



## REFERENCES

- Barraquio, W.L. and Watanabe, I. Occurrence of aerobic nitrogen-fixing bacteria in wetland and dryland Plants. Soil Sci. Plant Nutr. 27(1981): 121-125.
- Bashan, Y. Short exposure to *Azospirillum brasilense* Cd inoculation enhanced protein efflux of intact wheat roots. Can. J. Microbiol. 36(1990): 419-425.
- Boonjawat, J., Chalsiri, P., Limpananont, J., Soontaros, S., Pongsawasdi, P., Chaopongpang, S., Pornpattkol, S., Wongwaitayakul, B. and Saengduan, L. Biology of nitrogen-fixing rhizobacteria. Plant and Soil 137(1991): 119-125.
- Bradford, M.M. A rapid method for the quantitative of microgram quantities of protein utilizing the principle of protein dye binding. Ann. Biochem. 72(1976): 2248-2456.
- Brown, C.M. and Dilworth, M.J. Ammonium assimilation by *Rhizobium* cultures and bacteroid. J. Gen. Microbiol. 86(1975): 9-48.

- de-Brujin, J.F., Hilgert, V., Stiger, J., Schneider, M., Meyer, H., Klosses, U. and Pawlowski, K. Regulation of nitrogen fixation and assimilation gene in the free-living versus symbiotic state. In Gresshoff, R.S. & Newton. (eds.). Nitrogen Fixation: Achievements and Objectives. pp. 33-34. New York: Chapman and Hall Ltd., 1990.
- Burris, R.H. Methodology. In Quispel, A. (ed.). The biology of nitrogen fixations. PP. 9-33. Amsterdam: North Holland Publisher Co., 1974.
- Chong-Biao, Y. and Hui-Xian, W. Rhizosphere nitrogen fixation in wetland rice. Acta. Phytophysiological. Sinica. 16(1990): 209-214.
- Cullimore, J.V. and Bennett, M.J. The molecular biology and biochemistry of plant glutamine synthetase from roots nodule of *Phaseolus vulgaris* L. and other legume. J. Plant Physiol. 132(1988): 387-393.
- \_\_\_\_\_, J.V., Lara, M., Lea, P.J. and Mifin, B.J. Purification and properties of two form of glutamine synthetase in plant fraction of *Phaseolus* root nodules. Planta 157(1983): 245-253.

- Datta, D.B., Cai, X.X., Wong, P.O., and Triplett, E.W. Immunocytochemical localization of glutamine synthetase in organs of *Phaseolus vulgaris*. Plant Physiol. 96(1991): 5007-512.
- Dobereiner, J. Forage grasses and grain crops. Advance In Agronomy 29(1977): 11.
- Ericson, M.C. Purification and properties of glutamine synthetase from spinach leaves. Plant Physiol. 79(1985): 923-927.
- Farnden, K.J.E. and Robertson, J.G. Method for studying enzyme involved in metabolism related to nitrogenase. In Bergersen, F.J. (ed.). Method for Evaluating Biological Nitrogen Fixation. pp. 229-287. New York: John Wiley and Sons Ltd., 1980.
- Forde, B.J., Day, H.M., Turton, J.F., Wen-Jun, S., Cullimore, J.V. and Oliver, J.E. Two glutamine synthetase from *Phaseolus vulgaris* L. display contrasting developmental and spatial pattern of expression in transgenic *Lotus corniculatus* plant. Plant cell 76(1984): 1019-1023.
- Gallardo, F. Galvez, S., Quesada, M.A., Canoves, F.M. and Decastro, I.M. Glutamine synthetase activity during the ripening of tomato. Plant Physiol. Biochem. (Paris). 26(1988): 749-752.

- Gallon, J.R. and Chaplin, J.E. An Introduction on Nitrogen Fixation. pp. 52-65. London: Cassell Educational Limited. 1987.
- Gebhardt, C., Oliver, J.E., Forde, B.G. Saarelainen, R. and Mflin, B.J. Primary structure and differential expression of glutamine synthetase genes in nodule roots and leaves of *Phaseolus vulgaris* EMBO J. 5(1986): 1429-1435.
- Harinasut, P. Isolation and characterization of some nitrogen-fixing aerobic diazotropic bacteria from rice rhizosphere. Master 's Thesis, Chulalongkorn University, 1981.
- Hirel, B., Bouet, C., King, B., Layzell, D., Jacob, F. and Verma, D.P.S. Glutamine synthetase gene are regulated by ammonium provided externally or by symbiotic nitrogen fixation. EMBO J. 6(1987): 1167-1172.
- \_\_\_\_\_, B., Vidal, J. and Gadai, P. Evident for the cytosolic dependent rice induction of chloroplastic glutamine synthetase in etiolated rice leaves. Planta 155(1982): 121-125.

