Effects of CO2 on Production and Characterization of Hyaluronic Acid by Streptococcus zooepidemicus Submerged Fermentati

何嘉育、徐泰浩

E-mail: 9901180@mail.dyu.edu.tw

ABSTRACT

Hyaluronic acid (HA) is a linear polysaccharide composed of repeating disaccharide units of D-glucuronic acid and N-acetylglucosamine linkaged by β(1-4) and β(1-3) glycosidic bond. It has been widespread in medical application and cosmetics. In this study, Streptococcus zooepidemicus BCRC15414 was used for hyaluronic acid production. The fermentation condition was set at 37 ° C, 150rpm and the pH value at about 7.0, and the effects of aeration factor on hyaluronic acid production was investigated. The aeration factors were divided into two sections, the air and the carbon dioxide, where the aeration rate is 1vvm for comparisons. Then different aeration rate (0.5vvm, 1.5vvm and 2.0vvm) experiments,were carried out to discover the most suitable aeration condition for hyaluric acid production. The result showed that 1vvm of carbon dioxide as aeration factor for 6 hr would give a hyaluronic acid concentration of 0.256 g/L, which is greater than air (0.210 g/L, 4hr). Carbon dioxide was therefore used as main aeration ingredient for fermentation, this study discovered that the hyaluronic acid production had the maximum yield when 1vvm aeration rate was applied.. This study shows that when using Streptococcus zooepidemicus for producing hyaluronic acid, different aeration conditions and culturing time would highly affect the production.

Keywords : Streptococcus zooepidemicus ; Hyaluronic acid ; carbon dioxide ; air ; aeration rate ; fermentation

Table of Contents

REFERENCES

1. 王雲萍。1994。生物科技的寵兒-玻尿酸。化工資訊5:44-49。 2. 成霞、劉登如、陳堅和堵國成。2006。高產量、高分子量透明質酸發酵條件優化。過程工程學報6(5):809-813。 3. 沈慧彥。2006。培養基中碳氮源對獸疫鏈球菌(Streptococcus zooepidemicus)醱酵產程生成透明質酸之影響。大葉大學論文。彰化。 4. 吳鎮宇。2004。以微生物生產透明質酸製程參數之探討。南台科技大學論文。台南。 5. 金艷、凌沛學和張天民。2007。透明質酸鈉的光譜學性質研究。食品與藥品9(10):6-8。 6. 范紅結和路承平。2006。馬鏈球菌獸疫亞種毒力因子。中國人獸共患病學報 22(3):279-281。 7. 郭學平、王春喜和崔大鵬。1994。發酵法製備透明質酸。日用化學工業。2:47-48。 8. 郭學平、王春喜、凌沛學和張天民。1998。透明質酸及其發酵生產概述。中國生化藥物雜誌19(4):209-212。 9. 舒曉明、胡凝珠、藍芸、陶里、陳陽、羅愛華和胡云章。2008。低分子量透明質酸增?HAV抗原誘導的小鼠體液免疫應答的研究。細胞與分子免疫學雜誌24(2):183-185。 10. 黃定國。2001。透明質酸之開發與應用。菌種保存及研究簡訊14(3):1-9。 11. 賈赤宇和陳璧。1998。不同分子量的高純度透明質酸對豬去全厚皮後傷口癒合的影響。中國修復重建外科雜誌12(4)。 12. 張效良、羅隆曜和吳功柱。人臍帶透明質酸製備及理化性質分析。中國藥房10(1):10-11。 13. 陳永浩和王強。2008。透明質酸分離純化研究進展。化工進展 27(5): 666-670。 14. 劉文斌、溫耀和孫思勤。2003。深層鞏膜切除聯合Healon GV 注入治療開角型青光眼。眼科研究21(2):189-190。 15. 楊利。張旭和譚文松。2008。溶氧水平與攪拌轉速對醱酵生產透明質酸分子量的影響。華東理工大學學報34(6):805-808。 16. 鄭曉龍、賀玲和楊新光。2002。透明質酸鈉在眼科

