REFERENCES

Abelian, V. A. Adamian, M. O., Abelian, L. A., Balayan, A. M., and Afrikian, E. K. 1995. A new cyclodmaltodextrin glucanotransferase from halophilic *Bacillus. Biokhimiya.* **60**: 891-897. (in Russian).

Abelyan, V. A., Yamamoto, T., and Afrikyan, E.G. 1994. Isolation and characterization of cyclodextrin glucanotransferase using cyclodextrin polymers and their derivatives. *Biochemistry (Moscow)* **59**: 573-579.

Aeckerberg, F., Bak, F., and Widdel, F. 1991. Anaerobic oxidation of saturated hydrocarcons to CO_2 by a new type of sulfate-reducing bacterium. *Arch. Microbiol.* **156**: 5-14.

Allegre, M., and Deratani, A. 1994. Cyclodextrin uses: from concept to industrial reality. *Agro Fd. Drug carrier. Syst.* **12**: 311-337.

Amersham Phamacia Biotech. 1999. *Protein purification handbook.* Sweden.

Amizo. 1993. *Cavitron cyclo-dextrins: A breakthrough for molecular encapsulation* USA. (Mimeographed).

Bender, H. 1977. Cyclodextrin glucanotransferase from *Klebsiella pneumoniae.* Formation, purification and properties of the enzyme from *Klebsiella pneumoniae* M5 a1. *Arch. Microbiol.* **111**: 271-282.

Bender, H. 1986. Production, characterization and application of cyclodextrins. *Adv. Biotech, Proc.* **6**: 31-71.

Binder, H., Huber, O., and Bock, A. 1986. Cyclodextrin glycosyltransferase from *Krebsiella pneumoniae* M5 a1: Cloning nucleotide sequence and expression. *Gene.* **47**: 269-277.

Bio-Rad Laboratories. 2000. *Bio-Gel P Polyacrylamide gel instruction manual.* USA.

Biwer, A., Antranikian, G., and Heinzle, E. 2002. Enzymatic production of cyclodextrins. *Appl. Microbiol. Bioltechnol.* **59** : 609-617.

Bollag, M. D., and Edelstein, J. S. 1991. eds. Protein methods. Wiley-Liss, Inc.

Bovetto, L. J., Backe, D. P., Villette, J. R., Sicard, P. J., and Bouquelet, S. J-L. 1992. Cyclomaltodextrin glucanotransferase from *Bacillus circulans* E192 I : Purification and characterization of the enzyme. *Biotechnol. Appl. Biochem.* **15** (1) : 48-58.

Bradford, M. M. 1976. A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. *Anal. Biochem.* **72**: 248-254.

Casu, B. and Riggiani, M. 1979. Methylated cycloamyloses and their inclusion properties. *Carbohydr. Res.* **76**: 59-68.

Chung, J. H., Yoon, H. S., Lee, J. M., Kim, J. M., Kweon, S. K., Lee, W. I., Kim, W. J., Oh, H. B., Lee, S. H., Spiridonova, A. V., and Park, H. K. 1998. Characterization of a thermostable cyclodextrin glucanotransferase isolated from *Bacillus stearothermophilus* ET1. *J. Agric. Food. Chem.* **46**: 952-959.

DePinto, J. A., and Campbell, L. L. 1968. Purification and properties of the amylase of *Bacillus macerans. Biochemistry* **7**: 114-120.

DePinto, J. A., and Campbell, L. L. 1986. Purification and properties of the cyclodextrinase of *Bacillus macerans. Biochemistry* **7**: 121-125.

Eisenthal, R., and Dason, M. J. eds. 1992. *Enzyme assay: a practical approach.* New York: IRL press.

Engbrecht, A., Harrer, G., and Schimid, G. 1990. Biochemical and genetic characterization of cyclodextrin glycosyltransferase from an alkalophilic bacteria forming primarily cyclodextrin. In D. Duchene (ed.), *Proceeding of the 5th International Symposium on Cyclodextrin,* pp. 25-31. Paris: Edition de Sante.

Ensuiko 1994. *Stabilization of natural colors by cyclodextrin.* Japan (Mimeographed).

Fogarty, W. M. 1983. Microbial amylase. In W. M. Fogarty (ed.), *Microbial Enzymes and Biotechnology*, pp. 1-92. Essex: Applied science publishers.

Fujita, Y., Stubouchi, H., Inagi, Y., Tomita, K., Ozaki, A., and Nakanishi, K. 1990. Purification and properties of cyclodextrin glycosyltransferase from *Bacillus sp.* AL-6. *J. Ferment. Bioeng.* **70**: 150-154.

Gawande, N. B., Goel, A., Patker, Y. A., and Nene, N. S. 1999. Purification and properties of a novel raw starch degrading cyclomaltodextrin glucanotransferase from Bacillus firmus. Appl. Microbiol. Biotechnol. 51: 504-509.

Goel, A., and Nene. N. S. 1995. Modifications in the phenolphthalein method for spectrophotometric estimation of beta cyclodextrin. *Starch/starke.* **47** (10): 399-400.

Hames, B. D., Hooper, N. M., and Houghton, J. D. 1998. *Instant notes in biochemistry.* UK: BIOS scientific publisher. pp. 58-64.

Hedges, R. A. 1998. Industrial application of cyclodextrins. *Chem. Rev.* **98**: 2035-2044.

Horikoshi, K., and Akiba, T. 1982. *Alkalophilic microorganisms: A new Microbial World*, pp. 105-157. Tokyo: Scientific Societies Press.

Jamuna, R., Saswathi, N., Sheela, R., and Ramakrishna, S. V. 1993. Synthesis of cyclodextrin glucosyl transferase by *Bacillus cereus* for the production of cyclodextrins. *App. Biochem. Biotechnol.* **43**: 163-176.

