬化與交酯化。大 葉大學碩士論文。 7.郭靜娟。1998。健康油脂新主張。食品資訊。151:42-44。 8.黃偉勳。1998。EPA的功能、應用及利用SHEWANELLA PUTREFACIENS來生產。食品工業。30:30-37。 9.羅麗珠。1997。生物技術之專利保護。生物技術的發展與應用。3:36。 10.AKOH, C.C. 1998. STRUCTURED

LIPIDS. IN "FOOD LIPIDS: CHEMISTRY, NUTRITION, AND BIOTECHN -OLOGY." ED. C.C. AKOH AND D.B. MIN, MARCEL DEKKER, NEW YORK. 701-727. 11.AKOH, C.C. 1995. STRUCTURED LIPIDS-ENZYMATIC APPROACH. INFORM. 6: 1055-1061. 12.AKOH, C.C. AND HUANG, K.H. 1995. ENZYMATIC SYNTHESIS OF STRUCTURED LIPIDS: TRANSESTERIF -ICATION OF TRIOLEIN AND CAPRYLIC ACID. J. FOOD LIPIDS. 2: 219-230. 13.AKOH, C.C. AND MOUSSATA, C.O. 1998. LIPASE-CATALYZED MODIFICATION OF BORAGE OIL: INCORP -ORATION OF CAPRIC AND EICOSAPENTAENOIC ACIDS TO FORM STRUCTURED LIPIDS. J. AM. OIL CHE -M. SOC. 75: 697-701. 14.AKOH, C.C., JENNINGS, B.H., AND LILLARD, D.A. 1996. ENZYMATIC MODIFICATION OF EVENING PRIMROSE OIL: INCORPORATION OF N-3 POLYUNSATURATED FATTY ACIDS. J. AM. OIL CHEM. SOC. 73: 1059-1062. 15.BABAYAN, V.K. 1987. SPECIALTY LIPIDS AND THEIR BIOFUNCTIONALITY. LIPIDS. 22: 417-420. 16.BABAYAN, V.K. 1968. MEDIUM-CHAIN TRIGLYCERIDES - THEIR COMPOSITION, PREPARATION, AND APPLICATION. J. AM. OIL CHEM. SOC. 45: 23-25. 17.BACH, A.C. AND BABAYAN, V.K. 1982. MEDIUM-CHAIN TRIGLYCERIDES: AN UPDATE. AM. J. CLIN. NUTR. 36: 950-962. 18.BACH, A.C., STORCK, D., AND MERAIHI, Z. 1988. MEDIUM-CHAIN TRIGLYCERIDES-BASED FAT EMUL -SIONS: AN ALTERNATIVE ENERGY SUPPLY IN STRESS AND SEPSIS. J. PARENT. ENTER. NUTR. 12: 81S-88S. 19.BASHEER, S., SNAPE, J.B., MOGI, K., AND NAKAJIMA, M. 1995. TRANSESTERIFICATION KINETICS OF TRIGLYCERIDES FOR A MODIFIED LIPASE IN N-HEXANE. J. AM. OIL CHEM. SOC. 72: 231-236. 20.CROSBY, L.E., SWENSON, E.S., BABAYAN, V.K., ISTFAN, N., BLACKBURN, G.L., AND BISTRIAN, B.R. 1992. EFFECT OF STRUCTURED LIPID-ENRICHED TOTAL PARENTERAL NUTRITION IN RATS BEAR -ING YOSHIDA SARCOMA. J. NUTR. BIOCHEM. 1: 41-47. 21.DALY, J.M., LIEBERMAN, M., GOLDINE, J., SHOU, J., WEINTRAUB, F.N., ROSATO, E.F., AND LAVIN, P. 1991. ENTERAL NUTRITION WITH SUPPLEMENTALARGININE, RNA AND OMEGA-3 FATTY ACI -DS: A PROSPECTIVE CLINICAL TRIAL. J. OF PARENTERAL AND ENTERAL NUTR. 15: SUPPLEMENT. 22.FOMUSO, L.B. AND AKOH, C.C. 1998. STRUCTURED LIPIDS: LIPASE-CATALYZED INTERESTERIFICATI -ON OF TRICAPROIN AND TRILINOLEIN. J. AM. OIL CHEM. SOC. 75: 405-410. 23.GOTTENBOS, J.J. 1988. NUTRITIONAL EVALUATION OF N-6 AND N-3 POLYUNSATURATED FATTY ACIDS . IN "DIETARY FAT REQUIREMENTS IN HEALTH AND DEVELOPMENT." ED. J.B. ROGERS, AM. OIL CHEM. SOC., CHAMPAIGN. 107. 24.KENNEDY, J.P. 1991. STRUCTURED LIPIDS: FATS OF THE FUTURE. FOOD TECHNOL. 44: 76-83. 25.LAANE, C., BOEREN, S., VOS, K., AND VEEGER, C. 1987. RULES FOR OPTIMIZATIONS OF BIOCATA -LYSIS IN ORGANIC SOLVENTS. BIOTECHNOL. BIOENG. 