脂肪替代品甲基葡萄糖多酯的最優化合成條件探討及物理特性之研究

賴昱甫、謝淳仁

E-mail: 9015780@mail.dyu.edu.tw

摘 要

甲基葡萄糖多酯（METHYL GLUCOSIDE, MGPE）由甲基葡萄糖與長鏈脂肪酸酯化而成，是一種無卡路里的脂肪替代品（FAT SUBSTITUTE）。本實驗將15 G甲基葡萄糖在無溶劑系統下合成MGPE之研究，使用反應曲面技術（RSM）及三變數三階層部分因子設計評估合成參數，包括反應時間（4-8小時）、合成溫度（110-130 ° C）及大豆油脂肪酸甲酯（FAME）與甲基葡萄糖基質莫耳數比（4:1-6:1）對MGPE莫耳轉換率的影響，三個反應參數（反應時間、溫度及基質莫耳數比）均顯著影響MGPE的莫耳轉換率。藉由統計反應曲面迴歸分析，得到最適合成條件為：反應時間6.3小時、合成溫度123.8 ° C及基質莫耳數比5.9：1，預測此最適點的莫耳轉換率為55.68%。 混合棕櫚油、紅花籽油及大豆油脂肪酸甲酯合成MGPE，利用混合實驗設計找出物理特性類似大豆油的脂肪酸組成。脂肪酸的飽和度顯著的影響MGPE之物理特性，脂肪酸平均鏈長對物理特性僅有些微的影響，結果顯示混合紅花籽油與大豆油（莫耳比1:1）合成的MGPE，可以獲得類似大豆油的物理特性。

關鍵詞 : 甲基葡萄糖多酯、反應曲面法、最優化、物理特性、輪廓圖

目錄

參考文獻

1. 白賜清。1998。工業實驗設計法。P.1-6，三民書局。台北。 2. 白賜清。1998。工業實驗設計法。P.211-231，三民書局。台北。 3. 吳宗正。1995。迴歸分析理論與應用。P.545-554，復文書局。台南。 4. 羅積玉。1994。多元統計分析方法與應用。P.7，科技圖書有限公司。台北。 5. 鍾玉明、李敏雄。1994。油脂替代品。科學與技術。26（1）:19-25。 6. ANONYMOUS. 1998. THESE CHIPS MAY WOW YOU, BUT CONSIDER THE PRICE. CONSUM. REP. 63: 8. 7. AKOH, C. C. 1995. LIPID-BASED FAT SUBSTITUTES. CRIT. REV. FOOD SCI. NUTR. 35: 405-430. 8. AKOH, C. C. 1994. OXIDATIVE STABILITY OF FAT SUBSTITUTES AND VEGETABLE OILS BY THE OXI -DATIVE STABILITY INDEX METHOD. J. AM. OIL CHEM. SOC. 71: 211-216. 9. AKOH, C. C., SWANSON, B. G. 1990. OPTIMIZED SYNTHESIS OF SUCROSE POLYESTERS: COMPARIS -ON OF PHYSICAL PROPERTIES OF SUCROSE POLYESTERS, RAFFINOSE POLYESTERS AND SALAD OILS. J. FOOD SCI. 55: 236-243. 10. AKOH, C. C., SWANSON, B. G. 1991. ABSORBABILITY AND WEIGHT GAIN BY MICE FED METHYL GL -UCOSIDE FATTY ACID POLYESTERS: POTENTIAL FAT SUBSTITUTES. J. NUTR. BIOCHEM. 2: 652- 655. 11. AKOH, C. C., AND SWANSON, B. G. 1989. SYNTHESIS AND PROPERTIES OF ALKYL GLYCOSIDE AND STACHYOSE FATTY ACID POLYESTERS. J. AM. OIL CHEM. SOC. 66: 1295-1301. 12. AKOH, C. C., AND SWANSON, B. G. 1988. BASE CATALYSIS OF TRANSESTERIFICATION OF VEGETAB -LE OILS. J. FOOD PROC. PRESERV. 12: 139-149. 13. AKOH, C. C., AND SWANSON, B. G. 1987. ONE-STAGE SYNTHESIS OF RAFFINOSE FATTY ACID POLY -ESTERS. J. FOOD SCI. 52: 1570-1576. 14. ALBANO-GARCIA, E., LORICA, R. G., PAMA, M., AND DE LEON, L. 1980. SOLVENT-LESS SYNTHET -IC METHODS FOR METHYL GLUCOSIDE AND SORBITOL ESTERS OF COCONUT FATTY ACID. PHILIPP. J. COCONUT STUD. 5: 51. 15. BOUTTE, T. T., AND SWANSON, B. G. 1994. SUPERCRITICAL FLUID EXTRACTION AND CHROMATOGR -APHY OF SUCROSE AND METHYL GLUCOSE POLYESTER. IN" CARBOHYDRATE POLYESTERS AS FAT SUB -STITUTE" ED. C. C. AKOH AND B. G. SWANSON. VOL. 4, P. 65-93. DEKKER: NEW YORK. 16. BERGHOLZ, C. M. 1992. SAFETY EVALUATION OF OLESTRA, A NONABSORBED, FATLIKE FAT REPLAC -EMENT. CRIT. REV. FOOD SCI. NUTR. 32: 144-146. 17. BERNHARDT, C. A. 1988. OLESTRA—A NON-CALORIC FAT REPLACEMENT. FOOD TECH. INT. -EUROP -E 176-178. 18. BOX, G. E. P., AND