Jespersen, H. M., Macgregor, E. A., Sierks, M. R., and Svensson, B. 1991. Comparison of the domain-level organisation of starch hydrolases and related enzymes. *J. Biochem.* **280**: 51-55.

John, S. M., Hamilton, M. L., and Lash, T. D. 1997. Effect of covalent modification on coproporphyrinnogen oxidase from chicken red blood cells. *Prep. Biochem. Biotech.* **27**(1): 47-57.

JSPS-NRCT. 2000. Core University Program on Development of Thermotolerant Microbial Resources and Their Applications in Thailand and Japan, pp. 4-7.

Kadziola, A., Sogaard, M., Svenson, B., and Haser, R. 1998. Molecular structure of a barley α-amylase-inhibitor complex: implications for starch binding and catalytic. *J. Mol. Biol.* **278**: 205-217.

Kaneko, T., Kato, T., Nakamura, N., and Horikoshi, K. 1987. *J. Jpn. Soc. Starch. Sci.* **34**: 45.

Kaskangam, K. 1998. Isolation and characterization of cyclodextrin glycosyltransferase isozymes from *Bacillus* sp. A11. Master's Thesis, Faculty of Science, Chulalongkorn University.

Kato, K., and Horikoshi, K. 1984. Immobilized cyclodextrin glucanotransferase of an alkolophilic *Bacillus* sp. No38-2. *Biotechnol. Bioeng.* **26**: 595-598.

Kaulpiboon, J. 2000. Idenfication of essential histidines in cyclodextrin glycosyltransferase isoform 1 from *Bacillus circulans* A11. Master's Thesis, Faculty of Science, Chulalongkorn University.

Kim, T.-J., Kim, B.-C., and Lee, H.-S. 1995. Production of cyclomaltodextrins using moderately heat-treated cornstarch. *Enz. Microb. Technol.* **17**: 1057-1061.

Kimura, K., Kataoka, S., Nakamura, A., Takano, T., Kobayashi, S., and Yamane, K. 1989. Function of the C-terminal region of cyclodextrin glucanotransferase of alkalophilic *Bacillus* sp. #1011: Relation to activity and pH stability. *Biochem. Biophys. Res. Com.* **161**: 1273-1279.

Kitahata, S., and Okada, S. 1974. Action of cyclodextrin glycosyltransferase from *Bacillus metaterium* strain No. 5 on starch. *Agric. Biol. Chem.* **38**: 2413-2417.

Kitahata, S., and Okada, S. 1975. Transfer action of cyclodextrin glycosyltransferase on starch. *Agric. Biol. Chem.* **28**: 2413-2417.

Kitahata, S., and Okada, S. 1982. Purification and some properties of cyclodextrin glucanotransferase from *Bacillus stearthermophilus* TC-90. *J. Jpn. Starch. Sci.* **29**: 7-12.

Kitahata, S., Tsuyama, N., and Okada, S. 1974. Purification and some properties of cyclodextrin glycosyltransferase from a strain of *Bacillus* species. *Agric. Biol. Chem.* **38**: 387-393.

Kitahata, S., Okada, s., and Fukai, T. 1978. Acceptor specificity of tranglycosylation catalyzed by cyclodextrin glucosyltransferase. *Agric. Biol. Chem.* **42**: 2369-2374.

Klein, C., and Schulz, G. E. 1991. Structure of cyclodextrin glycosyltransferase refined at 2.0 Ao resolution. *J. Mol. Biol.* **217**: 737-750.

Kobayashi, S., Kainuma, K., and Suzuki, S. 1978. Purification and some properties of *Bacillus macerans* cycloamylose (cyclodextrin) glucanotransferase. *Carbohydr. Res.* **61**: 229-238.

Larsen, K.L., Olensen, L.D.,Christensen, H.J.,Mathiesem,F., Pedersen, L.H., and Zimmermann, W. 1998. Purification and characterization of cyclodextrin glyclosyltransferase from *Paenibasillus* sp. F8. *Carbohydr. Res.***310**: 211-219

Lawson, C. L., van Montfort, R., Strokopytov, B., Rozeboom, H. J., Kalk, K. H., de Vries, G. E., Penninga, D., Dijkhuizen, L., and Dijkstra, B.W. 1994. Nucleotide sequence and X-ray structure of cyclodextrin glycosyltransferase *from Bacillus circulans* strain 251 in a maltose-dependent crystal form. *J. Mol. Biol.* **236**: 590-600.

Lundblad, R. L. 1991. *Chemical reagents for protein modifica*tion. 2nd ed. CRC Press.

Makela, M., Mattsson, P., and Koppela, T. 1988. Purification and properties of cyclodextrin glucanotransferase from Alkalophilic *Bacillus. Biotechnol. Appl. Biochem.* **10**: 414-427.

Martins, R. F., and Hatti-Kaul, R. 2002. A new cyclodextrin glycosyltransferase from an alkaliphilic *Bacillus agaradhaerens* isolate: purification and characterisation. *Enz. Microb. Technol.* **30**: 116-124.

Matsuura, Y., Kusunoki, M., and Harada, W. 1984. Structure and possible catalytic residues of Taka-amylase A. *J. Biochem.* **95**: 697-702.

Mattsson, P., Meklin, S., and Korpela, T. 1990. Analysis of cyclodextrin glucanotransferase isozymes by isoelectric focusing in immobilized pH gradients. *J. Biochem. Biophys. Methods*. **20** (3): 237-276.