30: 81-87. 26.LEDEBOER, M., MASCLEE, A.A.M., JANSEN, J.B.M.M., AND LAMERS, C.B.H.W. 1995. EFFECT OF EQUIMOLAR AMOUNT OF LONG-CHAIN TRIGLYCERIDES AND MEDIUM-CHAIN TRIGLYCERIDES ON SMALL -BOWEL TRANSIT TIME IN HUMANS. J. PARENT. ENTER. NUTR. 12: 127S-132S. 27.LEE, K.T. AND AKOH, C.C. 1998. STRUCTURED LIPIDS: SYNTHESIS AND APPLICATIONS. FOOD REV. INT. 14: 17-34. 28.LI, Z.Y. AND WARD, O.P. 1994. SYNTHESIS OF MONOGLYCERIDE CONTAINING OMEGA-3 FATTY ACID BY MICROBIAL LIPASE IN ORGANIC SOLVENT. J. OF INDUS. MICROBIO. 13: 49-52. 29.LI, Z.Y. AND WARD, O.P. 1993. LIPASE-CATALYZED ESTERIFICATION OF GLYCEROL AND N-3 POLYU -NSATURATED FATTY ACID CONCENTRATION IN ORGANIC SOLVENT. J. AM. OIL CHEM. SOC. 70: 745- 748. 30.LING, P.R., ISTFAN, N.W., LOPES, S.M., AND BABAYAN, V.K. 1991. STRUCTURED LIPID MADE FROM FISH OIL AND MEDIUM-CHAIN TRIGLYCERIDE ALTERS TUMOR AND HOST METABOLISM IN YOSHIDA SARCOMA-BEARING RATS. AM. J. CLIN. NUTR. 53: 1177-1184. 31.LUISI, P.L. 1985. ENZYMES HOSTED IN REVERSE MICELLIS IN HYDROCARBON SOLUTION. ANGEW. CHEM. INT. ED. ENGL. 24: 439-450. 32.MACRAE, A.R. 1989. TAILORED TRIACYLGLYCEROLS AND ESTERS. BIOCHEM. SOC. TRANS. 17: 1146- 1148. 33.MAIZ, A., YAMAZAKI, K., SOBRADO, J., BABAYAN, V.K., MOLDAWER, L.L., BIATRIAN, B.R., AND BLACKBURN, G.L. 1984. PROTEIN METABOLISM DURING TOTAL PARENTERAL NUTRITION (TPN) IN INJ -URED RATS USING MEDIUM-CHAIN TRIGLYCERIDES. METABOLISM. 33: 901-909. 34.MASCIOLI, E.A., BISTRIAN, B.R., BABAYAN, V.K., AND BLACKBURN, G.L. 1987. MEDIUM-CHAIN TRIGLYCERIDES AND STRUCTURED LIPIDS AS UNIQUE NONGLUCOSE ENERGY SOURCES IN HYPERALIMEN -TATION. LIPIDS. 22: 421-423. 35.MEGREMIS, C.J. 1991. MEDIUM CHAIN TRIGLYCERIDES: A NONCONVENTIONAL FAT. FOOD TECHNOL. 45: 108-114. 36.MOK, L.T., MAIZ, A., YAMAZAKI, K., SOBRADO, J., BABAYAN, V.K., MOLDAWER, L.L., BIATRIAN, B.R., AND BLACKBURN, G.L. 1984. STRUCTURED MEDIUM AND LONG-CHAIN TRIGLYCERIDE EMULSIONS ARE SUPERIOR TO PHYSICAL MIXTURES IN SPARING BODY PROTEIN IN THE BURNED RAT. METABOLISM . 33: 910-915. 37.MU, H., XU, X., AND HOY, C.E. 1998. PRODUCTION OF SPECIFIC- STRUCTURED TRIACYLGLYCEROLS BY LIPASE-CATALYZED INTERESTERIFICATION IN A LABORATORY-SCALE CONTINUOUS REACTOR. J. AM. OIL CHEM. SOC. 75: 1187-1193. 38.MUKHERJEE, K.D. 1998. LIPID BIOTECHNOLOGY. IN "FOOD LIPIDS: CHEMISTRY, NUTRITION, AND BIOTECHNOLOGY." ED. C.C. AKOH AND D.B. MIN, MARCEL DEKKER, NEW YORK. 589-640. 39.MUTUA, L.N. AND AKOH, C.C. 1993. LIPASE-CATALYZED MODIFICATION OF PHOSPHOLIPIDS: INCORP -ORATION OF N-3 FATTY ACIDS IN BIOSURFACTANTS. J. AM. OIL CHEM. SOC. 70: 125-128. 40.OUINLAN, P. AND MOORE, S. 1993. MODIFICATION OF TRIGLYCERIDES BY LIPASE: PROCESS TECHNO -LOGY AND ITS APPLICATION TO THE PRODUCTION OF NUTRITIONALLY IMPROVED FATS. INFORM. 4: 580-585. 41.RAY, S. AND BHATTACHARYYA, D.K. 1995. COMPARATIVE NUTRITIONAL STUDY OF ENZYMATICALLY AND CHEMICALLY INTERESTERIFIED PALM OIL PRODUCTS. J. AM. OIL CHEM. SOC. 72: 327-330. 42.RAY, S. AND BHATTACHARYYA, D.K. 1993. DISTINCTION BETWEEN ENZYMATICALLY AND