- Hermoso, R., DeFelipe, M.R., Vivo, K.A., Chueca, A., Lasaro, J. J., and Gorge, J. Immunogold localization of photosynthetic fructose-1,6-biphosphatase in pea leaves tissue. Plant Physiol. 89(1989): 381-385.
- Horisberger, M. The gold method as applied to lectin cytochemistry in transmission and scanning electron microscopy Tech. Immunocytochem. 3(1985): 155-178.
- Joseph, C.M. and Meek, J.C. Regulation of *Nostoc* strains associated with *Anthoceros punctatus*. J. Bacteriol. 169 (1987): 2471-1475.
- Kamachi, K., Yamaya, T., Hayakawa, T., Mae, T. and Ojima, K. Vascular bundle-specific localization of cytosolic glutamine synthetase in rice leaves. Plant Physiol. 99(1992): 1481-148.
- Kozaki, A. The promoter of gene for glutamine synthetase from rice shows organ-specific and substrate-induced expression in transgenic tobacco plant. Plant Cell Physiol. 32(1991): 353-358.
- Kleeberger, A., Castroph, H. and Klingmuller, W. The rhizosphere microflora of wheat barley with special reference to Gram-negative bacteria. Arch. Microbiol. 136(1983): 306-311.

- Laemmli, U. K. Cleavage of structural proteins during the assembly of the head of bacteriophage T4. Nature 227(1970): 680-685
- Lara, M., Porta, H. Padilla, J. Folch, J. and Sanchez, F. Heterogeneity of glutamine synthetase polypeptide in *Phaseolus vulgaris* L. Plant Physiol. 76(1984): 1019-1023.
- Lee, K.Y., Joseph, C.M., and Meek, J.C. Glutamine synthetase specific activity and protein concentration in symbiotic *Anabaena* associated with *Azolla carolina*. J. Microbiol. 54(1988): 345-346.
- Limpananont, J. Role of lectin from rice (*Oryza sativa* L.) in the association between *Klebsiella* spp. and root epidermal cells. Doctor Thesis, Chulalong University, 1987.
- Lin, W. and Kasamatsu, H. On the electrotransfer of polypeptides from gel to nitrocellulose membrane. Ann. Biochem. 128(1983): 320-331.
- Lindblad, P., Rai, A. and Bergman, B. The *Cycas revoluta*-*Nostoc* symbiosis: Enzyme activity of nitrogen metabolism in the cyanobiont. J. Gen. Microbiol. 133(1987): 1695-1699.

- Ludwig, R.A. and Donald, R.G.K. *Rhizobium* sp. strain ORS 471 ammonium assimilation and nitrogen fixation. J Bacteriol. 158(1984): 1144-1151.
- Luria, S.E., Adam, J.N. and Teng, R.C. Transduction of lactose utilizing ability among strain of *Escherichia coli* and *Shigella dysenteria* and the properties of the transducing phage particle. Virology 12(1960): 348-390.
- Miao, G., Hirel, B., Marsolier, C.M., Ridge, R.W. and Verma, D. P. Ammonium regulated expression of a soy bean encoding cytosolic glutamine synthetase in transgenic *Lotus corniculatus*. The plant cell. 3(1991): 11-22.
- Malik, K.A., Bilal, R., Rasul, G., Mahmood, K. and Sajjad, M. I. Associative N<sub>2</sub>-fixation in plants growing in saline sodic soils and its relative quantification based on <sup>15</sup>N natural abundance. In Polsinelli, M., Materassi, R. and Vincenzini, M. (eds.). Development in Plant and Soil Sciences Nitrogen Fixation. pp. 569-571. Netherlands : Kluwer Academic Publisher. 1990.