Matzuzawa, M., Nakamura, N., and Horikoshi, K. 1975. An improve method for the preparation of Schardinger beta-dextrin on an industrial scale by cyclodextrin glycosyltrnsferase of an alkaphilic *Bacillus* sp. ATCC 21783. *Starch/ Strake.* **27**: 410-413.

Mean, G. E. and Feeney, R. E. 1971. *Chemical modification of proteins*. Holden-Day, Inc.

Nakamura, A., Haga, K., and Yamane, K. 1993. Three histidine residues in the active center of cyclodextrin glucanotransferase from *Bacillus* sp. 1011: Effect of the replacement on pH dependence and transition-state stabilization. *Biochemistry* **32**: 6624-6631.

Nakamura, A., Haga, K., and Yamane, K. 1994. Four aromatic residues in the active center of cyclodextrin glucanotransferase from alkalophilic *Bacillus* sp. 1011: Effect of the replacement on substrate binding and cyclization characteristics. *Biochemistry* **33**: 9929-9936.

Nakamura, N., and Horikoshi, K. 1976. Purification and properties of cyclodextrin glycosyltransferase of an alkalophilic *Bacillus sp. Agric. Biol. Chem.* **40**: 935-941.

Nakamura, N., and Horikoshi, K. 1976. Characterization and some cultural conditions of a cyclodextrin glycosyltransferase-producing alkalophilic *Bacillus* sp. *Agric. Biol. Chem.* **40**: 753-757.

Neri, D., Billeter, M., Wider, G., and Wuthrich, K. 1992. NMR determination of residual structure in a urea-denatured protien, the 434 repressor. *Science.* **257**:1559.

Ohnishi, M., Abe, M., Azuma, T., Kubota, M., and Rokushika, S. 1994. Tryptophan residues of Bacillus cycloamylose glucanotransferase: Effect of modification

with *N*-bromosuccinimide on the enzyme-catalysed synthesis of cyclomaltoheptaose from maltotriose. *Strach/Strake.* **46**: 272-275.

Ohnishi, M., Taniguchi, M., and Hiromi, K. 1983. Kinetic discrimination of tryptophan residues of glucoamylase from *Rhizopus niveus* by fast chemical modification with *N*-bromosuccinimide. *Biochem. Biophys. Acta.* **744**: 64-70.

Penninga, D., van der Veen, B. A., Knegtel, R. M. A., van Hijum, S. A. F. T., Rozeboom, H. J., Kalk, K. H., Dijkstra, B. W., and Dijkhuizen, L. 1996. The raw starch binding domain of cyclodextrin glycosyltransferase from *Bacillus circulans* strain 251. *J. Biol. Chem.* **271**: 32777-32784.

Pongsawasdi, P., and Yagisawa, M. 1987. Screening and identification of a cyclomaltodextrin glucotransferase producing bacteria, *J.Fermant. Technol.* **65**: 463-467.

Prasong, W. 2002. Structure analysis of cyclodextrin glycosyltransferase isoforms from *Paenibacillus* sp. A11. Master's Thesis, Faculty of Science, Chulalongkorn University.

Prowe. S.G., and Antranikian, G. 2001. *Anaerobranca gottschalkii* sp. nov. a novel thermoalkaliphilic bacterium that grows anaerobiclly at high pH and temperature. *Int. J. Syst. Evol. Microlbiol.* **51**: 457-465.

Pully, O. A., and French, D. 1961. Studies on the Schardinger dextrin XI: The isolation of new Schardinger dextrin. *Biochem. Biophys. Res. Com.* **5**: 11-15.

Qian, M. X., Haser, R., Buisson, G., Duee, E., and Payan, F. 1994. The active center of a mammalian α-amylase. Structure of complex of a pancreatic α-amylase with a carbohydrate inhibitor refined to 2.2 A° resolution. *Biochemistry* **33**: 6284-6294.

Queiroz, J. A., Tamaz, C. T., and Cabral, J. M. S. 2001. Hydrophobic interaction chromatography of proteins. *J. Biotechnol.* **87**: 143-159.

Renz, A., Schikora, S., Schmid, R., Kossmann, R., and Beck, E. 1998. CDNA sequence and heterologous expression of monomeric spinach pullulanase:

multiple isomeric forms arise from the same polypeptide. *Biochem. J.* **331**: 937-945.

Ruan, Q. 2002. Protein dynamics: studies of adenylate kinase mutants from E.coli and characterization of adenylate kinase isoforms from murine cells-application of fluorescence spectroscopy and microscopy. Doctor's thesis, Philosophy in Biochemistry, University of Illinois at Urbana-Champaign.

Saenger, W. 1980. Cyclodextrin inclusion compounds in research and industry. *Angew. Chem.* **19**: 344-362.

Saenger, W. 1982. Structure aspect of cyclodextrin inclusion compounds. In J. Szejtli (ed.), *Proceedings of the 1st International Symposium on Cyclodextrins,* Budapest, Akademial Kiado: 141-145.

Saenger, W., Jacob. J., Gessler, K., Steiner, T., Hoffmann, D., Sanbe, H., Koizumi, K., Smith, M. S., and Takaha, T. 1998. Structure of the common cyclodextrins and their larger analogues-beyond the doughut. *Chem. Rew.* **98**: 1787-1802.

Schmid, G. 1989. Cyclodextrin glycosyltransferase production: Yield enhancement by overexpression of clone genes. *Trends Biotechnol.* **7**: 244-248.

Schmid, G. 1996. Preparation and industrial production of cyclodextrins. In Atwoods *et al* (eds.), *Comprehensive supramolecular chemistry*, vol. 3. Cyclodextrins, pp. 41-56. Oxford: Pergamon.

Segal, I. H. 1976. *Biochemical calculations*. New York: John Wiley & Sons. pp. 273-279.