BEHNKEN, D. W. 1960. SOME NEW THREE LEVEL DESIGNS FOR THE STUDY OF QUANTITATIVE VARIABLES. TECHNOMETRICS. 2: 455-475. 19. CHESKIN, L. J., MIDARY, R., ZORICH, N., AND FILLOON, T. 1998. GASTROINTESTINAL SYMPTO -MS FOLLOWING CONSUMPTION OF OLESTRA OR REGULAR TRIGLYCERIDE POTATO CHIPS. JAMA. 279: 150-152. 20. COOPER, D. A., BERRY, D. A., JONES, M. B., KIORPES, A. L. AND PETERS, J. C. 1997A. OLE -STRA'S EFFECT ON THE STATUS OF VITAMINS A, D AND E IN THE PIG CAN BE OFFSET BY INCRE -ASING THE DIETARY LEVELS OF THESE VITAMINS. J. NUTR. 127: 1589S-1608S. 21. COOPER, D. A., BERRY, D. A., SPENDEL, V. A., KING, D., KIORPES, A. L., AND PETERS, J. C. 1997B. OLESTRA DOSE RESPONSE ON FAT-SOLUBLE AND WATER-SOLUBLE NUTRIENTS IN THE PIG. J. NUTR. 127: 1573S-1588S. 22. COOPER, D. A., WEBB, D. R., AND PETERS, J. C. 1997C. EVALUATION OF THE POTENTIAL FOR OLESTRA TO AFFECT THE AVAILABILITY OF DIETARY PHYTOCHEMICALS. J. NUTR. 127: 1555S-156 5S. 23. CORNELL, J. A. 1983. HOW TO RUN MIXTURE EXPERIMENTS FOR PRODUCT QUALITY. AMERICAN SOC -IETY FOR QUALITY CONTROL, MILWAUKEE, WI. 24. FEDERAL REGISTER, 1996. PART III, U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, FOOD AND DRUG ADMINISTRATION, 21 CFR PART 172, FOOD ADDITIVES PERMITTED FOR DIRECT ADDITION TO FOOD FOR HUMAN CONSUMPTION: OLESTRA, FINAL RULE. 62: 3118- 3173. 25. GIESE, J. 1996. OLESTRA: PROPERTIES, REGULATORY CONCERNS, AND APPLICATION. FOOD TECHN -OL. 51: 130-131. 26. GIBSON, M. S. 1990. PRODUCTION OF POLYESTERS HAVING REDUCED COLOR CONTENT. U.S. PATENT 4,942,228. 27. GLUECK, C. J., MATTSON, F. H., AND JANDACEK, R. J. 1979. THE LOWERING OF PLASMA CHOLES TEROL BY SUCROSE POLYESTER IN SUBJECTS CONSUMING DIETS WITH 800, 300, OR LESS THAN 50 MG OF CHOLESTEROL PER DAY. AM.J. CLIN. NUTR. 32: 1636-1644. 28. GIBBSON, J. P., AND SWANSON, B. G. 1959. METHYL GLUCOSIDE FATTY ACID DIESTERS. J. AM. OIL CHEM. SOC. 36: 553. 29. HARRIGAN, K. A. AND BREENE, W. M. 1989. FAT SUBSTITUTES: SUCROSE ESTERS AND SIMPLESSE. CEREAL FOODS WORLD. 34: 261-267. 30. HARE, L. B. 1974. MIXTURE DESIBNS APPLIED TO FOOD FORMULATION. FOOD TECHNOL. 28:50-62. 31. HIMMELBLAU. 1970. PROCESS ANALYSIS BY STATISTICAL METHOD. NEW YORK. 32. JANDACEK, R. J. 1991. DEVELOPING A FAT SUBSTITUTE. CHEMTECH. 21: 398-402. 33. JANDACEK, R. J., AND WEBB, M. R. 1978. PHYSICAL PROPERTIES OF PURE SUCROSE OCTAESTERS. CHEM. PHYS. LIPIDS. 22: 163-176. 34. KLIS, J. B. 1996. FDA APPROVES FAT SUBSTITUTE, OLESTRA. FOOD TECHNOL. 51: 124. 35. KESTER, J. J. 1993. FOOD PRODUCT DEVELOPMENT USING OLESTRA AS A FAT SUBSTITUTE. IN "SC IENCE FOR THE FOOD INDUSTRY OF THE 21ST CENTURY"; ATL PRESS, MOUNT PROSPECT, IL. 36. KIRSCHNER, E. M. 1997. FAKE FATS IN REAL FOOD. CHE. ENG. NEWS. 76:21-25. 37. KIRKEGAARD, P. 1988. FAT SUBSTITUTES: TASTES GREAT -LESS FATTENING. HAZELTON FOOD SCIE -NCE NEWSLETTER. HAZELTON LABORATORIES AMERICA, INC., MADISON. 