CHEMICALLY CATALYZED INTERESTERIFICATION. J. AM. OIL CHEM. SOC. 70: 1293-1294. 43.SCHUCH, R. AND MUKHERJEE, K.D. 1987. INTERESTERIFICATION OF LIPIDS USING AN IMMOBILIZED SN-1,3-SPECIFIC TRIACYLGLYCEROL LIPASE. J. AGRIC. FOOD CHEM. 35: 1005-1008. 44.SHIDAMA, Y., MARUYAMA, K., OKAZAKI, S., NAKAMURA, M., AND SUGIHARA, A. 1994. ENRICHMENT OF POLYUNSATURATED FATTY ACID WITH GEOTRICHUM CANDIDUM LIPASE. J. AM. OIL CHEM. SOC. 71: 951-954. 45.SHIEH, C-J, AKOH, C.C., AND YEE, L.N. 1996. OPTIMIZED ENZYMATIC SYNTHESIS OF GERANYL BUTYRATE WITH LIPASE AY FROM CANDIDA RUGOSA. BIOTECHNOL. BIOENG. 51: 371-374. 46.SHIEH, C-J, AKOH, C.C., AND KOEHLER, P.E. 1995. FOUR-FACTOR RESPONSE SURFACE OPTIMIZATI -ON OF THE ENZYMATIC MODIFICATION OF TRILOEIN TO STRUCTURED LIPIDS. J. AM. OIL CHEM. SOC. 72: 619-623. 47.TANAKA, Y., HIRANO, J., AND FUNADA, T. 1994. SYNTHESIS OF DOCOSAHEXAENOIC ACID-RICH TRIGLYCERIDE WITH IMMOBILIZED CROMOBACTERIUM VISCOSUM LIPASE. J. AM. OIL CHEM. SOC. 71: 331-334. 48.TEO, T.C., DEMICHELE, S.J., SELLECK, K., BABAYAN, V.K., BLACKBURN, G.L., AND BIATRIAN, B.R. 1989. ADMINISTRATION OF STRUCTURED LIPID COMPOSED OF MCT AND FISH OIL REDUCES NET PROTEIN CATABOLISM IN ENTERALLY FED BURNED RATS. ANN. SURG. 210: 100-106. 49.TOMARI, Y., IKREDA, I., SUGANO, M., WATANABE, S., AND NAGATA, J. 1991. LYMPHATIC ABSORP -TION OF STRUCTURED GLYCEROLIPIDS CONTAINING MEDIUM-CHAIN FATTY ACIDS AND LINOLEIC ACID, AND THEIR EFFECT ON CHOLESTEROL ABSORPTION IN RATS. LIPIDS 26: 369-373. 50.TOTANI, T. AND HARA, S. 1991. PREPARATION OF POLYUNSATURATED PHOSPHOLIPIDS BY LIPASE-CAT -ALYZED TRANSESTERIFICATION. J. AM. OIL CHEM. SOC. 68: 848-851. 51.VILLENEUVE, P. AND FOGLIA, T. 1997. LIPASE SPECIFICITIES: POTENTIAL APPLICATION IN LIPI -D BIOCONVERSIONS. INFORM. 8: 640-651. 52.WEETE, J.D. 1998. MICROBIAL LIPASES. IN "FOOD LIPIDS: CHEMISTRY, NUTRITION, AND BIOTECH -NOLOGY." ED. C.C. AKOH AND D.B. MIN, MARCEL DEKKER, NEW YORK. 665-698. 53.WILLIS, W.M. AND MARANGONI, A.G. 1998. ENZYMATIC INTERESTERIFICATION. IN "FOOD LIPIDS: CHEMISTRY, NUTRITION, AND BIOTECHNOLOGY." ED. C.C. AKOH AND D.B. MIN, MARCEL DEKKER, NEW YORK. 665-698. 54.WOLF, R.R., O'DONNELL, R.F.J., STONE, M.D., RICHMOND, D.A., AND BURKE, J.F. 1980. INVES -TIGATION OF FACTORS DETERMINING THE OPTIMAL GLUCOSE INFUSION IN TOTAL PARENTERAL NUTRI -TION. METABOLISM. 20: 892-900.