Production of γ – Linoleic Acid by Cunninghamella echinulata

蕭淵簇、吳淑姿 ; 余世宗

E-mail: 9708306@mail.dyu.edu.tw

ABSTRACT

γ -Linolenic acid, one of the ω -6 polyunsaturated fatty acid, is in the breast milk containing polyunsaturated fatty acids. It has physiological benefits in dermatitis, reduction of cholesterol, improvement of rheumatism arthritis. The aim of this study is to attempt the production of γ - linoleic acid (GLA) in a 20 L fermenter by Cunninghamella echinulata, and to investigate the changes in lipid accumulation, biomass and production of γ -linolenic acid during the batch culture. The cultivating condition for Cunninghamella echinulata was as follows: glucose 34.0 g/L, ammonium chloride 1.0 g/L, pH value control 6.5, temperature development 25℃, 0.375 v.v.m airflow and stirring rate of 100 rpm. The results of experiment show that after 63 h, the nitrogenous source was exhausted, but there was still 30.61 g/L of carbonic source in the broth. However, the biomass and lipid were keeping raising. After 96 h, the biomass and lipid increased greatly. Until glucose was exhausted, biomass and lipid was decreasing. Under no carbonic source, microbe would consume the lipid which made by itself so that lipid was just decreasing. At 160 h, biomass was 5.47 g/L and lipid was 2.84 g/L. It was close to the stationary phase of microbial growth and lipid. At this time, γ -linolenic acid was 1298.23 mg/L. The lipid was 51.92 % of biomass and the γ -linolenic acid was 23.73 % of biomass, respectively. Key word: Cunninghamella echinulata, γ -linolenic acid

Keywords : Cunninghamella echinulata ; γ -linolenic acid

Table of Contents

REFERENCES

1.吳淑姿。2002。海洋單細胞真菌-Schizochytrium sp. S31生產多元不飽和脂肪酸-DHA。國立台灣大學博士論文。台灣。 2.李秀、賴滋漢。1992。食品分析與檢驗。第173-174頁。精華出版社。台灣。 3.宋逸詩。2005。以影像分析技術探討Mucor rouxii生產γ -次亞麻油酸之