- Mann, A.F., Fentem, P.A. and Stewart, G.R. Identification of two forms of glutamine synthetase in barley (*Hordeum vulgare*). Biochem. Biophys. Commun. 88(1979): 515-521.
- Matin, G.B. and Chelm, B.K. *Bradyrhizobium japonicum ntr* BC/*gln* A and *nif* A/*gln* A mutants: Further evidence that separate regulatory pathways govern *gln* II expression in free-living and symbiotic cells. Mol. Plant Microbe Interaction. 4(1991): 254-261.
- Meek, J.C., Enderlin, C.S., Joseph, J.S. and Lollar, M.W.L. Fixation of nitrogen in the *Anthoceros-Nostoc* symbiotic association. Planta 164(1985): 406-414.
- Michiels, K., Broek, A.V., Eyers, M., Croes, C., Miecamps, A., DeTroch, P., Bastelaere, V. and Vanderleyden, A. In Polsinelli, M., Materassi, R. and Vincenzini, M. (eds.). Development in Plant and Soil Sciences Nitrogen Fixation. pp. 219-224. Netherlands: Kluwer Academic Publishers. 1990.
- Mc Nally, S.E. and Hirel, B. Glutamine synthetase isoform in higher plant. Plant Physiol. Veg. 21(1983): 761-774.



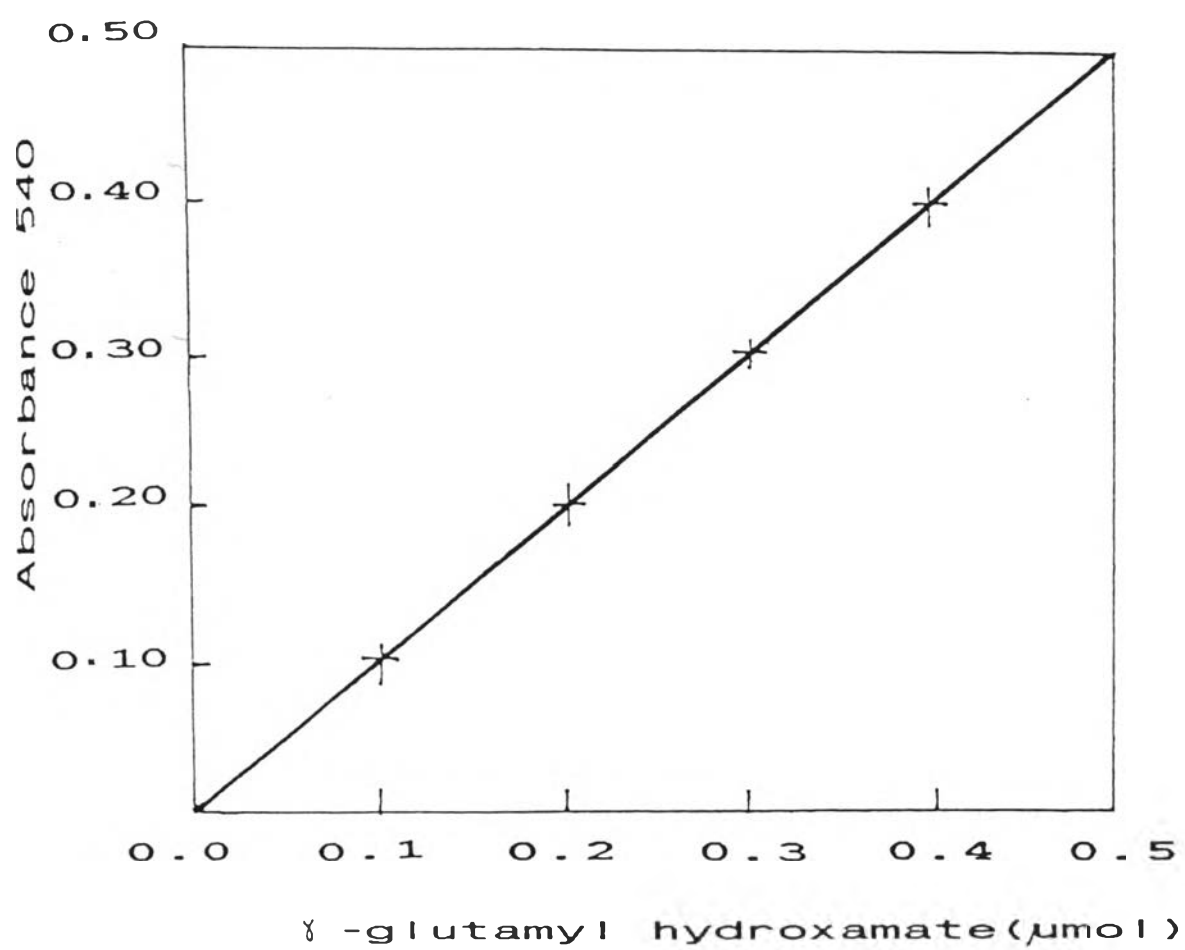
- Nierzwichi-Bauer, S.A. and Haselkorn, R. Difference in mRNA level in *Anabaena* living freely or in symbiotic association with *Azolla*. EMBO J. 5(1986): 24-25.
- O'Gara, F. and Shanmugan, K.T. Regulation of nitrogen fixation by *Rhizobium*: export of fixed-N<sub>2</sub> as NH<sub>4</sub><sup>+</sup> Biochem. Biophys. Acta. 347(1976): 313-321.
- Orr, J. and Haselkorn, R. Regulation of glutamine synthetase activity and synthesis in free-living and symbiotic *Anabaena* spp. J. Bacteriol. 152(1982): 626-635.
- \_\_\_\_\_, J. and Haselkorn, R. Kinetic and inhibition studies of glutamine synthetase from the cyanobacterium *Anabaena* 7120. J. Biological Chem. 256(1981): 13099-13104.
- Patriquin, D. J., Dobereiner, J. and Jain, D. K. Site and processes of association between diazotrophs and grasses. Can. J. Microbiol. 29(1983): 900-915.
- Pitaksuteepong, C. Association effect of nitrogen fixing *Klebsiella* sp. and rice lectin. Master' thesis, Chulalongkorn University, 1992.
- Qiu, Y.S. Zho U.S.P., Mo, X.Z., You, C.B. and Wong, D.S. Investigation of N<sub>2</sub>-fixation bacteria isolated from rice rhizosphere. J. Sci. Monthly 25(1980): 383.