Sin, K-A., Nakamura, A., Masaki, H., Matsuura, Y., and Uozumi, T. 1994. Replacement of an amino acid residue of cyclodextrin glucanotransferase of *Bacillus obhensis* double the production of γ-cyclodextrin. *J. Biotech.* **32**: 283-288.

Slominska L, Sobkowiak B.1997. Studies on cylcoldextrin synthesis by novel cyclodextrin glcosyl transferase. *Starch/Staerke* **49**: 301-305.

Starnes, R. L. 1990. Industrial potential of cyclodextrin glycosyl transferase. *Cereal Food World.* **35**: 1094-1099.

Starnes R. 2001. Thermostable cyclodextrin glycosyl transferase and processes using it. US Patent 6 184 001.

Stavn, A., Granum, P. E. 1979. Purification and physicochemical properties of an extracellular cycloamylose (cyclodextrin) glucanotransferase from Bacillus macerans. *Carbohydr. Res.* 75: 243-250.

Strattan, R. 2000. http://www.cyclodextrin.com.

Strokopytov, B., Penninga, D., Rozeboom, H. J., Kalk, K. H., Dijkhuizen, I., and Dijkstra, B. W. 1995. X-ray structure of cyclodextrin glycosyltransferase complex with acabose. Implications for the catalytic mechanism of glycosidase. *Biochemistry* 34: 2234-2240.

Sturmfels, A. Gotz, F., Peschel, A. 2001. Secretion of human growth hormone by the food grade bacerium *Staphylococcus carnosus* requires a propeptide irrespective of the signal peptide. *Arch Microbiol.* 175: 295-300.

Sundararajan, P.R., and Rau, V.S.R. 1970. Conformation studies on cycloamylose. *Carbohydr. Res.* **13**: 351.

Szejtli, J. 1988. *Cyclodextrins technology.* Netherland: Kluwer Academic Publisher.

Szejtli, J. 1998. Introduction and general overview of cyclodextrin chemistry. *Chem. Rev.* **98**: 1743-1753.

Takano, T., Fukuda, M., Monma, M., Kobayashi, S., Kaimuma, K., and Yamane, K. 1986. Molecular cloning, DNA nucleotide sequencing and expression in *Bacillus subtilis* cells of the *Bacillus macerans* cyclodextrin glucanotransferase gene. *J. Bacterio.* **166**: 1118-1122.

Tanford,C. 1968. Protein denaturation. *Adv.Protein Chem.* **23**: 121.

Tashibana, Y., Kuramura, A., Shirasaka, N., Suzuki, Y., Yamamoto, T., Fujiwara, S., Takagi, M., and Imanaka, T. 1999. Purification and characterization of an extremely thermostable cyclodextrin glyclosyltransferase from a newly isolated

hypothermophilic archaeon, a Thermococcus sp. *Appl. Environ. Microbiol.* **65**: 1991-1997.

Terada, Y., Sanbe, H., Takaha, T., Kitahata, S., Koizumi, K., and Okada, S. 2001. Comparative study of the cyclization reactions of three bacterial cylomaltodextrin glucanotransferase. *Appl. Environ. Microbiol.* **67**: 1453-1460

Tesana, S. 2001. Cyclodextrin glycosyltransferase from thermotolerant bacteria: screening, optimization, partial purification and characterization. Master's Thesis, Faculty of Science, Chulalongkorn University.

Tomohoro, E., Haruhis, U., Shoichi, K., and Tsuneji, N. 1994. Purification and characterization of η-cyclodextrin. In T. Osa (ed.), *Proceedings of the 7th International Symposium on Cyclodextrin,* pp. 66-69.

Tongsima, A. 1998. The active site of cyclodextrin glycosyltransferase from *Bacillus* sp. A11. Master's Thesis, Faculty of Science, Chulalongkorn University.

Tonkova, A. 1998. Bacterial cyclodextrin glucanotransferase. *Enzyme Microb. Technol.* **22**: 678-686.

van der Veen, B. A., Joost, C.M., Uitdehaag, B. W. D., and Lubbert. D. 2000. Engineering reaction and production specificity of cyclodextrin glycosyltransferase from *Bacillus circulans* strain 251. *Biochemica et Biophysica Acta*: Protein and proteomic. **1543**(2): 336-360.

Vikmon, M. 1981. Rapid and simple spectrophotometric method for determination of micro-amounts of cyclodextrins. *Proceeding of the First International Symposium on Cyclodextrins*, Hugary: 69-74.

Villette, J. R., Helbecque, N., Albeni, J. R., Sicard, P. J., and Bouquelet, S. J-L. 1993. Cyclodextrin glucanotransferase from *Bacillus circulans* E192: Nitration with tetranitromethane. *Biotech. Appl. Biochem.* **17**: 205-216.

Voet, D. and Voet, J. G. 1990. *Biochemistry* John Wiley & Sons, Inc.

Voet, D. and Voet, J. G. 1995. *Biochemistry* Canada: John Wiley&Sons. pp.333-337.

Volkova, D. A., Lopatin, S. A., and Varlamov, V. P. 2000. One-step affinity purification of cyclodextrin glucanotransferase from *Bacillus* sp.1070. *Biocatalysis.* **41**(6): 67-69.

Wind, R. D., Liebl, W., Buitellaar, R. M., Penninga, D., Spreinat, A., Dijkhuizen, L., and Bahl, H. 1995. Cyclodextrin formation by the thermostable α–amylase of *Thermoanaerobacterium thermosulfurigenes* EM1 and reclassification of the enzyme as a cyclodextrin glylcosyltransferase. *Appl. Environ. Microbiol.* **61**: 1257-1265.

