REFERENCES

1. Carlsson, D. J., and Wiles, D. M. Degradation. Encyclopedia of Polymer Science and Engineering., 4 (1986): 630-696.

2. Bailey, W. J., and Gapud, B. "Synthesis of Biodegradable polyethylene." in Polymer stabilization and degradation., ed. Comstock, M. J. (Washington, D. C. : ACS Symposium Series, 1985), pp. 423-431.

3. Huang, S. J. Biodegradable polymers. Encyclopedia of Polymer Science and Engineering., 22 (1986): 220-243.

4. Huang, S. J., Bansleben, D. A.,and Knox, J, R. Biodegradable polymers : Chymotrypsin degradation of low molecular weight poly(ester-urea) containing phenylalanine. J. Appl. Polym. Sci., 23 (1979): 429-437.

5. Bitrito, M, M., Bell, J. P., Brenckle, G. M., Huang, S. J., and Knox, J. R. Synthesis and biodegradation of polymers derived from 2-hydroxy-acids. J. Appl. Polym. Sci.: Appl. Polym. Symp., 35 (1979): 405-414.

6. Tokiwa, Y., and Suzuki, T. Microbial degradation of polyesters. Part III. Purification and some properties of polyethylene adipate degrading enzyme produced by Penicillium sp. strain 14-3. Agric. Biol. Chem., 41(2)(1977): 265-274.

7. Benedict, C. V., Cook, W. J., Jarrett, P., Cameron, J. A., Huang, S.J., and Bell, J. P. Fungal degradation of polycaprolactones. J. Appl. Polym. Sci., 28 (1983):

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

327-334.

8. Fanta, G.F., Swanson, C.L., and Doane, W. M. Composites of starch and poly(ethylene-co-acrylic acid); Complexing between polymeric components. J. Appl. Polym. Sci., 40 (1990): 811-821.

9. Gould, J. M., et al. Polymer compatibility and biodegradation of starch-poly(ethylene-co-acrylic acid)-polyethylene blends. J. Appl. Polym. Sci., 44 (1992): 1971-1978.

10. Wool, R. P., Goheen, S. M. Degradation of polyethylene-starch blends in soil. J. Appl. Polym. Sci., 42 (1991): 2691-2701.

11. Nikolov, Z. L., et al. Effect of compounding and starch modification on properties of starch-filled low-density polyethylene. Ind. Eng. Chem. Res., 30 (1991):1841-1846.

12. Hosokawa, J., et al. Biodegradable film derived from chitosan and homogenized cellulose. Ind. Eng. Chem. Res. , 29 (1990) : 800-805.

13. Paillet, M., and Peguy, A. New biodegradable films from exposed wood solutions. J. Appl. Polym. Sci., 40 (1990) : 427-433.

14. Huang, S. J., Cameron, J. A., and Benedict, C. V. Polycaprolactone degradation by mixed and pure cultures of bacteria and a yeast. J. Appl. Polym. Sci., 28 (1983): 335-342.

15. Byrne, C. A., and Huang, S. J. Biodegradable polymers : Photolysis and fungal degradation of poly (arylene

keto esters). J. Appl. Polym. Sci., 25 (1980): 1951-1960.

16. Pitt, C. G., Jensen, K., Hendren, R. W., and Zhu, K. J. Synthesis, properties and biodegradation of poly(1,3-trimethylene carbonate). Macromolecules., 24 (1991): 1736-1740.

17. Pitt, C. G., Zhong, W. G., Ingram, P., and Hendren, R. W. The synthesis of biodegradable polymers with functional side chains. J. Polym. Sci; Polym. Chem., 25 (1987) : 955-966.

18. Gilding, D. K., and Read, A. M. Biodegradable polymers for use in surgery - poly (glycolic)/poly (lactic acid) homo and copolymer : 2. *In vitro* degradation. Polymer., 22 (1981): 494-498.

19. ————. Biodegradable polymers for use in surgery - poly(ethylene oxide)/poly(ethylene terephthalate) (PEO/PET) copolymers : 2. *In vitro* degradation. Polymer. , 22 (1981): 499-504.

20. Zhu, K. J., Xianzhou, L., and Shilin, Y. Preparation and properties of D,L-lactide and ethylene oxide copolymers : A modifying biodegradable polymeric material. J. Polym. Sci; Polym. Lett., 24 (1986) : 331-337.

21. ————. Preparation, characterization, and properties of polylactide (PLA) - poly(ethylene glycol) (PEG) copolymers: A potential drug carrier. J. Appl. Polym. Sci., 39 (1990) : 1-9.

22. Cameron, J. A., Chen, X., and Gonsalves, K. E. Degradation of nonalternatong poly (ester-amides). Macromolecules., 25 (1992) : 3309-3312.

