重組柳松菇凝集素於蝦類抗白點症之效用分析

張琨鴻、張雲祥

E-mail: 9607791@mail.dyu.edu.tw

摘 要

白點症病毒 (White Spot Syndrome Virus, WSSV) 是甲殼類生物一個重要的病毒，對養殖蝦有很高的感染率與致死率。自從1993年於中國大陸爆發傳染以來，WSSV已成為世界養蝦產業的重大病源。目前對此疾病尚無藥物可以治療，因此養殖業將此病稱為「蝦癌」。凝集素 (lectin)，由於能和細胞表面的醣基結合造成凝集反應而得名。此外凝集素也可以辨識與許多的病源體的表面例如病毒外套膜上的醣基結合而與病源產生凝集反應防止病毒的感染，因此具有抗病的功能。所以凝集素是生物中先天免疫力 (innate immunity) 很重要的一部分。本研究即是以柳松菇凝集素 (Agrocybe aegerita lectin, AAL) 為對象，分析其抗WSSV感染的效用。首先選殖AAL基因cDNA全長序列，並以原核 (Escherichia coil) 的蛋白質表現系統，生產重組柳松菇凝集素 (rAAL)，再分析該重組蛋白對抗WSSV之活性。經由軟體分析AAL胺基酸序列其具有carbohydrate recognition domain (CRD) 及蛋白後修飾 (modifications motif) 辯識區域。此外，1997年Cooper等學者指出，凝集素胺基酸序列中若含有cysteine，則會降低凝集素之凝集活性。而AAL不具有cystine，推測其可能具有較佳之凝集活性。rAAL之分子量約為20 kDa，與軟體所預測之分子量大小相當。而以native gel的電泳分析顯示rAAL會形成具功能之雙聚合體 (dimer) 四級結構。利用E-coil大量表現並純化後的rAAL作為抗原生產抗體，以西方轉漬法分析，柳松菇之蛋白質萃取物，此抗體可高專一性的辨識出天然柳松菇凝集素。E-coli生產rAAL，以白蝦進行抗WSSV之活體實驗，結果發現以rAAL處理第五天,可降低20%累積死亡率,具有抑制白點症病毒之功效，值得進－步研究及應用，包含施用方式時機，劑量，頻率等。

關鍵詞 : 白點症病毒 ; 凝集素 ; 柳松菇

目錄

參考文獻

1. 王克行。1995。再析蝦病的病因、流行和預防。飼料工業 16:17-20。 2. 香川綾（監修）。1989。四訂食品成分表。女子榮養大學出版部 181-184。東京，日本。 3. 陳秀男、沈士新、冉繁華、林清龍、王俊順、黎錦超。2000。蝦類養殖技術實用大全。觀賞魚雜誌社，台北。214-224。 4. 陳冠佑。2003。日本沙菜之半乳糖專一性凝集素純化與定性。國立台灣大學海洋研究所碩士論文。 5. 陳勁初、黃仕政。2000。菇菌類機能性食品之開發。生物產業 11(3): 164-172。 6. 陳建男。2005。柳松菇凝集素之基因選殖及重組蛋白活性分評估。國立台灣大學食品科技研究所碩士論文。 7. 徐榮彬、彭增發、林文惠、謝明利、黃旭田、洪信雄。1991。白蝦陶拉症候群。九十一年度組織病理研討會專輯。12-14。 8. 許珮喧。2004。柳松菇及鴻喜菇翠取物對於人類白血病細胞株（U927）生長抑制於G0/G1期之機制。國立台灣大學食品科技研究所碩士論文。 9. 莊博智。2005。出口白蝦種蝦病毒性疾病之病理學及分子生物學診斷。國立屏東科技大學獸醫學系碩士學位論文 10. 賴慶亮譯。水野卓，川合正允原著。1997。菇類的化學、生化學。國立編譯館。台北，台灣。 11. Bantel, H., Engels, I. H., Voelter, W., Schulze-Osthoff, K. And Wesselborg, S. (1999) Mistletoe lectin activates caspase-8/FLICE independently of death receptorsignaling and enhances anticancer drug-induced apoptosis. Cancer Res. 59: 2083-2090. 12. Berger, E. G., Buddecke, E., Kamerling, J. P., Kobata, A., Paulson, J. C., and Vilegenthart, J. F. G. (1982) Structure, biosynthesis and functions of glycoprotein glycans. Experientia 38: 1129-1162. 13. Brady, P., Vanner, A. and Banwell, J. (1978) Identification of the dietary lectin, wheat germ agglutinin, in human intestinal contents. Gastroenterology 75: 236-239. 14. Brown, M.S. and Goldstein, J. L. (1986) A receptor-mediated pathway for cholesterol homeostasis. Science 232: 34-47. 15. Bonami JA, Bruce LD, Poulos BT, Mari J, Lightner DV. 1995. Partial characterization and cloning of the genome of PvSNPV (= BP-type virus) pathogenic for Penaeus vannamei. Dis Aquat Org 23: 59-66. 