Worn, A., and Pluckthun, A. 1999. Different equilibrium stability behavior of ScFv fragments: identification, classification, and improvement by protein engineering. *Biochemistry* **38**: 8739-8750.

Yamamoto, M., Tanaka, Y., and Horikoshi, K. 1972. Alkaline amylases of alkalophilic bacteria. *Agric. Biol. Chem.* **36**: 1819-1832.

Yamamoto, M., Aritumi, H., Ilie, T., Hirayama, F., and Uekama, K. 1990. Pharmaceutical evaluation of branched β-cyclodextrins as parental drugs carriers. In D. Duchene (ed.), *Minutes of the Fifth International Symposium on Cyclodextrins*, Paris, Edition De Sante: 541-544.

Yagi, Y., Sato, M., and Ishikura, T. 1986. Comparative studies of CGTase from *Bacillus ohbensis, B. macerans* and *B. circulans* and production of cyclodextrins using those CGTases. *J. Jpn. Soc. Starch. Sci.* **2**: 144-154.

Yang, C.P., and Su, C. S. 1989. Study of cyclodextrin production using cyclodextrin glucanotransferase immobilized on chitosan. *J. Chem. Tech. Biotechnol.* **46**: 283-289.

Yu, Y., Li, R., Xu, C., Ruan, K., Shen, Y., and Govindjee. 2001. *N*-bromosuccinimide modification of tryptophan 241 at the C-terminus of the manganese stabilizing protein of plant photosystem 11 influences its structure and function. *Physiol. Plant.* **111**: 108-115.

Zacharius, R. M., Zell, T. E., Morrison, J. H. and Woodlock, J. J. 1969. Glycoprotein staining following electrophoresis on acrylamide gels. *Anal. Biochem.* **30**: 148-152.

APPENDICES

Appendix 1: Preparation for polyacrylamide gel electrophoresis

1) Stock reagents

30% Acrylamide, 0.8% bis-acrylamide, 100 ml

acrylamide	29.2 g
N,N′-methylene-bis-acrylamide	0.8 g

Adjusted volume to 100 ml with distilled water

1.5 M Tris-HCl pH 8.8

Tris(hydroxymethyl)-aminomethane	18.17 g

Adjusted pH to 8.8 with 1 M HCl and adjusted volume to 100 ml with distilled water

2 M Tris-HCl pH 8.8

Tris(hydroxymethyl)-aminomethane	24.2 g

Adjusted pH to 8.8 with 1 M HCl and adjusted volume to 100 ml with distilled water

0.5 M Tris-HCl pH 6.8

Tris(hydroxymethyl)-aminomethane	6.06 g

Adjusted pH to 6.8 with 1 M HCl and adjusted volume to 100 ml with distilled water

1 M Tris-HCl pH 6.8

Tris(hydroxymethyl)-aminomethane	12.1 g

Adjusted pH to 6.8 with 1 M HCl and adjusted volume to 100 ml with distilled water

Solution B (SDS-PAGE)

2 M Tris-HCl pH 8.8	75 ml
10% SDS	4 ml
distilled water	21 ml

Solution C (SDS-PAGE)

1 M Tris-HCl pH 6.8	50 ml
10% SDS	4 ml
distilled water	46 ml

2) Non-denaturing PAGE

7.5% Separating gel

30% acrylamide solution	2.5 ml
1.5 M Tris-HCl pH 8.8	2.5 ml
distilled water	5.0 ml
10% $(NH_4)_2S_2O_8$	50 µl
TEMED	10 µl

5.0% stacking gel

30% acrylamide solution	0.67 ml
0.5 M Tris-HCl pH 6.8	1.0 ml
distilled water	2.3 ml
10% $(NH_4)_2S_2O_8$	30 µl
TEMED	5 µl

Appendix 2: Preparation of Periodic Acid-Schiff staining solution

Fixative solution

Trichloroacetic acid	12.5 g
Distilled water	100 ml

Schiff's reagent

1. Dissolved 1 g of Basic Fuchsin 200 ml of boiling distilled water. Stirred for 5 minutes and cooled to 50°C.
2. Filtered and added the filtrate to 20 ml of 1 N HCl.
3. Cooled to 25°C and added 1 g of sodium or potassium metasulfite (Fresh metabisulfite was required for optimum result).
4. Left this solution in dark for 12-24 hours.
5. Added 2 g of activated charcoal, shaked for 1 minute, filtered and stored at room temperature.

1% Periodic acid in 3% Acetic acid

Periodic acid	1 g
dissolved in 3% acetic acid	100 ml

0.5% Sodium Metabisulfite

Sodium metabisulfite	0.5 g
Distilled water	100 ml

7% Acetic acid

Glacial acetic acid	7 ml
Distilled water	93 ml

Appendix 3: Preparation for isoelectric focusing gel electrophoresis

Monomer-ampholyte solution

30% Acrylamide solution	0.9 ml
1.0% Bis-acrylamide solution	1.25 ml
Ampholyte pH 5-7	0.243 ml
Distilled water	1.39 ml
50% Sucrose	1.186 ml
TEMED	2 µl
0.02 M $(NH_4)_2S_2O_8$	39 µl

Fixative solution, 100 ml

Sulfosalicylic acid	4 ml
Trichloroacetic acid	12.5 ml
Methanol	30 ml

Immerse gels in this solution for 30 minutes.

Staining solution, 100 ml

Ethanol	27 ml
Acetic acid	10 ml
Coomassie brilliant blue R-250	0.04 ml
$CuSO_4$	0.5 ml
Distilled water	63 ml

Dissolve the CuSO4 in water before adding the alcohol. Either dissolve the dye in alcohol or add it to the solution at the end.