38. LINTECH, M. L. 1996. FDA SAYS OK TO OLESTRA. FOOD MANU. 71:51-53. 39. MILLER, K. W., LAWSON, K. D., TALLMADGE, D. H., MADISON, B.L., OKENFUSS, J. R., HUDSON, P., WILSON, S., THORSTENSON, J., AND VANDERPLOEG, P. 1995. DISPOSITION OF INGESTED OLE -STRA IN THE FISCHER 344 RAT. FUND. APPL. TOXICOL. 24: 229-237. 40. MCCOY, S. A., MADISON, B. L., SELF, P. M., AND WEINGERBER, D. J. 1989. SUCROSE POLYES -TERS WHICH BEHAVE LIKE COCOA BUTTERS. U.S. PATENT, 4,822,875. 41. MATTSON, F. H., AND VOLPENHEIN, R. A. 1971. LOW CALORIE FAT-CONTAINING FOOD COMPOSITI -ONS. U.S. PATENT 3,600,186. 42. MYHRE, D. V. 1971. PROCESS FOR THE PREPARATION OF FATTY ACID ESTERS OF SUGAR GLYCOSID -ES. U.S. PATENT 3,597,417. 43. OFFICIAL METHODS AND RECOMMENDED PRACTICES OF THE AMERICAN OIL CHEMISTS' SOCIETY. 1994. EDIT BY D. FIRESTONE, AMERICAN OIL CHEMISTS' SOCIETY, CHAMPAIGN, METHOD CC 1-25. 44. OTT, L. 1988. AN INTRODUCTION TO STATISTICAL METHODS AND DATA ANALYSIS. PWS-KENT PUBL -ISHING CO., BOSTON, MA. 45. OSIPOW, L., SNELL, F. D., MARRA, D., AND YORK, W. C. 1956. SURFACE ACTIVITY OF MONOES -TERS-FATTY ACID ESTERS OF SUCROSE. IND. ENG. CHEM. 48: 1462. 46. ROLLS, B. J., CASTELLANOS, V. H., SHIDE, D. J., MILLER, D. L., PELKMAN, C. L., THORWA -RT, M. L., AND PETERS, J. C. 1997. SENSORY PROPERTIES OF A NONABSORBABLE FAT SUBSTIT -UTE DID NOT AFFECT REGULATION OF ENERGY INTAKE. AM. J. CLIN. NUTR. 65: 1375-1383. 47. RIZZI, G. P., AND TAYLOR, H. M. 1978. A SOLVENT-FREE SYNTHESIS OF SUCROSE POLYESTER. J. AM. OIL CHEM. SOC. 55: 398-401. 48. ROWLAND, S. P., CIRINO, V. O., AND BULLOCK, A. J. 1966. STRUCTURAL COMPONENTS IN METH -YL VINYL SULFONE MODIFIED COTTON CELLULOSE. CAN. J. CHEM. 44: 1051-1058. 49. SHIEH, C. -J., AND LAI, Y. -F. 2000. APPLICATION OF RESPONSE SURFACE METHODOLOGY TO THE STUDY OF METHYL GLUCOSIDE POLYESTER SYNTHESIS PARAMETERS IN A SOLVENT-FREE SYSTEM. J. AGR. FOOD CHEM. 48: 1124-1128. 50. SCHLAGHECK, T. G., KESTER, J. M., JONES, M. R., ZORICH, N. L., TORRI, S. A., DUGAN, L. D., AND PETERS, J. C. 1997A. OLESTRA'S EFFECT ON VITAMINS A, D AND E IN THE HUMAN CAN BE OFFSET BY INCREASING THE DIETARY LEVELS OF THESE VITAMINS. J. NUTR. 127: 1666S-168 5S. 51. SCHLAGHECK, T. G., RICCARDI, K. A., ZORICH, N. L., TORRI, S., DUGAN, L. D., AND PETERS , J. C. 1997B. OLESTRA DOSE RESPONSE ON FAT-SOLUBLE AND WATER- SOLUBLE NUTRIENTS IN HUMANS. J. NUTR. 127: 1646S -1665S. 52. SHIEH, C. -J.; KOEHLER, P. E.; AKOH, C. C. 1996A. OPTIMIZATION OF SUCROSE POLYESTER SYNTHESIS USING RESPONSE SURFACE METHODOLOGY. J. FOOD SCI. 61: 97-100. 53. SHIEH, C. -J.; KOEHLER, P. E.; AKOH, C. C. 1996B. FORMULATION AND OPTIMIZATION OF SUCR -OSE POLYESTER PHYSICAL PROPERTIES USING MIXTURE RESPONSE SURFACE METHODOLOGY. J. AM. OIL CHEM. SOC. 73: 455-460. 54. SHIEH C. -J., AKOH, C. C., AND KOEHLER, P. E. 1996C.

OPTIMIZING LOW FAT PEANUT SPREAD CONTAINING SUCROSE POLYESTER. J. FOOD SCI. 61: 1227-1229. 55. SAS. 1990. SAS USER GUIDE, SAS INSTITUTE, INC., CARY, NC. 56. SCHEFFE, H. 1958. EXPERIMENTS WITH MIXTURES. J. ROYAL. STATIS. SOC. 20: 344-360. 57. TOMA, R. B., CURTIS, D. J., AND SOBOTOR, C. 1988. SUCROSE POLYESTER: ITS METABOLIC ROL -E AND POSSIBLE FUTURE APPLICATION. FOOD TECHNOL. 42: 93-95. 58. VAN LOOKEREN, G. J. 1991. METHOD OF PURIFYING CRUDE POLYOL FATTY ACID POLYESTERS. U.S. PATENT 5,055,571. 59. VAN DER PLANK, P., AND ROZENDAAL, A. 1991. PROCESS FOR PREPARING PARTIAL POLYOL FATTY ACID ESTERS. U.S. PATENT 5,006,648. 60. VAN DER PLANK, P. 1990. PROCESS FOR THE PREPARATION POLYOL FATTY ACID ESTERS. U.S. PAT -ENT 4,968,791. 61. WAGNER, F. W., DE LA MOTTE, R. S., AND DEAN, M. A. 1990. SUGAR ESTER SYNTHESIS. U.S. PATENT 4,927,920.