的應用。實用醫藥雜誌 19(5):387-388。 17. 謝慧冰。2005。攪拌剪應力是玻尿酸醱酵放大設計之關鍵因素。成功大學論文。台南。 18. 羅曼和蔣立科。1999。牛眼透明質酸的分離及性質測定。生物化學與生物物理進展26(6):596-600。 19. 蘇立榛。2007。促進鏈球菌透明質酸醱酵產程生理代謝控制之策略。大葉大學論文。彰化。 20. 顧其勝、王文斌和吳萍。1998。醫用透明質酸鈉在臨床中的應用綜述。中國修復重建外科雜誌 12(2):124-126。 21. Akasaka, J., Seto, S., Yanagi, M., Fukashima, S. and Mitsui, T. 1998. Industrial production of hyaluronic acid by Streptococcus zooepidemicus . Journal of the Society Cometic of Chemists Japan. 22: 35-42. 22. Armstrong, D. C., and Johns, M. R. 1997. Culture conditions affect the molecular weight properties of hyaluronic acid produced by Streptococcus zooepidemicus. Appl. environ. microbiol. 63: 2759-27648. 23. Balazs, E. A. 1979. Ulttrapure hyaluronic acid and the use therefore. U. S. Patent : 4,141,973. 24. Balazs, E. A.. 1990. Medical applications of hyaluronan and its derivatives. In Cosmetic and Pharmaceutical Applications of Polymers: 293. Plenum Pess, New York. 25. Bentley, J. P., Dunphy J. E., Van, Winkle, W. Jr. 1986. Mucopolysaccharide synthesis in healing wounds. Repair and regeneration. New York: McGraw-Hill: 151~160. 26. Bitter, T. and Muir, H.M. 1962. A modified uronic acid carbazole reaction. Anal Biochem. 4: 330-334. 27. Blank, L. M., McLaughlin, R. L., Nielsen, L. K. 2005. Stable Production of Hyaluronic Acid in Streptococcus zooepidemicus Chemostats Operated at High Dilution Rate. Biotecnology and Bioengineering. 90(6): 685-693. 28. Bothner, H. and O. Wik. 1987. Rheology of hyaluronate. Acta Otolaryngol (Stockh) 442:25-30. 29. Brake, J. W. and Thacker, K. 1985. Hyaluronic acid from bacterial cullar. U. S. Patent: 4,517295. 30. Carbera, R. C. 1995. The in vivo effect of hyaluronan associated protein-collagen complaex on wound healing. Biochem. And Molecular Biol. Int. 37: 151-158. 31. Cleary, P. P. and Larkin, A. 1979. Hyaluronic acid capsule strategy for oxygen resistance in group A streptococci. J. Bacteriol. 140(3): 1090-1097. 32. Day, R., Brooks, P., Conaghan, P.G. and Petersen, M. 2004. Adouble blind randomized multicenter parallel group study of the effectiveness and tolerance of intraarticular hyaluronan in osteoarthritis of the knee. J. Rheumatol. 31(4): 775-782. 33. Daly, T. H. The repair phase of wound healing-re-epitheliaiztion and contraction. Wound Healing: Alternatives in Management: 14. F. A. Davis Press, Philadephia. 34. Dostal, G. H. and Gamelli, R. L. 1993. Fetal wound healing. Surg. Gynecol. Obstet. 176: 299-306. 35. Fessler JH. and Fessler LI. 1966. Electron microscopic visualization of the polysaccharide hyaluronic acid. Proc Natl Acad Sci USA. 56: 141-147. 36. Ghosh, P. 1994. The role of hyaluronic acid (hyaluronan) in health and disease: Interactions with cells, cartilage and components of synovial fluid. Clin. and Exp. Rheumatol. 12:75-82. 37. Hascall, V. C. and Laurent, T. C. 1997. Hyaluronan: structure and physical properties. GlycoForum: Science of Hyaluronan-1. 38. Hascall, V. C. 1977. Interaction of cartilage proteoglycans with hyaluronic acid. J. Supramol. Struct. 7: 101-120. 39. Huang, W. C., Chen, S. J. and Chen, T. L. 2007. Modeling the microbial production of hyaluronic acid. Journal of the Chinese Institute of Chemical Engineers. 38: 355-359. 40. Huang, W. C., Chen, S. J. and Chen, T. L. 2006. The role of dissolved oxygen and function of agitation in hyaluronic acid fermentation, Biochem. Eng. J. 32: 239-243. 41. Hoffman, A. S. 2002. Hydrogels for biomedical application. Adv. Drug. Deliv. Rev. 43: 3-12. 42. Hofinger, E. S. A., Hoechstetter, J., Oettl, M., Bernhardt, G. and Buschauer, A. 2007. Isoenzyme specific differences in the degradation of hyaluronic acid by mammalian-type hyaluronidases. Glycoconjugate J. 25: 101-109. 