16. Breene, W. M. 1990. Nutritional and medicinal value of specialty mushrooms. J. Food Protect 53: 883-894. 17. Brock JA, Gose R, Lightner DV, Jasson KW. 1995. An overview on Taurasyndrome, an important disease of farmed Penaeus vannamei. IN: Swimming Trough Troubled Water, Proceedings of the Special Session on Shrimp Farming, Aquaculture ’ 95 eds Browdy, C.L. & J.S. Hopkins Baton Rouge, LA: World Aquculture Society. 84-89. 18. Bussing, A., Suzart, K., Bergmann, J., Pfuller, U., Schietzel, M. and Schweizer, K. (1996) Induction of apoptosis in human lymphocytes treated with Viscum album L. is mediated by the mistletoe lectins. Cancer Letters 99: 59-72. 19. Cai S, Huang J, Wang C, Song X, Sun X, Yu J, Zhang Y, Yang C. 1995. Epidemiological studies on the explosive epidemic disease of prawn in1993-1994. J Fish China 19: 112-117. 20. Chang YS, Lo CF, Peng SE, Liu KF, Wang CH, Kou GH. 2001. White spot syndrome virus (WSSV) genetic material found in association with Artemia cysts. (revised). 21. Chen LL, Lo CF, Chiu YL, Chang CF, Kou GH. 2000. Natural and experimental infection of white spot syndrome virus (WSSV) in benthic larvae of mud crab Scyla serrata. Dis Aquact Org 40: 157-161. 22. Chen SN, Chang PS, Kou GH. 1989. Observation on pathogenicity and epizootiology of Penaeus monodon baculovirus in cultured shrimp in Taiwan. Fish Pathol 24: 127-130. 23. Cheung, P. C. K. 1996. Dietary fiber content and composition of some cultivated edible mushroom fruiting bodies and mycelia. J. Agric. Food Chem. 44: 468-471. 24. Chou HY, Huang CY, Wang CH, Chiang HC, Lo CF. 1995. Pathogenicity of a baculovirus infection causing white spot syndrome in cultured penaeid shrimp in Taiwan. Dis Aquat Org 23: 165-173. 25. Cowley JA, Dimmock CM, Spann KM, Walker PJ. 2000a. Detection f Australian gill-associated virus (GAV) and lymphoid organ virus (LOV) of Penaeus monodon by RT-nested PCR. Dis Aquat Org 39: 159-167. 26. Cowley JA, Dimmock CM, Spann KM, Walker PJ. 2000b. Gill-associated virus of Penaeus monodon prawns: an invertebrate virus with ORF 1a and ORF 1b genes related to arteri- and coronaviruses. J Gen Virol 81: 1473-1484. 27. Cowley JA, Dimmock CM, Wongteerasupaya C, Boonsaeng V, Panyam S, Walker PJ. 1999. Yellow head virus from Thailand and gill-associated virus from Australian are closely related but distinct viruses. Dis Aquat Org 36: 153-157. 