23. Palumbo, R., Maglio, G., Corbo, P., and Castaldo, L. Synthesis and preliminary characterization ofpolyesteramides containing enzymatically degradable amide bonds. Polym. Bull., 28 (1992) : 301-307.

24. Chen, W. Y., Song, C. X., and Feng, X. D. Synthesis and evaluation of biodegradable block copolymers of caprolactone and D,L-lactide. J. Polym. Sci; Polym. Lett. Ed. , 21 (1983) : 593-600.

25. Teyssie, P. H., Jerome, R., Dubois, P. H., and Degee, P. H. Synthesis and characterization of biocompatible and biodegradable poly(-caprolactone-b-ɣ-benzyl glutamate) diblock copolymers. J. Polym. Sci; Polym. Chem. 31 (1993) : 275-278.

26. Odian, G. Principles of polymerization.(2 nd ed.). New York: John Wiley & Sons, 1970.

27. McGrath, J. E. " Ring-opening polymerization : Introduction." in Ring- opening polymerization, ed. McGrath, J. E. (Washington, D. C.: ACS Symposium Series, 1985), pp. 1-22.

28. Lee, C. L., Frye, C. L., and Johansson, O. K. Selective polymerization of reactive cyclosiloxanes to give non-equilibrium molecular weight distributions. Monodisperse siloxane polymers. Polym. Prepr., Amer. Chem. Soc., Div, Polym. Chem., 10 (2)(1971): 1361-

1367.

29. Zilliox, J. G., Roovers, J. E. L., and Bywater, S. Preparation and properties of polydimethylsiloxane and its block copolymers with styrene. Macromolecules., 8 (1975): 573-578.

30. Saam, J. C., Gordon, D. J., and Linsey, S. Block copolymers of poly(dimethylsiloxane) and polystyrene. Macromolecules., 3 (1)(1970): 1-4.

31. Hoelle, H. J., and Lehnen, B.R. Preparation and characterization of polydimethylsiloxane with narrow molecular weight distribution Eur. Polymp. J., 11 (1975): 663-667.

32. Potts, J. E., Clendinning, R. A., Ackart., W. B., and Niegisen, W. D. Biodegradability of synthetic polymers Polym. Sci. Technol., 3 (1973): 61-79.

33. Tokiwa, Y., and Suzuki, T. Degradation of synthetic polymer compounds by microorganisms. I. Degradation of polyethylene glycol adipate by fungus. Hakko. Kokaku. Zasshai. 52 (6)(1974): 393-398.

34. Reynolds, R. J. W., and Vickers, E. J. British. Pat. 766,347 (Jan 23, 1967).

35. Wilson, D. R., and Beaman, R. G. Cyclic amine initiation of polypivalolactone. J. Polym. Sci., 8(A-1) (1970): 2161-2170.

36. Zhang, Y., Gross, R. A., and Lenz, R. W. Stereochemistry of the ring-opening polymerization of (S)-β-butyrolactone. Macromolecules., 23 (1990) : 3206-3212.

37. Inoue, S., and Aida, T. "Control of ring-opening polymerization with metalloporphyrin catalysts.: Mechanistic aspects." in Ring-opening polymerization, ed. McGrath, J. E. (Washington, D. C.: ACS Symposium Series, 1985), pp. 137-160.

38. Inuoe, S., Asano, S., Maekawa, Y., and Aida, T. "Immortal" polymerization of epoxide and β-lactone with aluminum porphyrin in the presence of protic compound. Macromolecules. , 21 (1988): 1195-1202.

39. Cox, E. F., Hostettle, F., and Kiser R. R. "Poly-caprolactone" in Macromolecular synthesis, ed. Moore, J. A. (New York : John Wiley & Sons, 1977), pp. 327-328.

40. Pitt, C. G., Hibionada, Y. M., and Schindler, A. Aliphatic polyesters, III. Molecular weight and molecular weight distribution in alcohol-initiated polymerization of v-caprolactone. J. Polym. Sci.: Polym. Chem. Ed., 20 (1982): 319-326.

41. Morton, M., and Wu, M. "Organolithium polymerization of v-caprolactone" in Ring-opening polymerization, ed. McGrath, J. E. (Washington, D.C.: ACS Symposium series, 1985), pp. 175-194.

42. Inuoe, S., Aida, T., and Endo, M. "Immortal" polymerization of caprolactone initiated by aluminum porphyrin in the presence of alcohol. Macromelecules., 20 (1987): 2982-2988.

43. Battaerd, H. A. J., and Tregear, G. W. Graft copolymers., New York: John Wiley & Sons, 1967.

44. Whistler, R. L., and Zysk, J. R. Carbohydrates. Kirk-Othmer Encyclopedia of Chemical Technology., 4 (1983): 535-555.

45. Whistler, R. L., and Daniel, J. R. Starch. Kirk-Othmer Encyclopedia of Chemical Technology., 21 (1983): 492-507.

46. Veregin, R. P., Fyfe, C. A., Marchessault, R. H., and Taylor, M. G. Characterization of the crystalline A and B starch polymorphs and Investigation of starch crystallization by high-resolution ^{13}C CP/MAS NMR. Macromolecules., 19 (1986): 1030-1034.

