# 以脂解酵素合成建構脂肪之研究


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**摘 要**

建構脂肪可依特殊疾病或營養目的，將特殊功能性的脂肪酸鍵結於三甘油酯上，而且可被設計鍵結於特定位置以提供其機能性，可以改善脂質的功能性、吸收度及代謝等特性。目前已商業化的建構脂肪是以化學法合成，但化學法高溫長時間的反應易造成油的劣變，及產生不必要的副產物，並且無法得到依特殊目的所設計的建構脂肪。而以脂解酵素來合成建構脂肪，反應條件溫和，重要的是脂解酵素所具有的專一性可以製造出特殊設計的建構脂肪。 而脂解酵素可在有機溶劑中合成建構脂肪，但在有機系統中，有機溶劑及魯肪酸的直接傷害可能會對酵素活性造成影響；因此可以逆微胞系統來保護魯解酵素，以提高產量及延長使用效應。因此本研究想要探討脂解酵素IM77 在有機系統及逆微胞系統中以三油酸甘油醴及中鏈脂肪酸辛酸為原料來合成建構脂肪的研究，並套用實驗設計統計分析來求得其最優化的合成條件。 實驗結果發現固定化脂解酵素IM77在微水的情況下可得到較高的產率，水份的增加會抑制酵素的活性；而高溫短時間或低溫長時間的反應皆可使產率增加。結果並發現在有機系統中合成建構脂肪所得的產率較高，逆微胞系統反而會使得產率降低。因此以脂解酵素IM77成成建構脂肪較適合在有機系統中進行反應。最後可由等高線圖預測建構脂肪之最優化合成條件：脂解酵素IM77在有機系統正己烷中，基質莫耳比1:4 (三甘油酯：脂肪酸)、酵素用量20%、反應15h、溫度25℃、不需添加水。



關鍵詞 : 無


**目錄**



**參考文獻**


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.