28. Derewenda, Z., J. Yariv, J. R. Helliwell, A. J. Kalb, E. J. Dodson, M. Z. Papiz, T. Wan, and J. Campbell. 1989. The structure of the saccharide-binding site of Concanavalin A. EMBO J. 8: 2189-2193. 29. Dessen, A., D. Gupta, S. Sabesan, C. F. Brewer, and J. C. Sacchettini. 1995. X-ray crystal structure of the soybean agglutinin cross-linked with a biantennary analog of the blood group I carbohydrate antigen. Biochemistry 34: 4933-4942. 30. Elbein, A. D. (1991) The role of N-linked oligosaccharides inglycoprotein function. Trends in Biotechnol. 9: 346-352. 31. Farfante P, Kensley B. 1997. Penaeoid And Sergestoid Shrimps And Prawns of the World. Keys and Diagnosis For the families and Genera. Memories Du Museum National D'Historie Naturelle, Paris, France, 233. 32. Finlay, D. R., Newmeyer, D. D., Price, T. M. and Forbes, D. J. (1987) Inhibition of in vitro nuclear transport by lectin that binds to nuclear pores. J. Cell. Biol. 104: 189-200. 33. Flegel TM, Sriurairatana S, Wongteerasupaya C, Boonsaeng V, Panyim S, Withyachumnarnkul W. 1995. Progress in characterization and control of yellow head virus of Penaeus monodon. In: Browdy CL, Hopkins JS, eds. Swimming Through Troubled Water, Proceedings of the Special Session on Shrimp Farming. World Aquaculture Society, Baton Rouge, LA, USA, 76-83. 34. Flegel TW, Boonyaratpalin S, Withyachumnarmkul B. 1997. Progress in research on yellow-head virus and white-spot virus in Thailand. In: Flegel TW, MacRae IH eds. Diseases in Asian Aquaculture III, 285-295. Asian. 35. Flegel TW. 1997. Special topic review: Major viral diseases of the black tiger prawn (Penaeus monodon) in Thailand. World J Microbiol Biotech 13: 422-433. 36. Gabriel GA, Felipe AV. 2000. Infectious disease in shrimp species with aquaculture potential. Resent Res Devl Microbiol 4: 333-348. 37. Goldstein, I. J., Blake, D. A., Ebisu, S., Williams, T. J. and Murphy, L. A. (1981) Carbohydrate binding studies on the Bandeiraeasimplicifolia I isolectins. Lectins which are mono-, di-, tri-, andtetravalent for N-acetyl-D-galactosamine. J. Biol. Chem. 256: 3890-3893. 38. Hasson KW, Lightner DV, Mari J, Bonami J-R, Poulos BT, Mohney LL, Redman RM, Brock JA. 1999. The geographic distribution of Taura syndrome virus (TSV) in the Americas: determination by histopathology and in situ hybridization using TSV-specific cDNA probes. Aquaculture 171: 13-26. 39. Huang J, Song XL, Yu J, Yang CH. 1995a.