47. Ranby, B., and Rodehed, C. Water vapor absorption and aqueous retention of hydrolyzed starch polyacrylonitrile graft copolymers - " superabsorbent starch ". Polym. Bull., 5 (1981): 87-94.

48. Fanta, G. F., Burr, R. C., and Doane, W. M . Saponified starch-g-polyacrylonitrile. Variables in the Ce^{+4} Initiation of graft polymerization. J. Appl. Polym. Sci., 27 (1982): 2731-2737.

49. Ziderman, L. I., and Belayche, J. Role of polyacrylate starch copolymer in water sorption. J. Appl. Polym. Sci., 32 (1986): 5791-5798.

50. Bazuaye, A., Okieimen, F. E., and Said, O. B. Graft copolymerization of acrylonitrile on starch. J. Polym. Sci. : C : Polym Lett., 27 (1989): 433-436.

51. Castel, D., Ricard, A., and Audebert, R. Swelling of anionic and cationic starch-based superabsorbents in water and saline solution. J. Appl. Polym. Sci., 39

(1990): 11-29.

52. Ranby, B., "New methods for graft copolymerization onto cellulose and starch" in Modified Cellulosics, ed: Rowell ,R.W., and Young,R.A. (New York : Acad. Press, 1978), pp. 171-195.

monomers onto celluosic fibers. (1982): 33-43.

53. Stannett, V. T. "Aspects of cellulose graft copolymers" in Cellulose and its derivatives.: Chemistry, biochemistry and applications, ed: Kennedy, et al. (Chichester: Ellis Horwood, 1985), pp. 387-399.

54. Fanta, G. F., Swanson, C. L., Burr, R. C., and Doane, W. M Polysaccharide-g-polystyrene copolymers by persulfate initiation: Preparation and properties. J. Appl. Polym. Sci., 28 (1983): 2455-2461.

55. Goni, I., Gurruchaga, M., Valero, M., and Guzman, G. M. Graft polymerization of acrylic monomers onto starch fractions. I. Effect of reaction time on grafting methyl methacrylate onto amylose. J. Polym. Sci.: Polym. Chem. Ed., 21 (1983): 2573-2580.

56. Vazquez, M. B., Goni, I., Gurruchaga, M., Valero, M., and Guzman, G. M. Study of the ceric behavior on the initiation of butyl acrylate polymerization onto amylose. J. Polym. Sci.: A : Polym. Chem., 25 (1987): 1309-1314.

57. Samal, R. K., Sahoo, P. K., and Samantaray, H. S. Graft copolymerization of cellulose, cellulose derivatives, and lignocellulose. JMS-Rev. Macromol. Chem. Phys.,

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

C26(1) (1986): 81-141.

58. Huque, M. M., Habibuddowla, MD., Mahmood, A. J., and Mian, A. J. Graft copolymerization onto jute fiber: Ceric ion-initiated graft copolymerization of methyl methacrylate. J. Polym. Sci.: Polym. Chem. Ed., 18 (1980): 1447-1458.

59. Adams, R., Johnson, J. R., and Wilcox, C. F. Jr. Laboratory experiments in organic chemistry., (7 th ed). New York: Macmillan, 1979.

60. Joseph, J. L., and Dennis, B. M. Aluminum alkyls. Encyclopedia of chemical processing and design., 3 (1977): 1-56.

61. Shukla, J. S., and Sharma, G. K., Graft copolymerization of methylacrylate onto wool initiated by ceric ammonium nitrate-thioglycolic acid redox couple in presence of air. IV J. Polym. Sci.: A : Polym. Chem., 25 (1987): 595-605.

62. Fernandez, F. J., Casinos, I., and Guzman, G. M. Grafting of vinyl acetate-methylcrylate mixture on cellulose. Effect of ceric ion and nitric acid concentrations. J. Appl. Polym. Sci., 41 (1990): 2221-2240.

63. Nayak, N. C., Das, H. K., and Singh, B. C. Influence of glycine on the kinetics of the graft copolymerization of acrylonitrile onto jute fibers initiated by ceric ion. J. Appl. Polym. Sci., 42 (1991): 2391-2396.

64. Weaver, M. O., Gugliemelli, L. A., Doane, W. M., and Russel, C. R. J. Appl. Polym. Sci., 15 (1971): 3015-

65. Ardon, M. Oxidation of ethanol by ceric perchlorate. J. Chem. Soc., (1957): 1811-1815.

66. Duke, F. R., and Forist, A. A. The theory and kinetics of specific oxidation. III. The cerate-2,3-butanediol reaction in nitric acid solution. J. Am. Chem. Soc., 71 (1949): 2790-2792.