- Quispel, A.A. Critical evaluation of the prospects for nitrogen fixation with non-legumes. In Polsinelli, M., Materassi, R. and Vincenzini, M. (eds.). Development in Plant and Soil Sciences Nitrogen Fixation. pp. 1-11. Netherlands Kluwer Academic Publisher. 1990.
- Rowell, P., Rai, A.N. and Stewart, W.D.P. Studies on the nitrogen metabolism of the lichen *Peltigera aphthosa* and *Peltigera canina*. In Brown, D.H. (eds.). Lichen Physiology and Cell Biology. pp. 145-160. New York: Plenum Press. 1985.
- Russi, M., Deff, R., Chinrajzi, M., Lambert, A., Ferggi, A. and Iaccarino, M. Regulation of glutamine synthetase isoenzyme in *Rhizobium leguminosarum* biovar *viceae*. J Gen. Microbiol. 135(1989): 629-637.
- Sakakibara, H., Kavabata, S., Takahashi, H., Hase, T. and Sukiya, T. Molecular cloning of the family of glutamine synthetase genes from maize. Plant Cell Physiol. 33(1992): 43-49.
- Saengduan, L. A comparative study of glutamine synthetase in free-living *Klebsiella* R15 and *Klebsiella* R15 associated with rhizosphere of rice. Master' Thesis, Chulalongkorn University, 1991.

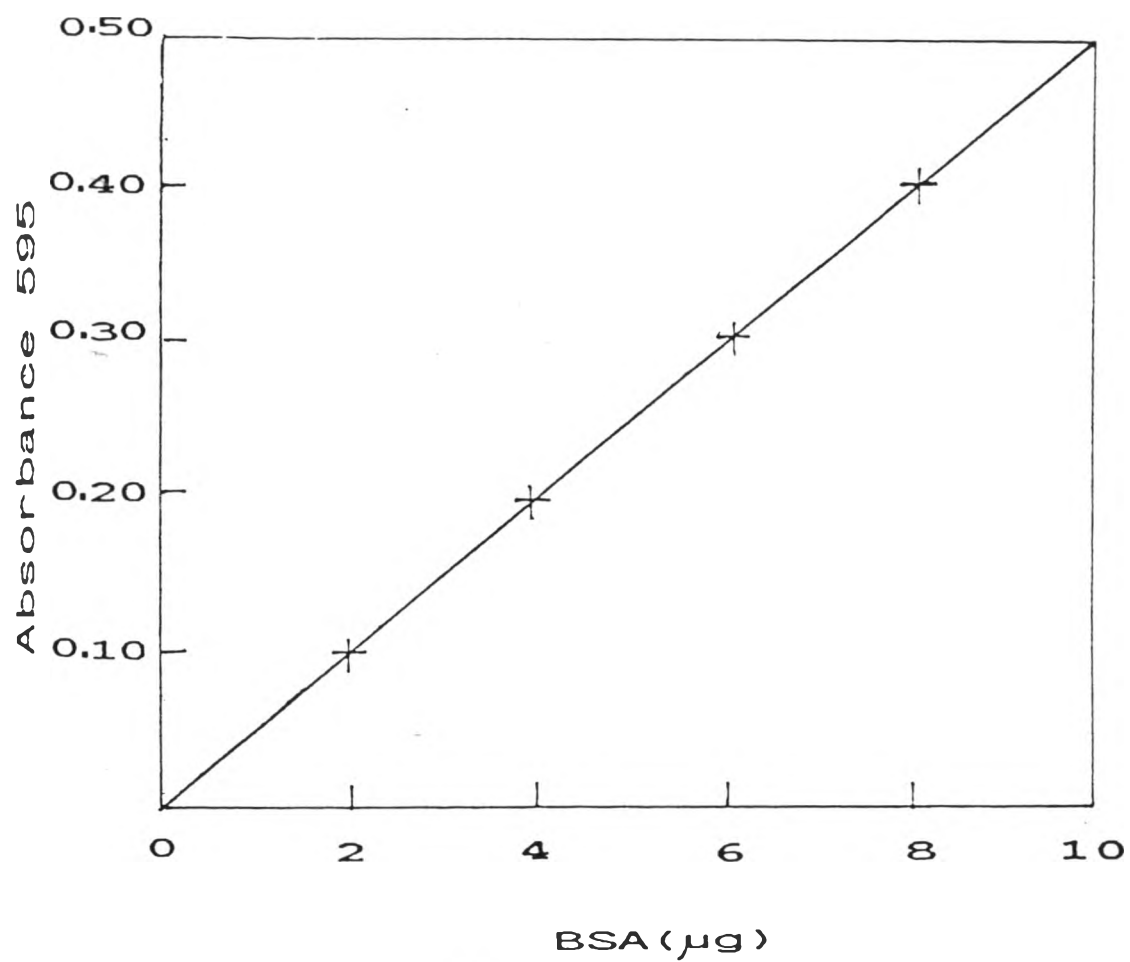
- Soderback, E., Linblad, P. and Bergman, B. The *Nostoc-Gunnera magellanica*: Developmental patterns related to nitrogen fixation. In Polsinelli, M., Materassi, R. and Vincenzini, M. (eds.). Development in Plant and Soil Sciences Nitrogen Fixation. pp. 569-571. Kluwer Academic Publisher: Netherlands. 1990.
- Stasiewicz, S. and Dunham, V.L. Isolation and characterization of two forms of glutamine synthetase from soybean hypocotyl. Biochem. Biophys. Res. 87(1979): 627-634.
- Tingey, S.V. and Courzzi, G.M. Glutamine synthetase of *Nicotiana plumbaginifolia*. Plant Physiol. 84(1987): 366-373.
- Tyler, B. Regulation of the assimilation of nitrogen compounds. Ann. Rev. Biochem. 47(1978): 1127-1162.
- Veeger, C., Laane, C., Schering, G., Matzi, L., Haaker, H., and Zeeland-Walkers. In Newton, W.E. & Johnson, W.H. (eds.) Nitrogen Fixation Vol.1. pp. 111-137. University Park, Baltimore, 1980.
- Weaver, P.K. Wall, J.D. and Gust, H. Arch Microbiol. 216(1975): 207-216.

- Wesellaar, R. and Ganry, F. Nitrogen balance in tropical agrosystems. In Dommergues, Y.K. (ed.). Microbiology of Tropical Soils and Plant Productivity. pp. 1-37. Netherlands: Dr.Junk Publishers., 1980.
- Yamaya, T., Hayakawa, T., Tanasawa, K., Kamachi, K., Mae, T. and Ojima, K. Tissue distribution of glutamate synthetaseand glutamine synthetase in rice leaves. Plant Physiol. 100(1992): 1427-1432.

## APPENDIX I

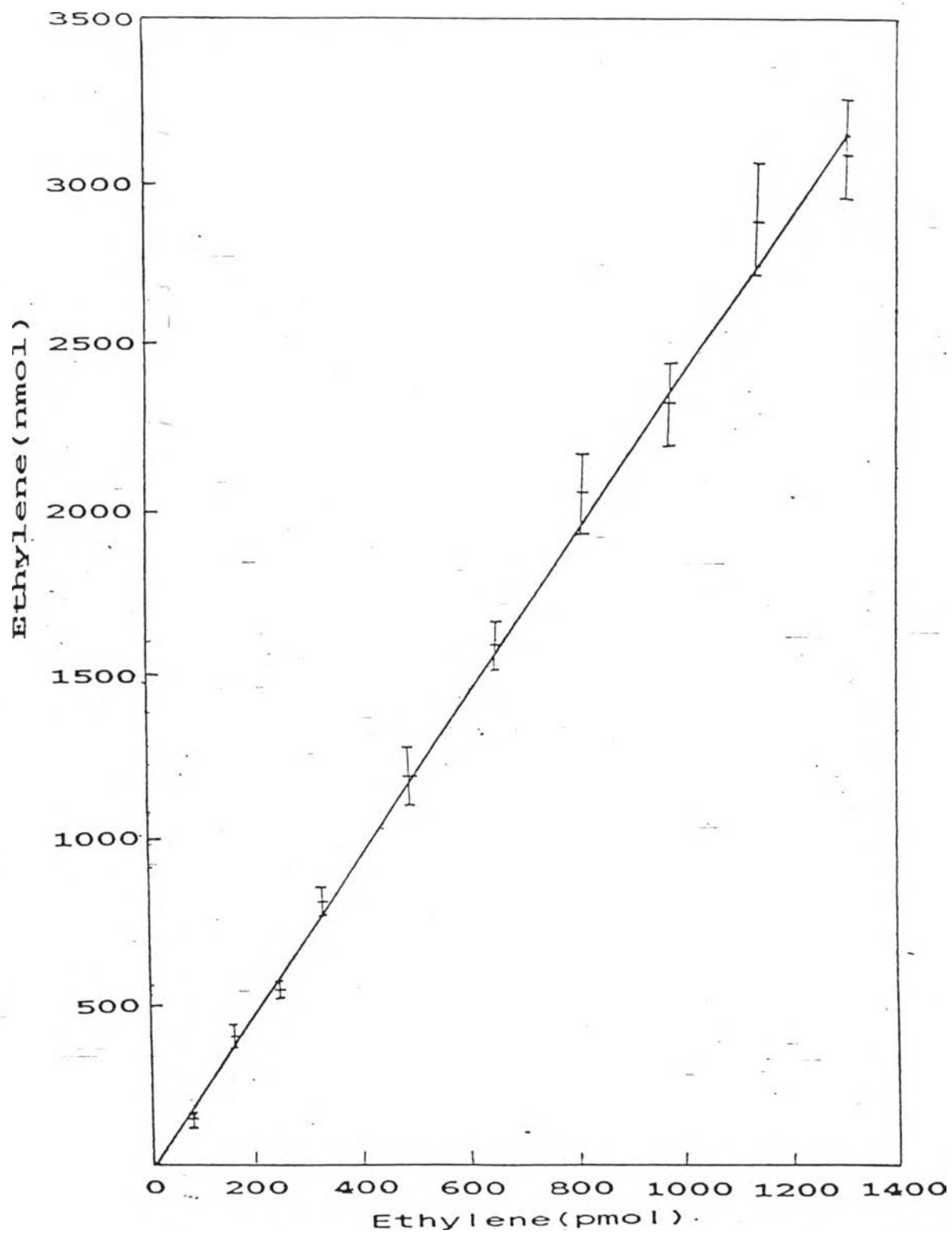
Standard curve of  $\gamma$ -glutamyl hydroxamate

## APPENDIX II



Standard curve of BSA.

## APPENDIX III



Standard curve of ethylene



## BIOGRAPHY

Miss Malee Saeguay was born on July, 20 1964. In Bangkok Thailand. She graduated with the Bachelor degree of Science in Medical Technology (2<sup>nd</sup> Honor) from the Faculty of Medical Technology, Khon Kaen University 1987.