Baculoviral hypodermal and hematopoietic necrosis-study on the pathogen and pathology of the shrimp explosive epidemic disease of shrimp. Mar Fish Res 16: 1-10. 40. Huang J, Yu J, Wang XH, Song XL, Ma CS, Zhao FZ, Yang CH. 1995b. Survey on the pathogen and route of transmission of baculoviral hypodermal and hematopoietic necrosis in shrimp by ELISA of monoclonal antibody. Mar Fish Res 16: 40-50. 41. Inouye K, Miwa S, Oseko N, Nakano H, Kimura T. 1994. Mass mortalities of cultured kuruma shrimp, Penaeus japonicus, in Japan in 1993: Electron microscopic evidence of the causative virus. Fish Pathol 29: 149-158. 42. Inouye K, Yamano K, Ikeda N, Kirmura T, Nakano H, Momoyama K, Kobayashi J, Miyajima S. 1996. The penaeid rod-shaped DNA virus (PRDV), which causes penaeid acute viremia (PAV). Fish Pathol 31: 39-45. 43. Jacobson, M. D., Burne, J. F., King, M. P., Miyashita, T., Reed, J. C. and Raff, M. C. (1993) Bcl-2 blocks apoptosis in cells lackingmitochondrial DNA. Nature 361: 365-369. 44. Jory DE. 1999. Shrimp whiespot virus in the western hemisphere. Aquaculture Magazine 25: 83-87. 45. Juliano, R. L. and Haskill, S. (1993) Signal transduction from theextracellular matrix. J. Cell. Biol. 120: 577-585. 46. Kim, M., Rao, M. V., Tweardy, D. J., Prakash, M., Galili, U. and Gorelik, E. (1993) Lectin-induced apoptosis of tumour cells. Glycobiology 3: 447-453. 47. Lai, P. S., L. P. So, and C. S. Russell. 1989. A lipid-associated sulfatedproteoglycan from nereis coelomic fluid is a hemagglutinin. Comp. Biochem. Physiol. 93B: 859-865. 48. Liao, D. I., G. Kapadia, H. Ahmed, G. R. Vasta, and O. Herzberg. 1994. Structure of S-lectin, a developmentally regulated vertebrate betagalactoside-binding protein. Proc. Natl. Acad. Sci. U. S. A 91: 1428-1432. 49. Liao IC, Huang TL, Katsutain K. 1969. A preliminary report on artificial propagation of Penaeus monodon Fabricius. Reports of Fish Culture Research Supported by Rockfeller Foundation, JCRR Fish Ser 8: 67-71. 50. Liao IC. 1989a. Penaeus monodon culture in Taiwan: Through two decades of growth. Int J Aquacult Fish Technol 1:16-24. 51. Liao IC. 1989b. Taiwanese shrimp culture: A molting industry. In: Chauvun K, Meneses P, Chauvin W, Cuccia A, eds. Proc Shrimp World IV (The Fourth Shrimp World Marketing Conference), Shrimp World Incorporated, New Orleans, Louisiana, U.S.A., 55-83. 52. Liener, I. E., Sharon, N. and Goldstein, I. J. (1986) The Lectins. pp294. Academic Press, UK. 53. Lightner DV, Redman RM, Bell TA, Brock JA. 1983a. Detection of IHHN virus in Penaeus stylirostris and Penaeus vannamei imported into Hawaii. J World Maric Soc 14: 212-225. 54. Lightner DV, Redman RM, Bell TA. 1983b. Infectious and hematopoietic necrosis a newly recognized virus disease of penaeid shrimp. J invertebr pathol 42: 62-70. 55. Lightner DV, Redman RM, Hasson KW, Pantoja CR. 1995. Taura syndrome in Penaeus vannamei (Crustacea: Decapoda): gross signs, histopathology and ultrastructure. Dis Aquat Org 21: 53-59. 56. Lightner DV. 1996a. A Handbook of Shrimp Pathology and Diagnostic Procedures for Diseases of Culturd Penaeid Shrimp. Society, Baron Rouge, LA.: The World Aquaculture. 