67. Duke, F. R. and Bremer, R. F. The theory and kinetics of specific oxidation. IV. The cerate-2,3-butanediol reactions in perchlorate solution. J. Am. Chem. Soc., 73 (1951): 5179-5181.

68. Misra, B. N., Mehta, I. K. and Dogra, R. Grafting onto wool. VII. Ceric ion-initiated graft copolymerization of vinyl monomers. Comparison of monomer reactivities. J. Appl. Polym. Sci., 25 (1980): 235-241.

69. Nayak, P. L., Lenka, S., and Mishra, M. K. Grafting vinyl monomers onto wool fibers. V. Graft copolymerization of methyl methacrylate onto wool using peroxydiphosphate as initiator. J. Appl. Polym. Sci., 25 (1980): 63-75.

70. Panda, G., Pati, N. C., and Nayak, P. L. Grafting vinyl monomers onto silk fibers. X. Graft copolymerization of methyl methacrylate onto silk using hydrogen peroxide-thiourea redox system. J. Appl. Polym. Sci., 26 (1981): 775-784.

71. Aminabhavi, T.M., and Balundgi, R.H. A review on biodegradable plastics. Polym.-Plast. Technol. Eng., 29 (3) (1990): 235-262.

APPENDIX

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

APPENDIX A

Chemical Treatments of Reagents

A.1 Dry ether

Diethyl ether (laboratory grade) and Na wire were placed in round bottommed flask (A). The stopcock C was closed and the stopcock B was opened while flask A was heated until mild reflux started. The ether was allowed to boil and reflux for 3 hrs. The stopcock B was closed to collect the dried pure ether. The apparatus for drying is shown below;

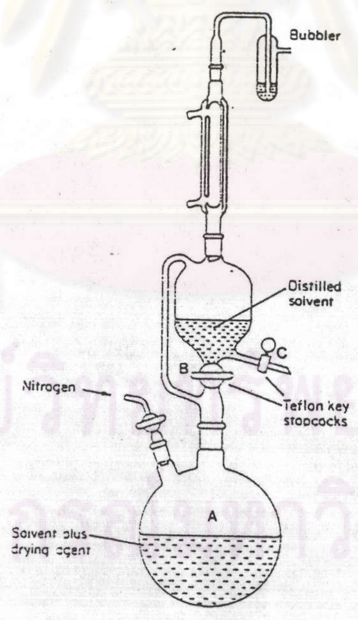


Figure A.1 Apparatus for drying of solvent

A.2 Dry toluene

The toluene used as a dry solvent can be pre-treated by the same apparatus and same steps as that used for ether.

APPENDIX B

Preparation of Fungi's Spore

Procedure

(1) The fungi were transfered from lyophilized tube by aseptic technique. The fungi were cultured on PDA medium and incubated at room temperature.

(2) The 5-7 day-old fungi from (1) were subcultured on PDA slant.

(3) The 7 day-old fungi were filtered by the following steps:

3.1 Fill a 10 ml of clean water and 2 drop of Tween to the slant.

3.2 Scuff the spore out of fraiting body and medium by sterized loop.

3.3 Pour the liquid in slant to the 125 ml sterized flask containing 45 ml of water and 15 glass bead.

3.4 Shake the flask vigorously

3.5 Filter the suspended mixture through filter paper Whatman No.4

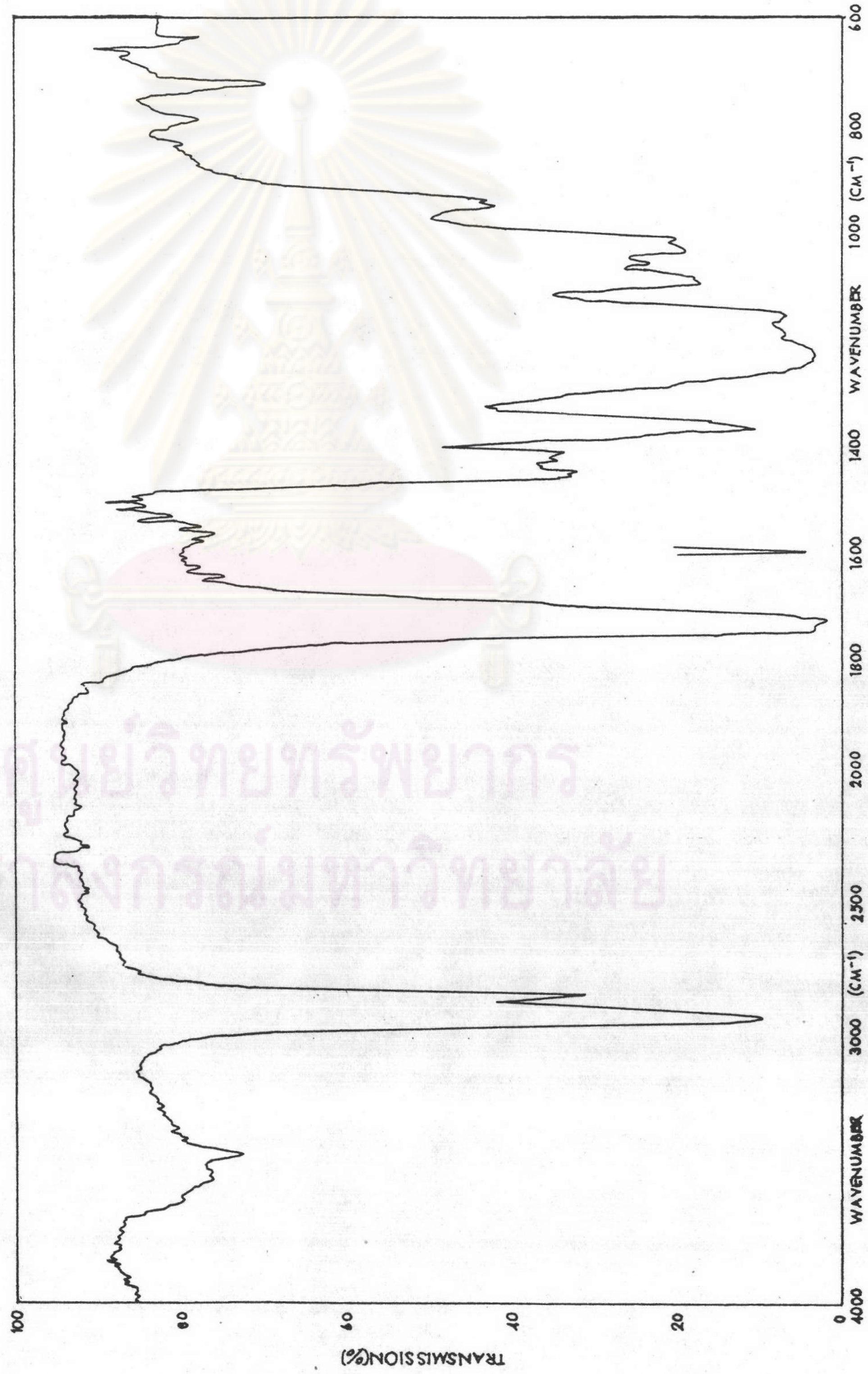
3.6 Collect the filtrate by the sterized flask