43. Johns, M. R., Goh, L. T., and Oeggrli, A. 1994. Effect of pH, agitation and aeration on hyaluronic acid production by Streptococcus zooepidemicus. Biotechnology letters. 16: 507-512. 44. Kendall, F. E. Heidelberger, M., and Dawson, M. H. 1937. A serologically inactive polysaccharide elaborated by mucoid strains of group a hemolytic Streptococcus. J. Biol. Chem. 118: 61-69. 45. Kim, J. H., Yoo, S. J., Oh, D. K., Kweon, Y. G., Park, D.W., Lee, C. H., and Gil, G. H. 1996. Selection of a Streptococcus equimutant and optimization of culture conditions for the production of high molecular weight hyaluronic acid. Enzyme Microb. Technol. 19: 440-445. 46. Laurent, T. C., and Fraser, J. R. E. 1986. The properties and turnover of hyaluronan. In: function of proteoglycans (Evered D, Whelan J, Eds) ciba foundation symposium 124, pp9-29, New York. Wiley. 47. Laurent, T. C. 1987. Biochemistry of hyaluronan. Acta Otolaryngol Suppl. 442: 7-24. 48. Laurent, T. C., and Fraser, J. R. 1992. Hyaluronan. FASEB J. 6:2397-2404. 49. Liu, L., Liu D., Wang, M., Du, G. and Chen J. 2007. Preparation and characterization of sponge-like composites by cross-linking hyaluronic acid and carboxymethylcellulose sodium with adipic dihydrazide. European Polymer Journal.43: 2672 – 2681. 50. Liu, L., Dua, G., Chen, J., Wang, M. and Sun, Jun. 2008. Influence of hyaluronidase addition on the production of hyaluronic acid by batch culture of Streptococcus zooepidemicus. Food Chemistry. 110: 923-926. 51. Meyer, K. 1947. The biological significance of hyaluronic acid and hyaluronidase. Physiol. Rev. 27: 335-359. 52. Nimrod, A., Greenman, B., Kanner, D. and Landsberg, M. 1988. Method ofproducing high molecular weight sodium hyaluronate by fermentationof Streptococcus, ” U.S. Patent. 4780414 53. Oksala, O., Salo, T., Tammi, R., Hakkinen, L., Jalkanen, M., Inki, P., and Larjava, H. 1995. Expression of proteoglycans and hyaluronan during wound healing. J. Histochem. Cytochem. 43(2):125-135. 54. O ’Regan, M., I. M. Martini, F. Cresscenzi, C. Luca and M. Lansing. 1994. Molecular mechanism and genetic of hyaluronan biosynthesis. Int. J. Biol. Macromol. 16: 283-286. 55. Pace, G. W. and Righelato, R. C. 1980. Production of extracellular microbial polysaccharides. Adcances in Biochemical Engineering. 15: 41-70. 56. Palumbo, F. S., Pitarresi, G., Mandracchia, D., Tripodo, G. and Giammona, G. 2006. New graft copolymers of hyaluronic acid and polylactic acid: Synthesis and characterization. Carbohydrate Polymers.66: 379-385. 57. Pitarresi G., Palumbo, F. S., Tripodo, G., Cavallaro, G. and Giammona G. 2007. Preparation and characterization of new hydrogels based on hyaluronic acid and α, β-polyaspartylhydrazide. European Polymer Journal. 43(9): 3953-3962. 58. Prisell, P. T. Camber, O., Hiselius, J. and Norstedt, G. 1992. Evaluation of hyaluronan as a vehicle for peptide growth factors. Int. J. Pharm. 85: 51-56. 59. Sandra D. Taylor, DVM, and W. David Wilson, BVMS, MS. 2006. Streptococcus equi subsp. equi (Strangles) Infection. Clin Tech Equine Pract 5:211-217. 60. Scott, J. E.. 1998. Secondary and tertiary structures of hyaluronan in aqueous solution. Some biological consequences. Glycoforum: Science of Hyaluronan-2. 61. Stern R. 2003. Divising a pathway for hyaluronan catabolism:are we there yet. Glycobiology. 13(12):105-115. 62. Weigel, P. H.. 1998. Bacterial hyaluronan synthases. GlycoScience: Science of Hyauronan HA06. 63. Weissmann, B. and Meyer, K. 1954. The structure of hyalobiuronic acid and of hyaluronic acid from umbilical cord. J. Am. Chem. Soc. 76:

1753-1757. 64. West, D. C., I. N. Hampson, F. Aronoid and S. Kumar. 1985. Angiogenesis induced by degradation products of hyaluronic acid. Science. 288: 1324-1326.