57. Lightner DV. 1996b. The penaeid shrimp viruses IHHNV and TSV: epizootiology, production impacts and role of international trade in their distribution in the Americas. Rev Sci Tech Off Int Epiz 15: 579-601. 58. Lo CF, Kou GH. 1998. Virus associated white spot syndrome of shrimp in Taiwan: a review. Fish Pathol 33: 365-371. 59. Lo CF, Ho CH, Chen CH, Liu KF, Chiu YL, Yeh PY, Peng SE, Hsu HC, Liu HC, Chang CF, Su MS, Wang CH, Kou GH. 1997. Detection and tissue tropism of white spot syndrome baculovirus (WSBV) in captured brooders of Penaeus monodon with a special emphasis on reproductive organs. Dis Aquat Org 30: 53-72. 60. Lo CF, Ho CH, Peng SE, Chen CH, Hsu HC, Chiu YL, Chang CF, Liu KF, Su MS, Wang CH, Kou GH. 1996b. White spot syndrome baculovirus (WSBV) detected in cultured and captured shrimp, crab and other arthopods. Dis Aquat Org 27: 215-225. 61. Lo CF, Hsu HC, Tsai MF, Ho CH, Peng SE, Kou GH, Lightner DV. 1999. Specific genomic DNA fragment analysis of different geographical clinical samples of shrimp white spot syndrome virus. Dis Aquat Org 35: 175-185. 62. Lo CF, Leu JH, Ho CH, Chen CH, Peng SE, Chen YT, Chou CM, Yeh PY, Huang CJ, Chou HY, Wang CH, Kou GH. 1996a. Detection of baculovirus associated with white spot syndrome (WSBV) in penaeid shrimps using polymerase chain reaction. Dis Aquat Org 25: 133-141. 63. Lu CP, Zhu S, Guo FS, Wu SY. 1997. Electron microscopic observation on a non-occluded baculo-like virus in shrimp. Arch Virol 142: 2073-2078, 64. Minoru M, Hiroyuki S, Eiichi M, Toshiaki I, Michio O. 2004. Replication of white spot syndrome virus in ovarian primary cultures from the kuruma shrimp, Marsupenaeus japonicus. J Virol Meth 116: 89-94. 65. Mizuno, T., Saito, H., Nishitoba, T. and Kawagishi, H. 1995. Antitumor-active substances from mushrooms. Food Rev. Int. 11: 23-61. 66. Momoyama K, Hiraoka M, Nakano H, Koube H, Inouye K, Oseko N. 1994. Mass mortalities of cultured kuruma shrimp, Penaeus japonicus, in Japan in 1993: Histopathological study. Fish Pathol 29: 141-148. 67. Nadala ECB Jr, Loh PC. 1998. A comparative study of three different isolates of white spot virus. Dis Aquat Org 33: 231-234. 68. Nadala ECB Jr, Tapay LM, Loh PC. 1997. Yellow-head virus: a rhabdovirus-like pathogen of penaeid shrimp. Dis Aquat Org 31: 141-146. 69. Nakano H, Koube H, Umezawa S, Momoyama K, Hiraoka M, Inouye K, Oseko N. 1994. Mass mortalities of cultured kuruma shrimp, in Japan in 1993: epizootiological survey and infection trials. Fish Pathol 29: 135-139. 70. Perez-Farfante I. 1969. Western Atlantic shrimps of the genus Penaeus. U.S. Fish Wildl Serv Fish Bull 67: 461-591. 71. Perillo, N. L., Pace, K. E., Seilhamer, J. J. and Baum, L. G. (1995) Apoptosis of T cells mediated by galectin-1. Nature 378: 736-739. 72. Perillo, N. L., Uittenbogaart, C. H., Nguyen, J. T. and Baum, L. G. (1997) Galectin-1, an endogenous lectin produced by thymicepithelial cells, induces apoptosis of human thymocytes. J. Exp. Med. 185: 1851-1858. 73. Peumans, W. J. and E. J. Van Damme. 1995. Lectins as plant defense proteins. Plant Physiol. 109: 347-352. 74. Rogers, D. J. and W. Loveless. 