3.7 Drop 0.1 ml of the filtrate on hemacytometer and count the spore by microscope

APPENDIX C

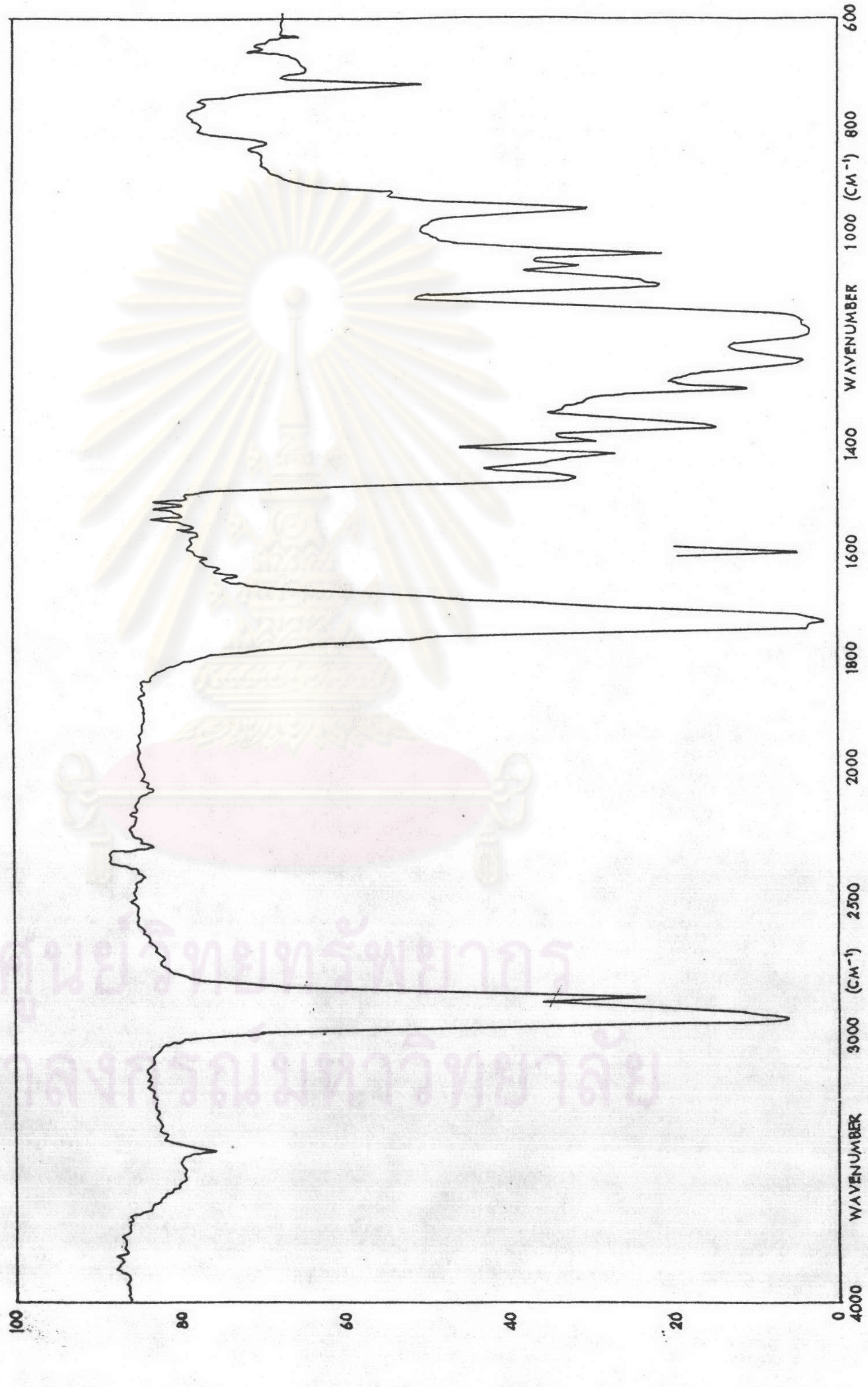
Spectra of polymer blends

C.1 IR spectrum of PCL / PVAc Blends



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

C.2 IR spectrum of PCl / PVC blends



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

C.3 GPC standard curve

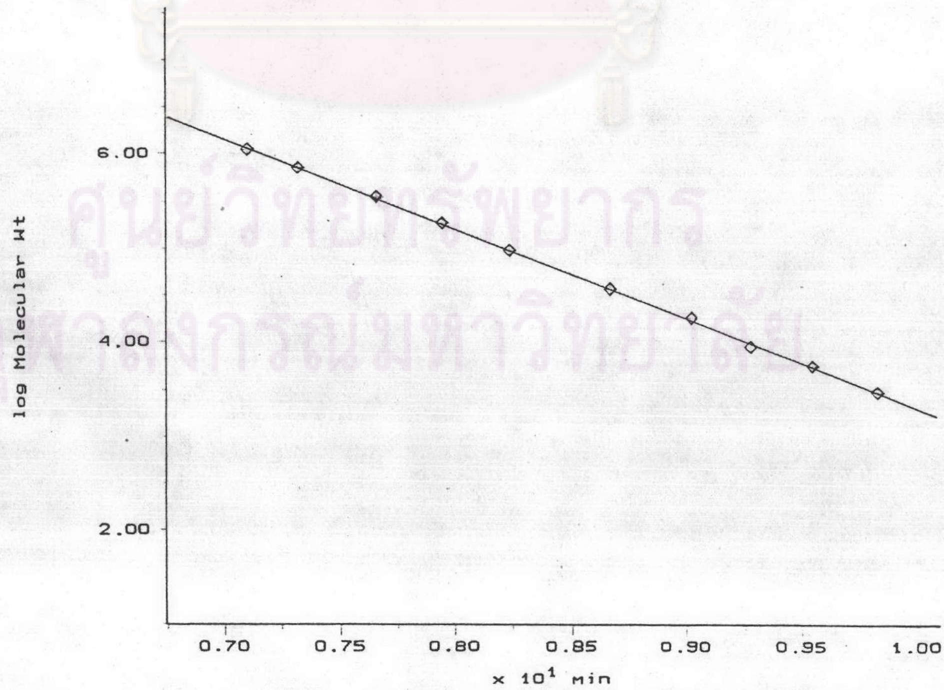
METHOD NAME : MW-BIOPOLYM
Calibration Type : Narrow Standards