Immerse the gel in stain for approximately 1-2 hours.

Appendix 4: Preparation for buffer solution

- 0.2 M Potassium Acetate pH 3.0, 4.0 and 5.0

  CH_3COOK 1.96 g

  Adjusted to pH 3, 4 or 5 by 0.2 M acetic acid and adjusted volume to 100 ml with distilled water.

- 0.2 M Phosphate pH 6.0

  KH_2PO_4 2.27 g

  K_2HPO_4 0.58 g

  distilled water 100 ml

- 0.2 M Phosphate pH 7.0

  KH_2PO_4 0.91 g

  K_2HPO_4 2.32 g

  distilled water 100 ml

- 0.2 M Tris-HCl pH 8.0 and 9.0

  Tris(hydroxymethyl)-aminometane 2.42 g

  Adjusted to pH 8.0 or 9.0 by 1 M HCl and adjusted to 100 ml with distilled water.

- 0.2 M Tris-Glycine NaOH pH 10.0 and 11.0

  Glycine 1.5 g

  Adjusted to pH 10.0 or 11.0 by 1 M NaOH and adjusted volume to 1000 ml with distilled water.

Appendix 5 Reactivities of amino acid side chains

Reagent	$-NH_2$	-SH						-S-S-	$-S-CH_3$
Acetic anhydride	+++	+++[b]	+++[c]	+++[c]	+++[b]	-	-	-	-
N-Acetylimidazole	±±	+++[b]	+++[c]	+++[b]	-	-	-	-	-
Acrylonitrile	±±	+++	-	-	-	-	-	-	-
Aldehyde/$NaBH_4$	+++	-	-	-	-	-	-	-	-
N-Bromosuccinimide	-	+++	++	+	-	-	+++	-	-
N-carboxyanhydrides	+++	-	-	-	-	-	-	-	-
Cyanate	+++	+++[b]	++[b]	+[b]	-	+[b]	-	-	-
Cyanogen bromide	-	+	-	-	-	-	-	-	+++
1,2-cyclohexanedione	±	-	-	-	+++	-	-	-	-
Diacetyl trimer	+	-	-	-	+++	-	-	-	-
Diazoacetates	-	++	-	-	-	+++	-	-	-
Diazonium salts	+++	+	+++	+++	+	-	+	-	-
Diethylpyrocarbonate	+++	-	-	+++[c]	-	-	-	-	-
Diketone	+++[c]	-	+	-	-	-	-	-	-
Dinitrofluorobenzene	+++	+++	++	++	-	-	-	-	-
5,5'-dithiobis(2-nitrobenzoic acid)	-	+++[c]	-	-	-	-	-	-	-

Appendix 5 Reactivities of amino acid side chains (continued)

Reagent	$-NH_2$	-SH						-S-S-	$-S-CH_3$
Ethyleneimide	-	+++	-	-	-	-	-	-	-
N-ethylmaleimide	±	+++	-	-	-	-	-	-	-
Ethyl thiotrifluoacetate	+++[b]	-	-	-	-	-	-	-	-
Formaldehyde	+++	+++	+++	+++	+	-	+	-	-
Glyoxal	++	-	-	-	+++	-	-	-	-
Haloacetates	+	+++	-	+	-	-	-	-	+
Hydrogen peroxide	-	+++	-	-	-	-	+	+	+++
2-hydroxy-5-nitrobenzyl bromide	-	++	-	-	-	-	+++	-	-
Iodine	-	+++	+++	+++	-	-	--	-	-
O-iodosobenzoate	-	+++	-	-	-	-	-	-	-
Maleic anhydride	+++[c]	++[c]	++[b]	++[b]	-	-	-	-	-
p-mercuribenzoate	-	+++	-	-	-	-	-	-	-
Methanol/HCl	-	-	-	-	-	+++	-	-	-
2-methoxyl-5-nitrotropone	+++[c]	-	-	-	-	-	-	-	-
Methyl acetimidate	+++	-	-	-	-	-	-	-	-
O-methylisourea	+++	-	-	-	-	-	-	-	-
Nitrous acid	+++	+++	±	-	-	-	-	+	-

Appendix 5 Reactivities of amino acid side chains (continued)

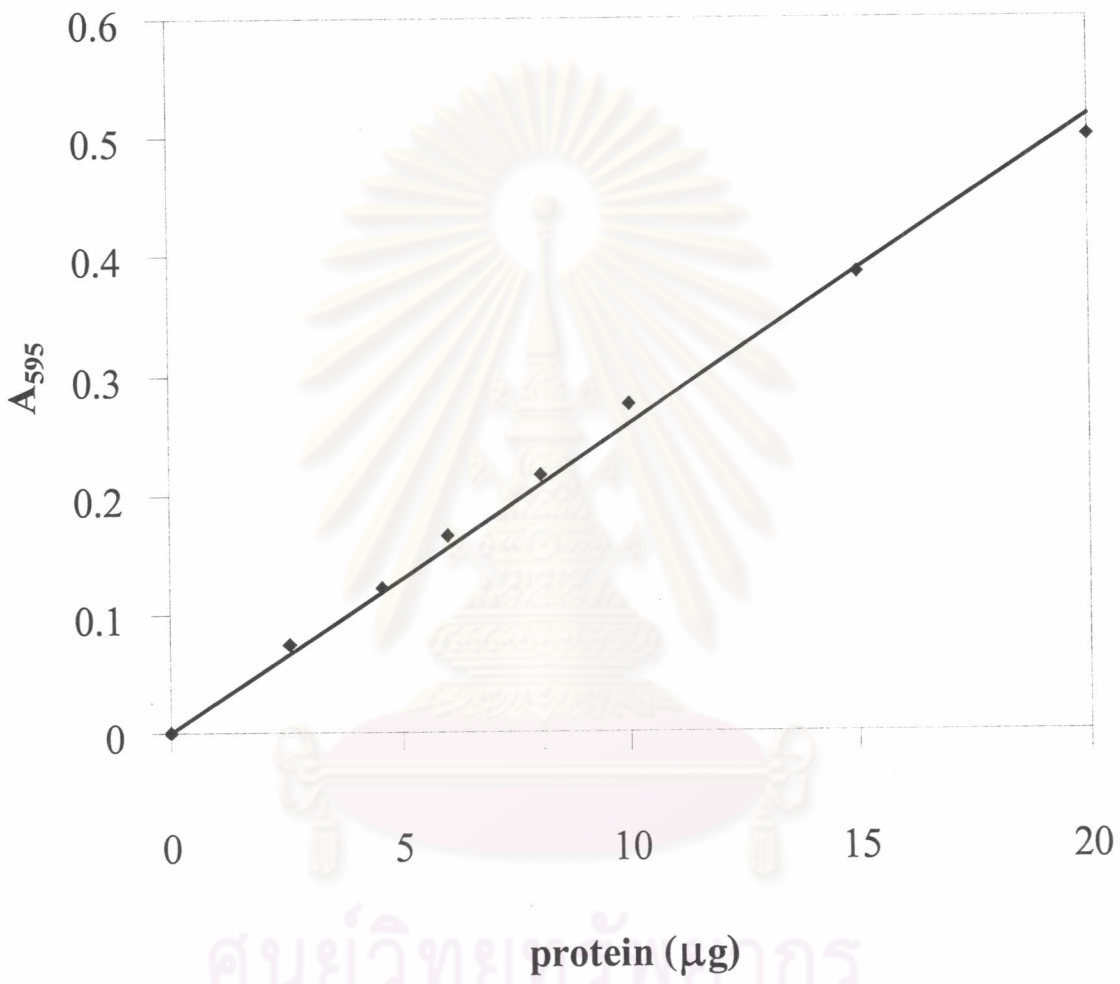
Reagent	$-NH_2$	-SH						-S-S-	$-S-CH_3$
Performic acid	-	+++	-	-	-	-	++	+++	+++
Phenylglyoxal	++	-	-	-	+++	-	-	-	-
Photooxidation	-	+++	±±	+++	-	-	+++	±	+++
Sodium borohydride	-	+++[b]	++[b]	++[b]	-	-	-	-	-
Succinic anhydride	+++	+++	-	-	-	-	+++	-	-
Sulfite	-	+++	+++	+++	-	-	-	-	-
Sulfonyl halides	+++	+++	+++	-	-	-	+	-	+
Tetranitromethane	-	+++	+++	-	-	-	+	-	-
Tetrathionate	-	+++	-	-	-	-	-	+++	-
Thiols	-	-	-	-	-	-	-	+++	-
Trinitrobenzenesulfonic acid	+++	++[b]	-	-	-	-	-	-	-
Water-soluble carbodiimide and nucleophile	±	±	±	-	-	+++	-	-	-

[a] -,+,++, and +++ indicate relative reactivities; ±, ±±, and ±±± likewise indicate relative reactivities which may or not be attained depending on the condition used.

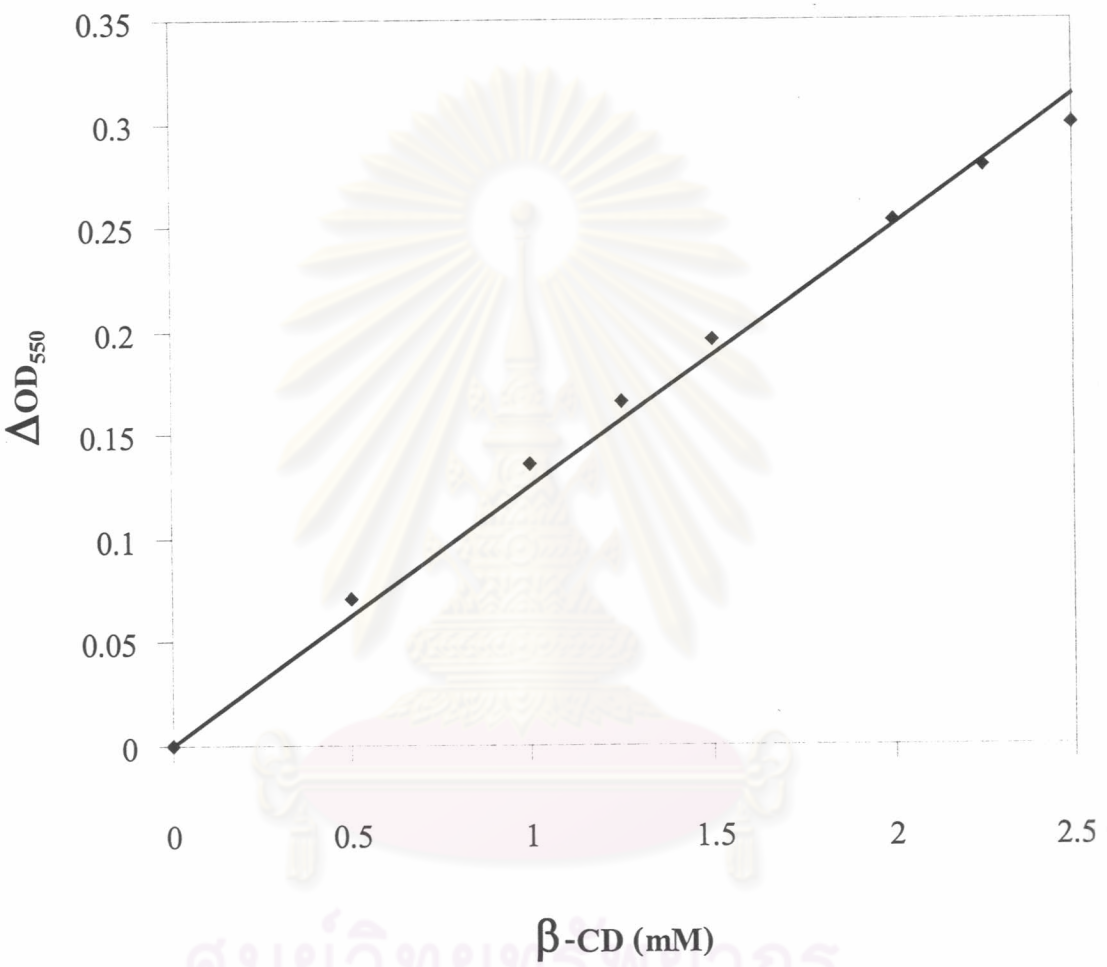
[b] Spontaneously reversible under the reaction conditions or upon dilution, regenerating original group.