研究。國立清華大學碩士論文。台灣。 4.邱怡翠。2005。培養Cunninghamella echinulata和Bacillus cereus DYU-Too12生產多元不飽和脂肪酸。大葉大學碩士論文。台灣。 5.段盛秀、楊海明。2002。食品化學實驗修定版。第20-32頁。藝軒圖書出版社。台灣。 6.陳啟祥。1999。微生物油脂質開發與生產。生物產業，10(2): 94-104。 7.蘇惠美。1999。飼料生物之培養與利用。台灣省水產試驗所。台灣。 8.Alonso, D. L. and Maroto, F. G. 2000. Plants as chemical factories for the production of polyunsaturated fatty acids. Biotechnology Advances 18:481 – 497. 9.Bajpai, P. Bajpai, P. K. and Ward, O.P.1991. Optimization of production of docosahexaenoic acid (DHA) by Thrauatochytrium aureum ATCC 4304. J.Am..Oil Chem.Soc. 68:509-514. 10.Bajpai, P., Bajpai, P. K. and Ward, O. P. 1992. Optimization of culture condition for production of eicosapentaenoic acid by Mortierella elongata NRRL 5513. J. Ind. Microbiol. 9:1-18. 11.Barclay, W. R. and Boulder, C. 1992. Process for the heterotrophic production of microbial products with high concentrations of omega-3 highly unsaturated fatty acids. US Patent. 5130242. 12.Brown, C. M. and Rose, A.H. 1969. Fatty acid composition of Candida utilis as affected by growth temperature and dissolved oxygen tension, J. Bacteriol. 99:371-376. 13.Bugnariu, S. 1996. Beneficial Effect of Gamma-Linolenic Acid-Enriched Diet Therapeutic Properties of Oenothera Biennis(Evening Primrose Oil).Farmicia. 44:3-4. 14.Certik, M., Balteszova, L. and Sajbidor, J. 1997.Lipid formation and γ-linolenicacid production by Mucorales fungi grown on sunflower oil. Lett. Appl. Microbiol. 25:101-105. 15.Certik, M. and Shimizu, S. 1998. Review-Biosynthesis and Regulation of Microbial Polyunsaturated Fatty Acid Production. Journal of Bioscience and Bioengineering 87:1-14. 16.Crozier, G. L. and Secretin, M. C. 1996. ?蛄^-Linolenic Acid in Infant Formula, in γ-Linolenic Acid: Metabolism and Its Roles in Nutrition and Medicine, Editd by Huang, Y. S. and Mills, D. E. AOCS Press, Champaign. p. 246-251. 17.Dyerberg, J. 1986. Linolenate-derived polyunsaturated fatty acids and prevention of atherosclerosis. Nutrition Reviews 44 (4): 125-134. 18.Fearon, K. C. H., Falconer, J. S., Ross, J. A., Carter, D. C., Hunter, J. O., Reynolds, P. D. and Tuffnell, Q. 1996. An Open Label Phase I/II Dose Escalation Study of the Treatment of Pancreatic Cancer Using Lithium Gamma- linolenate. Anticancer Res. 16:867-874. 19.Galbraith, J. C. and Smith, J. E. 1969. Filamentous growth of Aspergillus niger in submerged shake culture. Trans Br. Mycol. Soc. 52:237 – 46. 20.Gellerman, J. L. and Schlenk, K. 1979. Methyl directed desaturation of arachidonic acid to eicosapentaenoic acid in the fungus Saprolegnia parasitica. Biochem. Biophys. Acta. 573:23- 30. 21.Gill, I. and Valivety, R. 1997 .Polyunsaturated Fatty Acids, Part 1: Occurrence, Biological Activities and Applications, TIBTECH. 15:401-409. 22.Gunstone, F. D. 1992. Gamma linolenic acid-occurrence and physical & chemical properties. Prog. Lipid. Res.31:145-161. 23.Horrobin, D. F. and Huang, Y. S. 1987. The role of linolenic acid and its metabolites in the lowering of plasma cholesterol and the prevention of cardiovascular disease. Int. J. Cardio. 17:241-255. 24.Horrobin, D. F. 1992. Nutritional and Medical Importance of Gamma-Linolenic Acid. Prog. Lipid Res. 31:163-194. 25.Jang, H. D., Lin, Y. Y. and Yang, S. S. 2000. Polyunsaturated fatty acid production with Mortierella alpine by solid substrate fermentation. Bot. Bull. Acad. Sin. 41:41-48. 26.Jiang, W. G., Hisocx, S., Hallett, M. B., Scott, C., Horrobin, D. F. and Puntis M.C.A. 1995. Inhibition of hepatocyte growth factor-induced motility & in-vitro invation of human colon-cancer cells by gamma-linolenic acid. BRITISH JOURNAL OF CANCER 71 (4): 744-752. 27.Kavadia, A., Komaitis, M., Chevalot, I., Blanchard, F., Mark, I. And Aggelis, G. 2001. Lipid and γ-linolenic acid accumulation in strains of Zygomycetes Growing on Glucose. J.Am.Oil Chem. Soc. 78(4): 341-346. 28.Kermer, J. M., Jubiz, W. and Michalek, A. 1987. Fish oil acids supplement in active rheumatoid arthritis. Ann.Intern.Med.106:497-503. 29.Kinsella, J. E. 1987. Effects of polyunsaturated fatty acid on factors related to cardiovascular disease. Am. J. Cardiol. 60(12):23-32. 30.Marx, J. L. 1982. The leukotrienes in allergy and inflammation. Scuence.215: 1380-1383. 31.Pirt, S. J. and Callow, D.S.1959. Continuous flow culture of the filamentous mould Penicillium chrysogenum and the control of its morphology. Nature 184:307-310. 32.Ratledge, C. 1994. Yeast, moulds, algae and bacteria as source of lipid, in advances in improved and alternative sources of lipids. 235-291. BlackiePublishers, London, England. 33.Reddy, B. S. and Maruyama, H. 1986. Effect of dietary fish oil on azoxymethan -induced colon carcinogenesis in MALE F344 rats. CANCER RESEARCH 46 (7): 3367-3370. 34.Reddy, D. R., Prassad, V. S. S. V. and Das, U. N. 1998. Intratumoral Injection of Gamma- Linolenic Acid in Malignant Gliomas. J. Clin. Neurosci. 5:36-39. 35.Silva, T. L., Pinheiro, H. M. and Roseiro, J. C. 2003. Stress- induced morphological and physiological changes in γ-linolenic acid production by Mucor fragilis in batch and continuous cultures. Enzyme and Microbial Technology 32:880 – 888. 36.Singh, A. and Ward, O. P. 1997. Production of high yields of arachidonic acid in a fed-batch system by Mortierella alpine ATCC32222 Appl. Microbiol. Biotechnol. 48(1):1-5. 37.Stylianos, F., Maria, G. P., Seraphim, P., Michael, K. and George, A. 2007. Compositional shifts in lipid fractions during lipid turnover in Cunninghamella echinulata. Enzyme and Microbial Technology 40:1321 – 1327. 38.Wen, Z. Y. and Chen, F. 2000. Heterotrophic production of eicosapentaenoic acid by the diatom Nitzschia laevis: effects of silicate and glucose. J. Ind. Microbiol. Biotechnol. 25: 218-224. 39.Wu, D. and Meydani, S. N. 1996. Gamma-Linolenic Acid and Immune Function, in Gamma-Linolenic: Metabolism and Its Roles in Nutrition and Medicine, Edited by Huang, Y. S. and Mills, D. E. AOCS Press, Champaign. p. 106-117. 40.Yongmanitchai, W. and Ward, O. P. 1989. Omega-3 fatty acids: alternativesources of production. Proces Biochem. 24:117-125. 41.Yongmanitchai, W. and Ward, O. P. 1991. Growth and omega-3 fatty acid production by Phaeodactylum tricornnyum under different culture condition.Appl. Environ. Microbiol. 57:419- 426.