Curve Type : Linear
Equation of Curve : log MW = + 1.28E+01 - 9.50E-01*R

Correlation Coef : r^2 = 0.99960348
Std Err of Estimate: 0.01911049

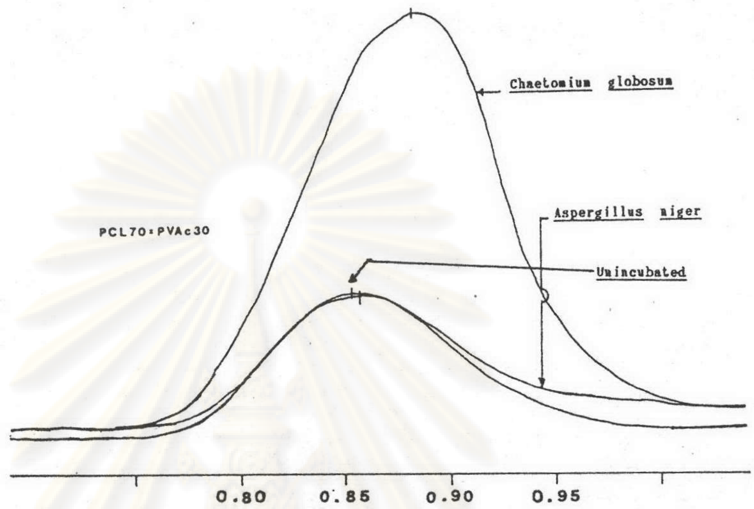
Calibration Points :

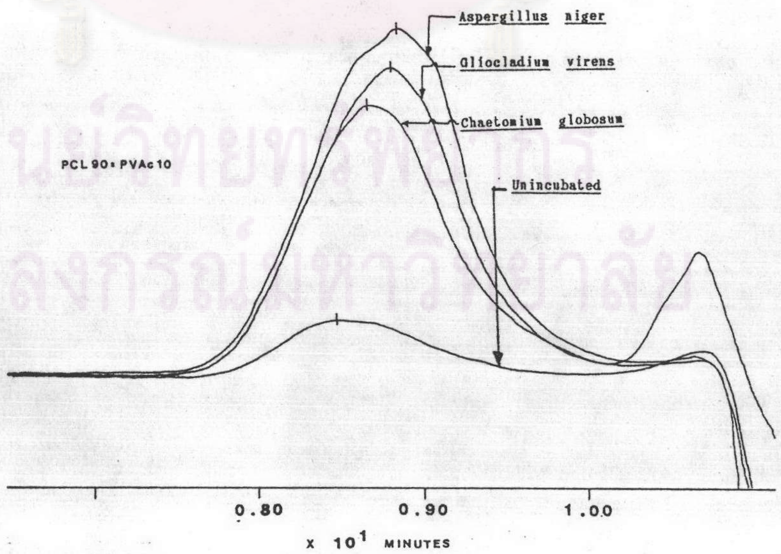
Ret Time (min)	Specified Molecular Wt	Calculated Molecular Wt
7.10	1090000	1149286
7.32	706000	715651
7.66	355000	339068
7.94	190000	182498
8.23	96400	96454
8.67	37900	37400
9.02	18100	17400
9.28	9100	9891
9.54	5570	5521
9.83	2980	2972



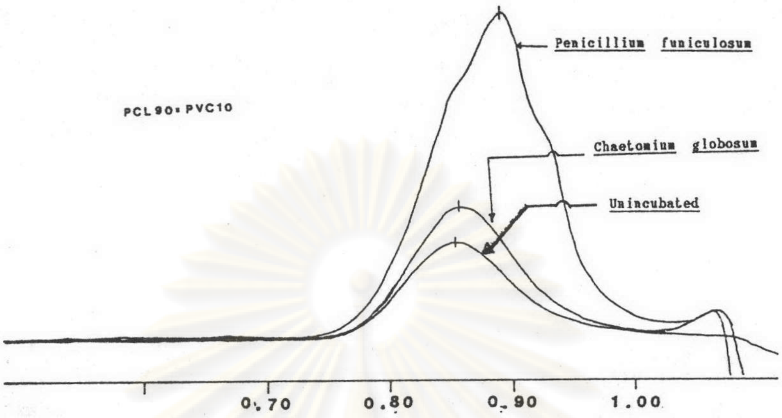
ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

C.4 Overlay of GPC chromatograms of the incubated with respect to the unincubated films.





C.4 (Continued)