1991. Electron microscopy of human erythrocytes agglutinated by lectin from Codium fragile ssp. Tomentosoides and pseudohaemagglutinin from Ascophyllum nodosum. J. Appl. Phycol. 3: 83-86. 75. Ryder, S. D., Smith, J. A. and Rhodes, J. M. (1992) Peanut lectin: amitogen for normal human colonic epithelium and human HT29colorectal cancer cells. J. Natl. Cancer Inst. 84: 1410-1416. 76. Sakagami, H., Aoki, T., Simpson, A. and Tanuma, S. 1991. Induction ofimmunopotention activity by a ptotein-bound polysaccharide, PSK. Anticancer Res. 11: 993-1000. 77. Schwarz, R. E., Wojciechowicz, D. C., Picon, A. I., Schwarz, M. A., and Paty, P. B. (1999) Wheatgerm agglutinin-mediated toxicity inpancreatic cancer cells. Br. J. Cancer 80: 1754-1762. 78. Shaanan, B., H. Lis, and N. Sharon. 1991. Structure of a legume lectin with an ordered N- linked carbohydrate in complex with lactose. Science 254: 862-866. 79. Sharon, N. and Lis, H. (1989) Lectins as cell recognition molecules. Science 246: 227-246. 80. Sharon, N. and Lis, H. (1993) Carbohydrates in cell

recognition. Sci. Am. J. 1: 74-81. 81. Sharon, N. and H. Lis. 1990. Legume lectins-a large family of homologous proteins. FASEB J. 4: 3198-3208. 82. Spaulding, S. W. (1993) The ways in which hormones change cyclic adenosine 3', 5'-monophosphate-dependent protein kinase subunits, and how such changes affect cell behavior. Endocr. Rev. 14: 632-650. 83. Springer, T. A. (1990) Adhesion receptors of the immune system. Nature 346: 425-434. 84. Tabary, F., J. Balandreau, and R. Bourrillon. 1984. Purification of the rice embryo lectin and its binding to nitrogen- fixing bacteria from the rhizosphere of rice. Biochem. Biophys. Res. Commun. 119: 549-555. 85. Takahashi Y, Itami T, Kondo M, Maeda M, Fujii R, Tomonaga S, Supamattaya K, Boonyaratpalin S. 1994. Electron microscopic evidence of bacilliform virus infection in kuruma shrimp (Penaeus japonicas). Fish Pathol 29: 121-125. 86. Takahashi Y, Itami T, Maeda M, Kondo M. 1998. Bacterial and viral diseases of kuruma shrimp (Penaeus japonicus) in Japan. Fish Pathol 33: 357-364. 87. Tang KFJ, Spann KM, Owens L, Lightner DV. 2002. In situ detection of Australian gill-associated virus with a yellow head virus gene probe. Aquaculture 205: 1-5. 88. Tapay LM, Nadala ECB Jr, Loh PC. 1999. A polymerase chain reaction protocol for the detection of various geographical isolates of white spot virus. J Virol Meth 82: 39-43. 89. Tsai MF, Kou GH, Liu HC, Liu KF, Chang CF, Peng SE, Hsu HC, Wang CH, Lo CF. 1999. Long-term presence of white spot syndrome virus (WSSV) in a cultivated shrimp population without disease outbreaks. Dis Aquat Org 38: 107-114. 90. Van Hulten MCW, Witteveldt J, Peters S, Kloosterboer N, Tarchini R, Fiers M, Sandbrink H, Lankhorst RK, Vlak JM. 2001. The white spot syndrome virus DNA genome sequence. Virology 286: 7-22. 91. Vijayan, M. and N. Chandra. 1999. Lectins. Curr. Opin. Struct. Biol. 9: 707-714. 92. Wang, H. X., Liu. W. K., Ng, T. B., Ooi, V. E.C. and Chang, S. T. 1995. Immunomodulatory and antitumor activities of a polysaccharidepeptidecomplex from a mycelial culture of Tricholoma sp., a localedible mushroom. Life Sci. 57: 269-281. 93. Wang CH, Lo CF, Leu JH, Chou CM, Yeh PY, Chou HY, Tung MC, Chang CF, Su MS, Kou GH. 1995. Purification and genomic analysis of baculovirus associated with white spot syndrome (WSBV) of Penaeus monodon. Dis Aquat Org 23: 239-242. 94. Wang CS, Tsai YJ, Kou GH, Chen SN. 1997. Detection of white spot disease virus infection in wild-caught greasy back shrimp, Metapenaeus ensis (deHann) in Taiwan. Fish Pathol 32: 35-41. 95. Wang Q, Poulos BT, Lightner DV. 2000a. Rotenin analysis of geographic isolates of shrimp white spot syndrome virus. Arch Virol 145: 263-274. 96. Wang Q, White BL, Nunan LM, Lightner DV. 2000b. Identification of genomic variations among geographic isolates of white spot syndrome virus using restriction analysis and southern blot hybridization. Dis Aquat Org 43: 175-181. 97. Wang Q, White BL, Redman RM, Lightner DV. 1999. Per os challenge of Litopenaeus vannamei postlarvae and Farfantepenaeus duorarum juveniles with six geographic isolates of white spot syndrome virus. Aquaculture 170: 179-194. 98. Wangteerasupaya C, Vickers JE, Sriurairatana S, Nash GL, Akarajamorn A, Boonsaeng V, Panyim S, Tassankajon A, Withyanchumnarnkul B, Flegel TW. 1995. A non-occluded, systemic baculovirus that occurs in cells of ectodermal and mesodermal origin and causes high mortality in the black tiger prawn Penaeus monodon. Dis Aquat Org 21: 69-77. 99. Weis, W. I. and K. Drickamer. 1996. Structural basis of lectin-carbohydraterecognition. Annu. Rev. Biochem. 65: 441-473. 100. Weis, W. I., K. Drickamer, and W. A. Hendrickson. 1992. Structure of a C-type mannose-binding protein complexed with an oligosaccharide. Nature 360: 127-134. 101. Wongteerasupaya C, Sriurairatana S, Vickers JE, Anutara A, Boonsaeng V, Panyim S, Tassanakajon A, Withachum-narnkul B, Flegel TW. 1995. Yellow head virus of Penaeus monodon is an RNA virus. Dis Aquat Org 22: 45- 50. 102. Wang, K. Y. and Q. Xu. 2000. Lectins and Toxins. Sheng Wu Hua Xue. YuSheng Wu Wu Li Xue. Bao. (Shanghai) 32: 201-205. 103. Yan DC, Dong SL, Huang J, Yu XM, Feng YM, Liu XY. 2004. White spot syndrome virus (WSSV) detected by PCR in rotifers and rotifer resting eggs from shrimp pond sediments. Dis Aquat Org 59: 69-73. 104. Yang, Q. Y. and Jong, S. C. 1989. Medicinal mushroom in China. Mushroom Sci. 12: 631-643. 105. Yang F, He J, Lin X, Li Q, Pan D, Zang X, Xu X. 2001. Complete genome sequence of the shrimp white spot bacilliform virus. J Virol 75: 1811-1820. 106. Yang, R. Y., Hsu, D. K. and Liu, F. T. (1996) Expression of galectin-3 modulates T-cell growth and apoptosis. Proc. Natl. Acad. Sci. U S A 93: 6737-6742. 107. Yoon, T. J., Yoo, Y. C., Kang, T. B., Shimazaki, K., Song, S. K. Lee, K. H., Kim, S. H., Park, C. H., Azuma, I. and Kim, J. B. (1999) Lectins isolated from Korean mistletoe (viscum album coloratum) induce apoptosis in tumor cells. Cancer Lett. 136: 33-40. 108. Yu, L. G., Fernig, D. G., White, M. R. H., Spiller, D. G., Appleton, P., Evans, R. C., Grierson, I., Smith, J. A., Davies, H., Gerasimenko, O. V., Petersen, O. H., Milton, J. D. and Rhodes, J. M. (1999) 109. Zanetta, J. P., Badache, A., Maschke, S., Marschal, P. and Kuchler, S. (1994) Carbohydrates and soluble lectins in the regulation of cell adhension and proliferation. Histol. Histopath. 9: 385-412.