[c] Easily reversible, regenerating original group.

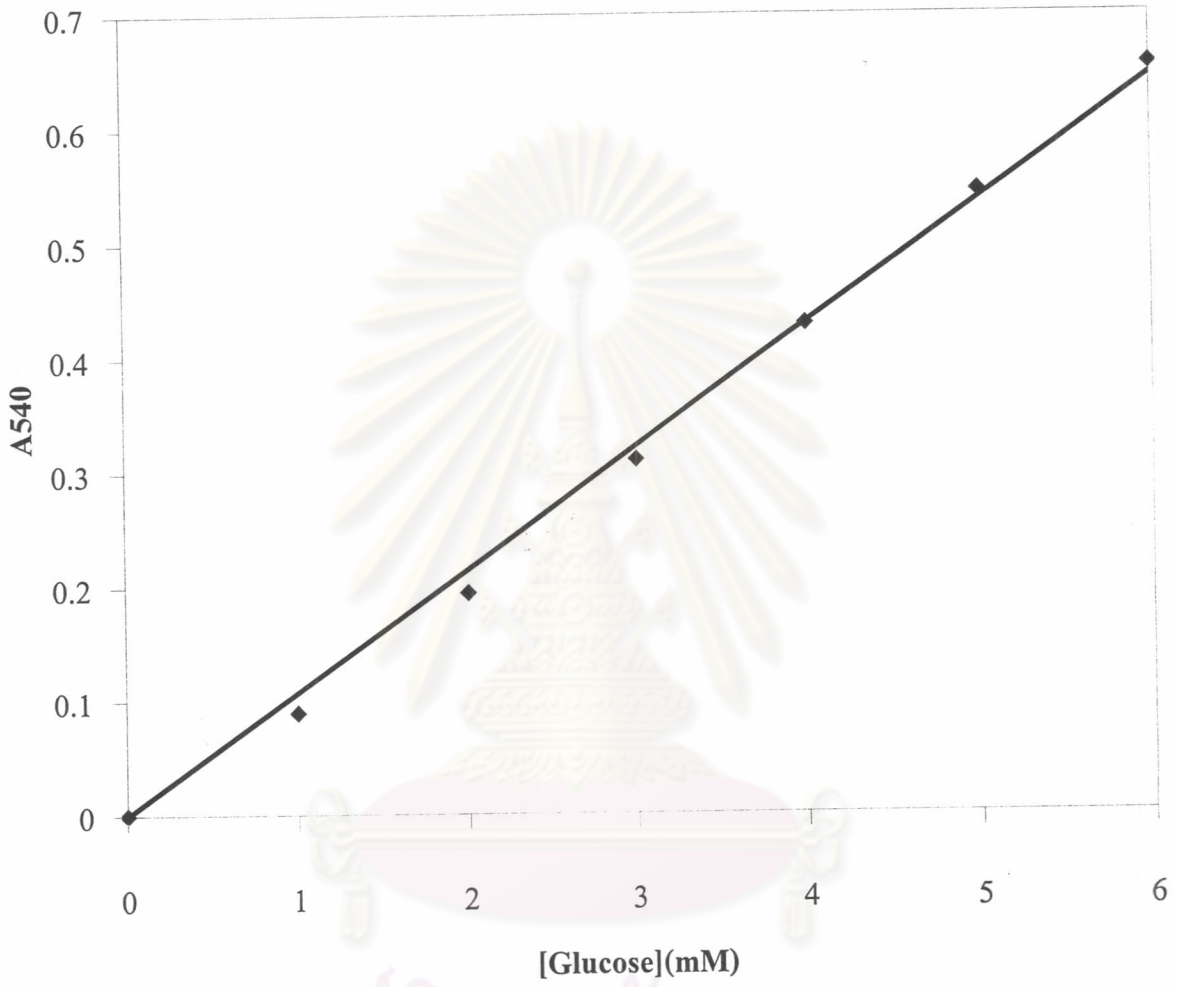
Appendix 6: Standard curve for protein determination by Bradford's method



Appendix 7: Standard curve of β–cyclodextrin by phenolpthalein method



Appendix 8: Standard curve of glucose by dinitrosalicylic acid method



BIOGRAPHY

Mr. Wanchai Yenpetch born on September 25, 1975. He graduated with the Bachelor Degree of Science in Biochemistry form Khonkhan University in 1998. He has working at Department of Physiology, faculty of Veterinary Science, Chulalongkorn University. Then continued studying for Master in Biochemistry Program.