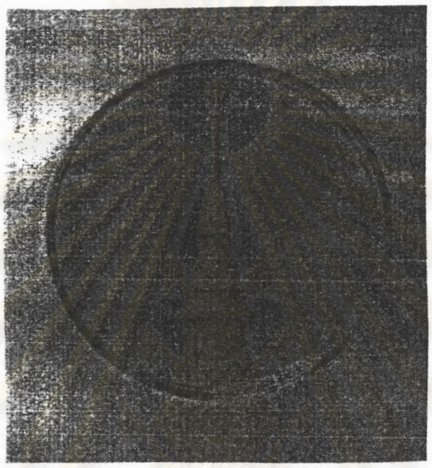


ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

APPENDIX D

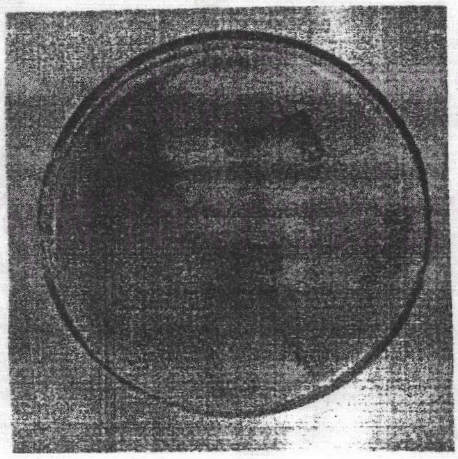
Rating of the observed growth of fungi

D.1 Traces of growth (less than 10 %), rating = 1

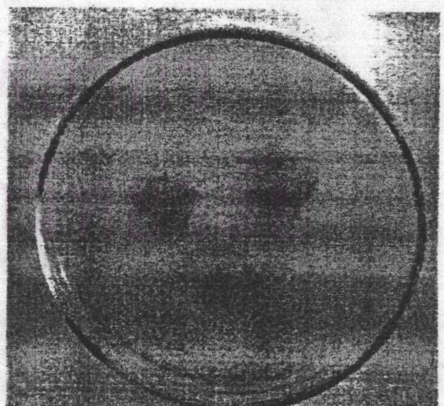


Growth of *Aspergillus flavus* on PCL / PVC (70 : 30)

D.2 Light growth (10 to 30 %), rating = 2



A

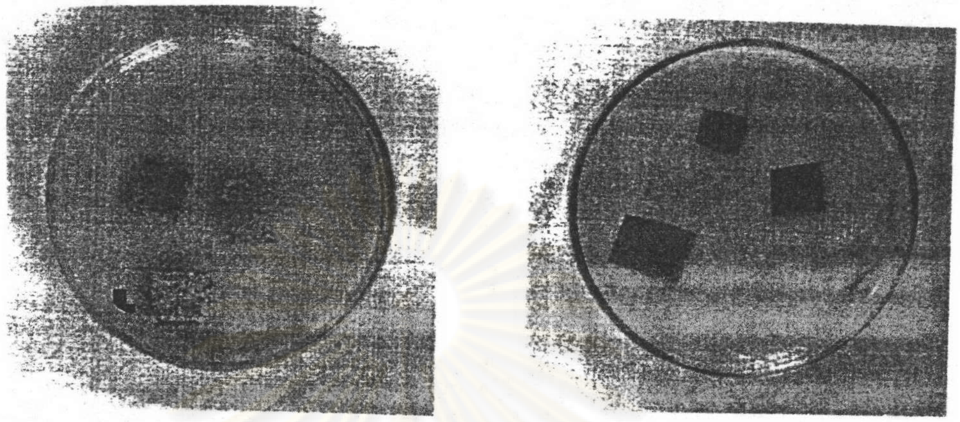


B

(A) Growth of *Aspergillus flavus* on PCL / PVAc (60 : 40)

(B) Growth of *Gliocladium virens* on PCL / PVAc (80 : 20)

D.3 Medium growth (30 to 60 %), rating = 3

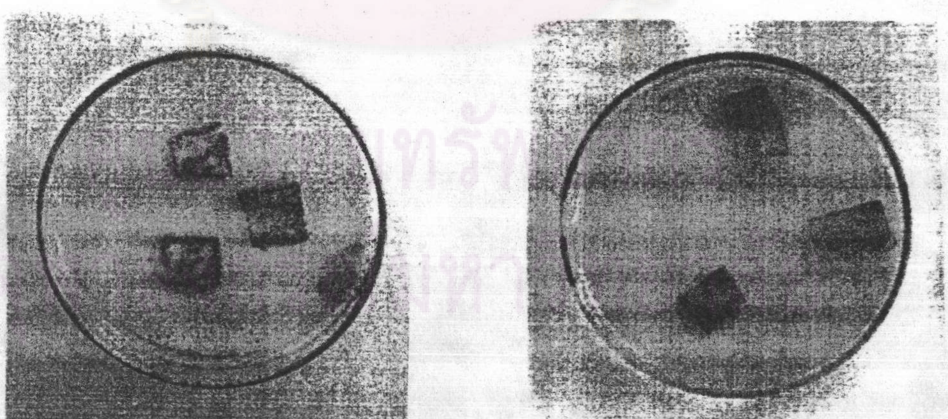


A B

(A) Growth of *Gliocladium virens* on PCL / PVAc (60 : 40)

(B) Growth Of *Penicillium funiculosum* on PCL / PVC (90 : 10)

D.4 Heavy growth (60 % to complete coverage), rating = 4



A B

(A) Growth of *Chaetomium globosum* on PCL / PVAc (70 : 30)

(B) Growth of *Penicillium funiculosum* on PCL 100 %

VITA

Mr. Ruangdaj Tongsri was born in Roi-Et on February 10, 1966. He received Bachelor's Degree in Chemistry from the Faculty of Science, Khonkaen University in 1989.

หอสมุดกลาง สถาบันวิทยบริการ จุฬาลงกรณ์มหาวิทยาลัย
ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย