REFERENCES

A.-L. Cornaz, P. Buri. Nasal Mucosa as an Absorption Barrier. 1994. **Eur. J. Pharm. Biopharm.** 40: 261-270.

Abd EI-Hameed, M.D. and Kellaway, I.W. 1997. Preparation and in vitro characterisation of mucoadhesive polymeric micropheres as intra-nasal delivery system. **Eur. J. Pharm. Biopharm.** 44: 53-60.

Agarwal, V., and Mishra, B. 1999. Design, development, and biopharmaceutical properties of buccoadhesive compacts of pentazocine. **Drug Dev. Ind. Pharm.** 25(6): 701-709.

Ahuja, A., Khar, R.K., and Ali, J. 1997. Mucoadhesive drug delivery systems. **Drug Dev. Ind. Pharm.** 23(5): 489-515.

Anderbueg, E.K., Lindmark, T., and Artursson, P. 1993. Sodium caprate elicits dilatations in human intestinal tight junctions and enhances drug absorption by the paracellular route. **Pharm. Res**. 10(6): 857-864.

Aoki, F.Y., and Crawley, J.C.W. Distribution and removal of human serum albumin-technetium instilled intranasally, Br. 1976. **J. Clin. Pharmacol.** 3:869.

Billon, A., Bataille, B., Cassanas, G., and Jacob, M. 2000. Development of spray-dried acetaminophen microparticles using experimental designs. **Int. J. Pharm.** 203: 159-168.

Biswas, M., Akogyeram, C.O., Scott, K.R., Potti, G.K., Gallelli, J.F., and Habib, M.J. 1993. Development of carbamazepine: phospholipids solid dispersion formulations. J. Controlled Release. 23: 239-245.

BjØrk, E., Bjurstrom, S., and Edman, P. 1991. Morphological examination of rabbit nasal mucosa after nasal administration of degradable starch microspheres. **Int. J. Pharm.** 75:73-80.

BjØrk, E.,and Edman, P. 1988. Degradable starch micropheres as a nasal delivery system for insulin. **Int. J. Pharm**. 47:233-238.

Bjork, E. and Edman, P. 1990. Characterization of degradable starch microspheres as a nasal delivery system for drugs. **Int. J. Pharm.** 62: 187-192.

Bodmeier, R. and Chen, H. 1988. Preparation of biodegradable poly(±)lactide microparticles using a spray-drying technique. **J. Pharm. Pharmacol.** 40: 754-757.

Brabander, C.D., Vervaet, C., and Remon, J.P. 2003. Development and evaluation of sustained release mini-matrices prepared via hot melt extrusion. **J. Controlled Release** 89:235-247.

Broadhead, J. 1994. The effect of process and formulation variables on the properties of spray-dried β-galactosidase. **J.Pharm.Pharmacol.** 46: 458-467.

Bruschi, M.L., Cardoso, M.L.C., Lucchesi, M.B., and Gremiao, M.P.D. 2003. Gelatin microparticles containing propolis obtained by spray-drying technique: preparation and characterization. **Int. J. Pharm.** 264: 45-55.

Callens, C., Ceulemans, J., Ludwig, A., Foreman, P., and Remon, J.P. 2003. Rheological study on mucoadhesivity of some nasal poeder formulations. **Eur. J. Pharm. Biopharm.** 55:323-328.

Chawla, A., Taylor, K.M.G., Newton, J.M., and Johnson, M.C.R. 1994. Production of spray dried salbutamol sulphat for use in dry powder aerosol formulation. **Int. J. Pharm.** 108: 233-240.

Chng, H.S., Park, H., Kelly, P., and Robinson, J.R. 1985. Bioadhesive polymers as platforms for oral controlled drug delivery II: synthesis and evaluation of some swelling, water-insoluble bioadhesive polymers. **J. Pharm. Sci.** 74(4): 399-405.

Chu, J.S., Chandrasekharan, R., Amidon, G.L., Weiner, N.D., and Goldberg, A.H. 1991. Viscosmetric study of polyarylic acid systems as mucoadhesive. **Pharm. Res.** 8(11): 1408-1412.

Conte, **U.**, Conti, B., Giunchedi, P., and Maggi, L. 1994. Spray dried polylactide microshere preparation: influence of the technological parameters. **Drug Dev. Ind. Pharm.** 20(3): 235-258.

Cornaz A-L, De Ascentiis, A. Columbo, P., and Buri, P. 1996. In vitro characteristics of nicotine microspheres of transmucosal delivery. **Int. J. Pharm**. 129: 175-183.

Critchley, H, Davis SS, Farraj NF, Illum L. 1994. Nasal absorption of desmopressin in rats and sheep. Effect of a bioadhesive microsphere delivery system. **J. Pharm Pharmacol** 46:651-656.

Davis, S.S., and Bubb, M.D. Physicochemical studies on aerosal solutions for drug delivery III. The effect of relative humidity on the particle size of inhalatio aerosals. 1978. **Int. J. Pharm.** 1:303.

De Ascentitis A, Bettini R, Capoetti G, Catellani PL, Peracchia MT, Santi P.Colombo P. 1996. Delivery of nasal powers of β-cyclodextrin by insufflation. **Pharm Res** 13:734-738.

Deurloo MJM, hermens AJJ, romeyn SG, Verhoef JC, MerkusbFwhm. 1989. Absorption enhancement of intranasally administered insulin by sodium taurodihydrofusidate (STDHF) in rabbits and rats. **Pharm Res** 6: 853-856.

Dortunc, B and Gunal, N. 1997. Release of acetazolamide from swellable hydroxypropylmethylcellulose matrix tablets. **Drug. Dev. Ind. Pharm.** 23 (12): 1245-1249.

Duchene, D., Touchard, F., and Pappas, N.A. 1988. Pharmaceutical and medical aspects of biadhesive systems for drug administration. **Drug Dev. Ind. Pharm.** 14(2&3): 283-318.

Edman, P., Bjork, E., and Ryden, L. 1992. Microspheres as a nasal delivery system for peptide drugs. **J. Controlled Release** 21: 165-172.

Farraj NF, Johansen BR, Davis SS, Illum L. 1990. Nasal administration of insulin using bioadhesive microspheres and lysophosphatidylcholine as a delivery system. **J Controlled Release** 13: 253-261.

Ford, J.L., and Timmins, P. 1989. **Pharmaceutical thermal analysis techniques and applications.** New York: Ellis Horwood. pp. 150 -159.

Gaserod, O., Jolliffe, I.G., Hampson, F.C., Dettmar, P.W., and Skjak-Braek, G. 1998. The enhancement of the bioadhesive properties of calcium alginate gel beads by coating with chitosan. **Int. J. Pharm.** 175: 237-246.

H.Kubo, K.L. Hosoya, H.Natsume, K. Sugibayashi, Y. Morimoto. In vitro permeation of serveral model drugs across rabbit nasal mucosa. 1994. **Int. J. Pharm.** 103:27-36.

Hardy, J.G., Lee, D.W., and Wilson, C.G. 1985. Intranasal drug delivery by spray and drops, **J. Pharm. Pharmacol.** 937-924.

Hascicek, C., Gonul, N., and Erk, N. 2003. Mucoadhesive microspheres containg gentamicin sulfate for nasal administration: preparation and in vitro characterization. **Il Farmaco.** 58: 11-16.

He, P., Davis, S.S., and Illum, L. 1998. In vitro evaluation of the mucoadhesive properties of chitosan microspheres. **Int. J. Pharm.** 166: 75-88.

Higuchi, T.J. 1963. Mechanism of sustained-action medication. **J.Pharm.Sci.** 52: 1145-1149.

Hiller, F.C., Mazumder, M.K., Wilson, J.D., and Bone, R.C. Aerodermic size diistribution, hygroscopicity and decomposition estiation of beclomethasone dipropionate aerosal. 1980. **J. Pharm. Pharmacol.** 32:605.

Hogan, J.E. 1989. Hydroxypropylmethylcellulose sustained release technology. **Drug. Dev. Ind. Pharm**. 15: 975-999.

Hussain, A., Hirai, S., and Bawarshi, R. 1980. Nasal absorption of propranolol from different dosage forms by rats and dogs. **J. Pharm. Sci.** 69(12): 1411-1413.

Illum, L., Farraj, N., Cristchley, H., and Davis, SS., 1988. Nasal administration of gentamicin using a novel microsphere delivery system. **Int. J. Pharm**. 46: 261-265.

Illum, L., Farraj, NF., and Davis, SS. 1994a. Chitosan as a novel nasal delivery system for peptide drugs. **Pharm. Res**. 11: 1186-1189.

Illum, L., Farraj, NF., Davis, SS Johansen, B.R., and O' Hagan, D.T. 1990. Investigation of the nasal absorption of biosynthetic human growth hormone in sheep-use of a bioadhesive microsphere delivery system. Int. J. Pharm. 63: 207-211.

Illum, L., Farraj, NF., Fisher, A.N., Gill, I., Miglietta, M., and Benedetti, L.M. 1994b. Hyaluronic acid ester microspheres as a potential nasal delivery system of insulin. **J. Controlled Release**. 29: 133-141.

Illum, L., Jorgensen, H., Bisgaard, H., Krogsgaard, O., and Rossing, N. 1987. Bioadhesive microspheres as a potential nasal drug delivery system. **Int. J. Pharm.** 39: 189-199.

Imai, T., Shiraishi, S., Saito, H., and Otagiri, M. 1991. Interaction of indomethacin with low molecular weight chitosan and improvements of some pharmaceutical properties of indomethacin by low molecular weight chitosan. **Int. J. Pharm**. 67: 11-20.

Ishikawa, T., Watanabe, Y., Takayama, K. Endo, H., and Matsumoto, M. 2000. Effect of hydroxypropylmethylcellulose (HPMC) on the release profiles and bioavailbility of a poorly water-soluble drug from tablets prepared using macrogol and HPMC. **Int. J. Pharm.** 202: 173-178.

Jimenez-Castellanos, M.R., Zia, H., and Rhodes, C.T. 1993. Mucoadhesive drug delivery systems. **Drug Dev. Ind. Pharm.** 19(1&2): 143-194.

K.L. Audus, R.L. Bartel, I.J. Hisalgo, R.T. Borchardt. The use of cultured epithelial and endothelial cells for drug transport and metabolism studies. 1990. **Pharm. Res.** 7:435-451.

K.R. Kamath and K.Park, Mucosal adhesive preparations, in Encyclopedia of Pharmaceutical Technology, Vol. 10 (J. Swarbrick and J.C. Baylan, eds.) New York, Marcel Dekker, 1994. 133.

K.S.E. Su, Nasal route of peptide and protein Drug Delivery, in V.H.L. Lee, (Ed.), Peptide and Protein Drug Delivery, New York, Basel, Hong Kong; Marcel Dekker Inc.,1991.

Kenneth L. Audus, Ronnda L. Bartel, Ismael J. Hidalgo, and Ronald T. Borchardt. 1990. The use of cultured Epithelial and Endothelial Cells for Drug Transport and Methabolism Studies. **Pharm. Res.** vol.7, No.5.

Khanna, R., Agarwal, S.P., and Ahuja, A. 1997. Muco-adhesive buccal tabletes of clotrimazole for oral candidiasis. **Drug Dev. Ind. Pharm.** 23(8): 831-837.

Korsmeyer, R.W., Gurny, R., Doelker, P., Buri, P., and Peppas, N.A. 1983. Mechanism of potassium chloride release from compressed, hydrophilic, polymeric matraices; Effect of entrapped air. **J. Pharm. Sci**. 72: 1189-1191.

Kumar, S. and Himmelstein, K.J. 1995. Modification of in situ gelling behavior of carbopol solutions oby hydroxypropyl methylcellulose. **J. Pharm. Sci.** 84(3): 344-348.

Labrude, P., Rasolomanana. M., Vigneron, C., Thirion, C., and Chaillot, B. 1989. Protective effect of sucrose on spray drying of oxyhemoglobin. **J.Pharm.Sci.** 78 : 223-229.

Lacasse, F.X., Hildgen, P., and McMullen, J.N. 1998. Surface and morpho;ogy of spray-dried pegylated PLA microspheres. **Int. J. Pharm.** 174: 101-109.

Lehr, C.M., Bouwstra, J.A., Schacht, E.H., and Junginger, H.E. 1992. In vitro evaluation of mucoadhesive properties of chitosan and some other natural polymers. **Int. J. Pharm.** 78: 43-48.

Lejoyeux, F., Ponchel, G., Wouessidjewe, D., Pappas, N.A., and Duchene, D. 1989. Bioadhesive tablets influence of the testing medium composition on bioadhesion. **Drug Dev. Ind. Pharm.** 15(12): 2037-2048.

Li, S., Lin, S., Daggy, B.P., Mirchandani, H.L. and Chien, Y.W. 2003. Effect of HPMC and Carbopol on the release and floating properties of gastric floating drug delivery system using factorial design. **Int. J. Pharm.** 253: 13-22.

Lim, S.T., Martin, G.P., Berry, D.J., and Brown, M.B. 2000. Preparation and evaluation of the in vitro drug release properties and mucoadhesion of novel microspheres of hyaluronic acid and chitosan. **J. Controlled Release** 66: 281-292.

Lin, S.Y., and Kao, Y.H. 1991. Tablet formulation study of spray-dried sodium diclofenac enteric-coated microcapsules. **Pharm.Res.** 8(7): 919-924.

Martin, E., Romeiji, S.G., Verhoef, J.C., and Merkus, W.H.M. 1997. Nasal absorption of di-hydroergotamine from liquid and powder formulations in rabbits. J. Pharm. Sci. 86: 535-540.

Master, K. 1979. **Spray drying handbook**(3rd.ed.). New York : John willey&Sons.

Matsuda, Y., Otsuka, M., Onoe, M., and Tatsumi, E. 1992. Amorphism and physicochemical stability of spray-dried Frusemide. **J.Pharm.Pharmacol.** 44: 624-633.

McMartin, E., Hutchinson, LEF., Hyde, R, and Peter, G.E. 1987. Analysis of structural requirements for the absorption of drugs and macromolecules from the nasal cavity. **J. Pharm. Sci.** 76: 535-540.

Mitchell, K., Ford, J.L., Armstrong, D.J., Elliott, P.N.C., Rostrom, C. and Hogan, J.E. 1990. The influence of additives on the cloud point, disintegration and dissolution of hydroxypropylmethylcellulose gels and matrix tablets. **Int. J. Pharm.** 66: 233-242.

Mortazavi, S.A., Carpenter, B.G., and Smart, J.D. 1992. An investigation of the rheological behaviour of the mucoadhesive / mucosal interface. **Int. J. Pharm.** 83: 221-225.

Nagai, T., and Machida, Y. 1985. Mucosal adhesive dosage froms. **Pharm. Int**. 6: 196-200.

Nagai, T. Nishimoto, Y., Nambu, N., Suzuki, Y., and Sekine, K. 1984. Powder dosage form of insulin for nasal administration. **J. Controlled Release**. 1: 15-22.

Newman, S.P., Steed, K.P., Hooper, G., and Brickwell, J. 1995. Scintigraphic assessment of the oropharyngeal and nasal depositions of fusafungine from a pressurized inhaler and frm a novel pump spray device. **J. Pharm. Pharmacol.** 47: 818-821.

Palmieri, G.F., Wehrle, P., and Stamm, A. 1994. Evaluation of spray-drying as a method to prepare microparticles for controlled drug release. **Drug Dev. Ind. Pharm.** 20(18): 2859-2879.

Peppas, N.A. 1985. Analysis of Fickian and non-Fickian drug release from polymers. **Pharm. Acta. Helve.** 60(4): 110-111.

Pereswetoff-Morath, L.P., Edman, P. 1995b. Dextran microspheres as a potential nasal drug delivery system for insulin –in vitro and in vivo properties. **Int. J. Pharm**. 124; 37-44.

Pereswetoff-Morath, L.P., Edman, P. 1996.Immunological consequences of nasal drug delivery in dextran microspheres and ethyl(hydroxyethyl) cellulose in rats. **Int. J. Pharm**. 128; 23-28.

Perez-Marcos, B., Ford, J.L., Amstrong, D.J., Elliott, P.N.C., Rostron, C. and Hogan, J.E. 1994. Release of propranolol hydrochloride from matrix tablets containing hydroxypropylmethylcellulose K4M and carbopol 974. **Int. J. Pharm.** 111: 251-259.

Perez-Marcos, B., Ford, J.L., Armstrong, D. J., Elliott, P.N.C., Rostron, C., and Hogan, J.E. 1996. Influence of pH on the release of propranolol hydrochloride from matrices containing hydroxypropylmethylcelluose K4M and Carbopol 974. **J. Pharm. Sci.** 85(3): 330-334.

Polli, J. E., Rekhi, G.S., Augsburger, L.L., and Shah, V.P. 1997. Methods to compare dissolution profiles and a ratinale for wide dissolution specifications for metoprolol tartrare tablets. **J. Pharm. Sci.** 86(6): 690-700.

Ponchel, G., Touchard, F., Wouessidjewe, D., Duchene, D., and Peppas, N.A. 1987. Bioadhesive analysis of controlled-release systems. III. Bioadhesive and release behavior of metronidazole-containing poly(acrylic acid)-hydroxypropyl methylcellulose systems. **Int. J. Pharm.** 38: 65-70.

Proctor, D.F. Nasal physiology in intranasal drug administration, on Transnasal systemic medictions. 1985. (Y.W. Chien,Ed), Elsevier, Amsterdam. 101-106.

Ranga Rao, K.V., Padmalatha Devi, K., and Buri, P. 1990. Influence of molecular size and water solubility of the solute on its release from swelling and erosion controlled polymeric matrices. **J.Control.Release.** 12: 133-141.

Rao, Y.M., Veni, J.K., and Jayasagar, G. 2001. formulation and evaluation of diclofenac sodium using hydrophilic matrices. **Drug Dev. Ind. Pharm** 27(8): 759-766.

Ritger, P.L., and Peppas, N.A. 1987a. A simple equation for description of solute release I Fickian and non-Fickian release from non-swellable devices in the form of slabs, spheres, cylinders or discs. **J. Controlled Release**. 5: 23-26.

Ritger, P.L., and Peppas, N.A. 1987a. A simple equation for description of solute release II Fickian and non-Fickian release from swellable devices. **J. Controlled Release**. 5: 37-42.

Roy, D.S. and Rohera, B.D. 2002. comparative evaluation of rate of hydration and matrix erosion of HEC and HPC and study of drug release from their matrices. **Eur. J. Pharm Sci.** 16: 193-199.

Ryden, L., and Edman, P. 1992. Effect of polymers and microspheres on the nasal absorption of insulin in rats. **Int. J. Pharm.** 83: 1-10.

S.R. Byrd, R. Gelber, L.E. Bermudez. Roles of soluble fibronectin and beta 1 integrin receptors in binding of mycobacterium leprae to nasal epithelial cells. 1993. **Clin. Immunol. Immuno pathol.** 69:266-271.

Sa, B., Bandayyopadhyay. A.K., and Gupta, B.K. 1990. Development and in vitro evaluation of ethyl cellulose micropellets as a controlled release dosage form theophylline. **Drug Dev.Ind.Pharm.** 16 : 1153-1169.

Sacchetti, C., Artusi, M., Santi, P., and Colombo,. 2002. Caffeine microparticles for nasal administration obtained by spray drying. **Int. J. Pharm.** 242: 335-339.

Samani, S.M., Montaseri, H., and Kazemi, A. 2003. The effect of polymer blends on release profiles of diclofenac sodium from matrices. **Eur. J. Pharm. Biopharm.** 55: 351-355.

Satoh, K., Takayama, K., Machida, Y., Suzuki, Y., Nakagaki, M., and Nagai, T. 1989. Factors affecting the bioadhesive property of tabblets consisting of hydroxypropyl cellulose and carboxyvinyl polymer. **Chem. Pharm. Bull.** 37 (5): 1366-1368.

Sawayanagi, Y., Nambu, N., and Nagai, T. 1982. Use of chitosan for sustained-release preparations of water-soluble drugs. **Chem. Pharm. Bull.** 30(11): 4213-4215.

Schwach, G., Oudry, N., Delhomme, S., Luck, M., Lindner, H., and Gurny, R. 2003. Biodegradable microparticles for sustained release of a new GnRH antagonist-part I: screening commercial PLGA and formulation technologies. **Eur. J. Pharm. Biopharm.** 56: 327-336.

Schmidt, M.C., Peter, H., Lang, S., Ditzinger, G., and Merkel, H.P. 1998. In vitro cell models to study nasal mucosal permeability and metabolism. Advanced Drug Delivery Reviews. 29:51-59.

Schwartz, J.B., Simonelli, A.P., and Higuchi, W.I. 1968. Drug release from wax matrices I, analysis of data with first-order kinetics and with the diffusion controlled model. **J.Pharm.Sci.** 57 : 274-277.

Seagar, H. 1977. Spray-coating bulk drugs aid dosage form production. **Manuf.Chem. and Aerosol News.** 48(4) : 25-35.

Shah, V.P., Tsong, Y., Sathe, P., and Liu, J.P. 1998. Comparison statistics and analysis of the similarity factor, f_2. **Pharm.Research.**15(6): 657-664.

Smart, J.D., Kellaway, I.W., and Worthington, H.E.C. 1984. An in vitro investigation of mucosa-adhesive materials for use in controlled drug delivery. **J. Pharm. Pharmacol.** 36: 295-299.

Su, K.S.E., and Companale, K.M. Nasal drug delivery systems:Requirenebts, development and evaluates, in Transnasal Systemic Medications (Y.M. Chien, Ed.) Elservier, Amsterdam. 1985. 139-159.

Takeuchi, H., Handa, T., and Kawashima, Y. 1989. Controlled release theophylline tablet with acrylic polymers prepared by spray-drying technique in aqueous system. **Drug Dev.Ind.Pharm.** 15(12) :1999-2016.

Ting, T-Y., Gonda, I., and Gipps, E.M. 1992. Microparticles of polyvinyl alcohol for nasal delivery. I. Genetration by spray-drying and spray-desolvation. **Pharm. Res.** 9(10): 1330-1335.

Ute Wernex and Thomas Kissel. 1995. Development of a Human Nasal Epithelial Cell Culture Model and Its Suitability for Transport and Metabolism Studies Under in Vitro Conditions. **Pharm. Res.** vol. 12(4): 565-571.

Vermehren, C., Hansen, H.S., Thomsen, M.K. 1996. Time dependent effects of two absorption enhancers on the nasal dabsorption of growth hormone in rabbits. **Int. J. Pharm**. 128: 239-250.

Vidgren, M.T., Vidgren, P.A., and Paronen, T.P. 1987. Comparison of physical and inhalation properties of spray-dried and mechanically micronized disodium cromoglycate. **Int. J. Pharm.** 35: 139-144.

Vidgren, P., Vidgren, M., Arppe, J., Hakuli, T., Laine, E., and Paronen, P. 1992. In vitro evaluation of spray-dried mucoadhesive microspheres for nasal administration. **Drug Dev. Ind. Pharm.** 18(5): 581-597.

Vidgren, P., Vidgren, M., Vainio, P, Nuutinen, J., and Paronen, P. 1991. Double-labelling technique in the evaluation of nasal mucoadhesion of disodium cromoglycate microspheres. **Int. J. Pharm.** 73: 131-136.

Vyas, S.P., Bhatnagar, S., Gogoi, P.J., and Jain, N.K. 1991. Preparation and characterization of HSA-propranolol microsheres for nasal administration. **Int. J. Pharm.** 69: 5-12.

Vyas, S.P., Talwar, N., Karajgi, J.S., and Jain, N.K. 1993. An erythrocyte based bioadhesive system for nasal delivery of propranolol. **J. Controlled Release** 23: 231-237.

Wagner, J.G. 1969. Interpretation of percent dissolved-time plots derived from in vitro testing of conventional tablets and capsules. **J.Pharm.Sci.** 58(10): 1253-1257.

Walter L. (ed.). 1994. **The Pharmaceutical Codex,** pp. 1025-1028. London: The pharmaceutical press.

Wan, L.S., Heng, P.W., and Chia, C.G. 1991. Preparation of coated particles using a spray drying process with an aqueous system. **Int.J.Pharm.** 77: 183-191.

Wan, L.S.C., Heng, W.S., and Chia, C.G.H. 1992. Spray drying as a process for microencapsulation and the effect of different coating polymers. **Drug. Dev. Ind. Pharm.** 18(9): 997-1011.

Werner, U., T.Kissel. Development of a human nasal epithelial cell culture model and its suitability for transport and metabolism studies under in vitro conditions. 1995. **Pharm. Res.** 12:565-571.

Werner, U., T.Kissel. In-vitro cell culture models of the nasal epithelium: A comparative histochemical investigation of their suitability for drug transport studies. 1996. **Pharm. Res.** 13:978-988.

Y.W. Chien, K.S.E. Su, and S.P. Chang, (eds.), Nasal Systemic Drug Delivery, New York, Marcel Dekker, 1994. 1-25.

Yakou, S., Umehara, K., Sonobe, T., Nagai, T., Sugihara, M., and Fukuyama, Y. 1984. Particles size dependency of dissolution rate and human bioavailability of phenytoin powders and phenytoin-polyethylene glycol solid dispersions. **Chem. Pharm. Bull.** 32: 4130-4136.

Yu, C.D., Jones, R.E., and Henesian, M. Cascade impactor method for the droplet size characterization of a metered-dose nasal spray. 1984. **J. Pharm. Sci.** 73:344.

Yu, C.D., Jones, R.E., Wright, J., and Henesian, M. Characterization of dose delivery and spray pattern of metered-dose flunisolide nasal delivery spray. 1983. **Drug. Devel. Ind. Pharm.** 9:473.

Zhou, M., Donovan, M.D. 1996. Intranasal mucociliary clearance of putative bioadhesive. **Int. J. Pharm.** 135: 115-125.

APPENDICES

Calibration curve for determination of drug release

The concentration versus absorbance of propranolol HCl in phosphate buffer pH 6.8 at 218 nm were presented in Table 34, showed a linear relationship with the correlation coefficient of 0.99998. The standard curve of propranolol HCl after regression analysis were illustrated in Figure 56.

Table 34. Absorbance of propranolol HCl in phosphate buffer pH 6.8

Concentration (μg / ml)	Absorbance
0	0.0000
12	0.2402
16	0.3210
20	0.4018
24	0.4826
28	0.5634
32	0.6442

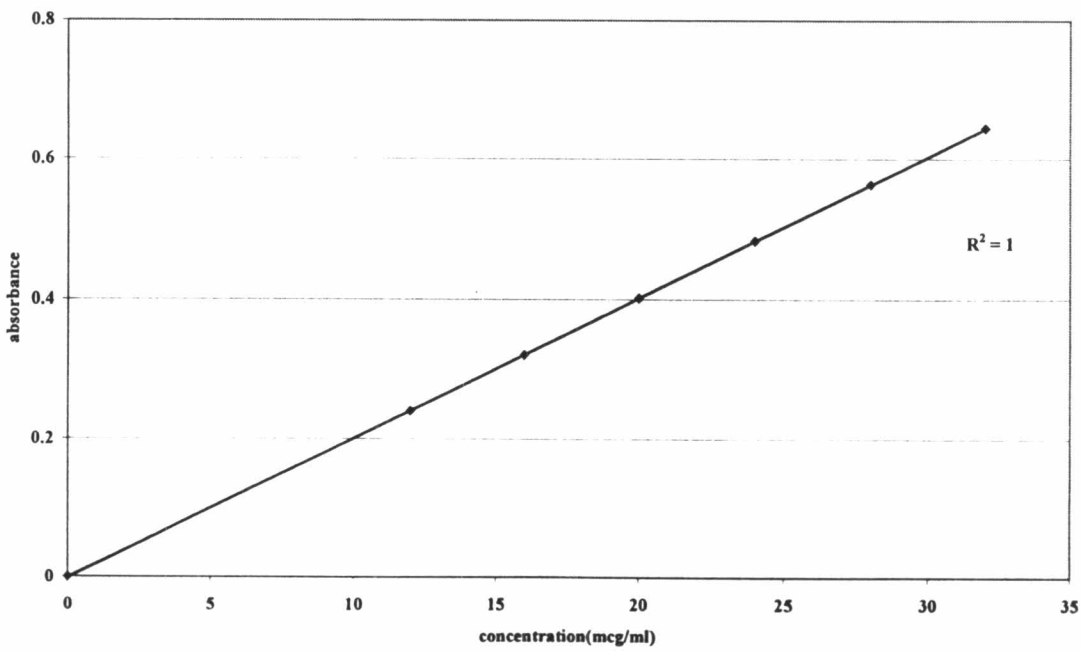

Figure 56 The calibration curve of proparanolol HCl in phosphate buffer pH 6.8

Calibration curve for determination of drug content

The concentration versus ratio between peak area of propranolol HCl and internal standard (theophylline) with HPLC method at 220 nm were presented in Table 35. and showed a linear relationship with the correlation coefficient of 0.99994. The standard curve of propranolol HCl after regression analysis was illustrated in Figure 57.

Table 35. Ratio between peak area of propranolol HCl and internal standard with HPLC method

Concentration (μg / ml)	Ratio
0	0.0000
0.8	0.7542
2.0	1.8194
3.2	2.9933
4.4	4.0672
5.6	5.2223

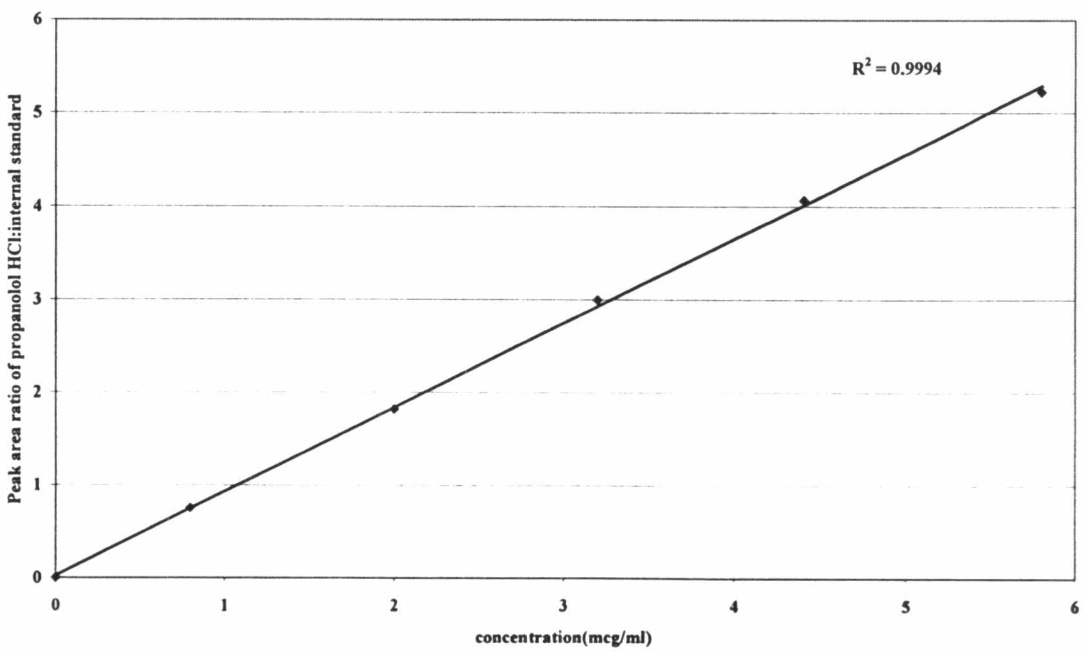

Figure 57. The calibration curve of Propranolol HCl by using HPLC for determining the drug content.

Calibration curve for determining the amount of FITC – labeled dextran

Calibration curve for determining the amount of FITC – labeled dextran in phosphate buffer pH 6.8 at emission/excitation wavelengths of 490/515 nm were presented in Table 36, showed a linear relationship with the correlation coefficient of 0.9996. The standard curve of FD-4 after regression analysis were illustrated in Figure 58.

Table 36. Intensity of FITC – labeled dextran in phosphate buffer pH 6.8

Concentration (μg / ml)	Intensity
0	0
0.08	189.9
0.12	294.7
0.16	362.8
0.20	465.8
0.24	544.2
0.28	648.8

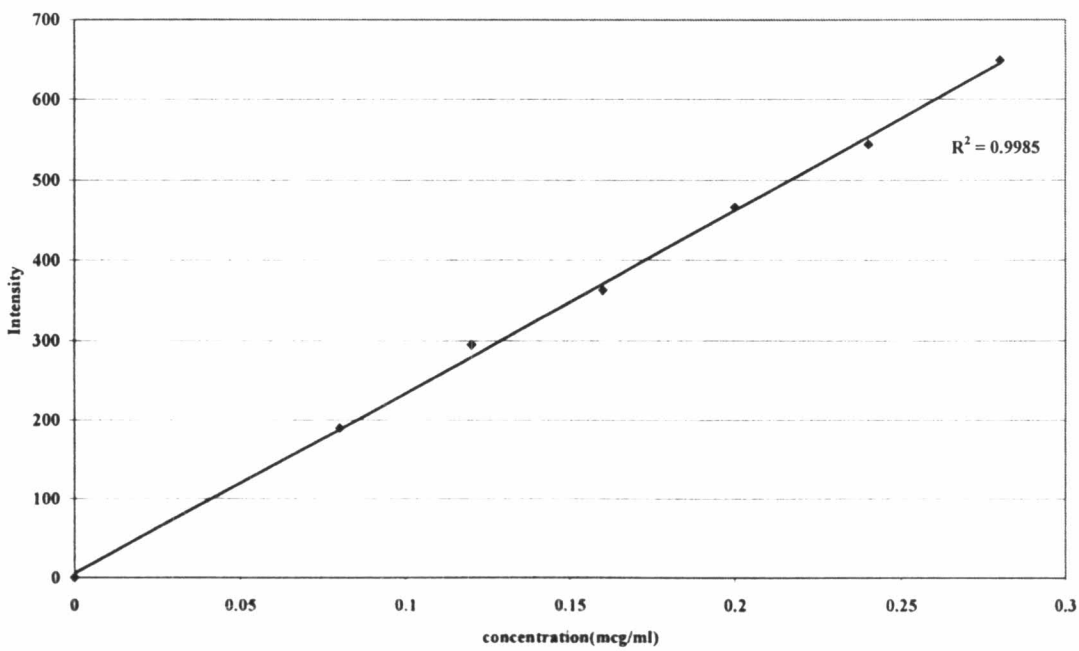

Figure 58 The calibration curve of FITC – labeled dextran by using fluorescense spectrophotometer

Table 37 The percentage amount of propranolol release from microspheres

Formulation	time (hr.)	Cumulative % of drug release			Mean (%)	SD	log % drug remained
		A	B	C			
F1	0.00	0.00	0.00	0.00	0.00	0.00	2.00
	0.25	43.53	35.94	37.20	38.89	4.07	1.79
	0.50	68.88	59.19	50.94	59.67	8.98	1.61
	0.75	80.08	69.07	57.57	68.91	11.26	1.49
	1.00	86.62	75.38	62.10	74.70	12.27	1.40
	1.50	91.89	81.84	70.42	81.38	10.74	1.27
	2.00	101.01	98.34	98.10	99.25	1.62	2.00
F2	0.00	0.00	0.00	0.00	0.00	0.00	2.00
	0.25	47.48	49.18	44.28	46.98	2.49	1.72
	0.50	69.26	67.73	65.39	67.46	1.95	1.51
	0.75	77.59	78.10	74.47	76.72	1.97	1.37
	1.00	82.76	84.81	80.05	82.54	2.39	1.24
	1.50	87.50	91.21	86.78	88.50	2.38	1.06
	2.00	102.23	99.76	100.03	100.67	1.35	2.00
F3	0.00	0.00	0.00	0.00	0.00	0.00	2.00
	0.25	42.86	39.87	40.74	41.16	1.54	1.77
	0.50	63.69	58.19	57.45	59.78	3.41	1.60
	0.75	73.90	70.06	70.46	71.47	2.11	1.46
	1.00	82.37	80.98	82.08	81.81	0.73	1.26
	1.50	91.44	91.32	92.57	91.78	0.69	0.92
	2.00	96.94	97.91	100.61	98.49	1.90	0.18
F4	0.00	0.00	0.00	0.00	0.00	0.00	2.00
	0.25	25.72	23.69	27.27	25.56	1.80	1.87
	0.50	35.93	35.22	39.89	37.01	2.52	1.80
	0.75	44.87	43.65	48.13	45.55	2.32	1.74
	1.00	52.13	49.89	56.80	52.94	3.53	1.67
	1.50	60.78	59.10	66.08	61.99	3.64	1.58
	2.00	70.13	65.60	74.05	69.93	4.23	1.48
	3.00	80.92	74.97	84.81	80.23	4.96	1.30
	4.00	91.26	82.16	92.61	88.68	5.68	1.05
	5.00	99.07	87.59	98.65	95.10	6.51	0.69

Table 38 The percentage amount of propranolol release from microspheres

Formulation	time (hr.)	Cumulative % of drug release			Mean (%)	SD	log % drug remained
		A	B	C			
F5	0.00	0.00	0.00	0.00	0.00	0.00	2.00
	0.25	60.69	66.26	62.54	63.16	2.84	1.57
	0.50	85.77	87.66	89.85	87.76	2.04	1.09
	0.75	95.23	96.61	95.49	95.78	0.73	0.63
	1.00	98.52	101.07	99.98	99.86	1.28	-0.84
F6	0.00	0.00	0.00	0.00	0.00	0.00	2.00
	0.25	39.46	37.03	42.36	39.62	2.67	1.78
	0.50	55.55	52.65	58.09	55.43	2.72	1.65
	0.75	62.55	63.24	70.07	65.29	4.16	1.54
	1.00	72.79	72.04	77.34	74.06	2.87	1.41
	1.50	86.55	82.69	89.84	86.36	3.58	1.13
	2.00	99.24	102.66	99.89	100.60	1.82	-
F7	0.00	0.00	0.00	0.00	0.00	0.00	2.00
	0.25	25.57	24.43	25.58	25.28	0.75	1.87
	0.50	40.69	40.33	42.79	41.27	1.33	1.77
	0.75	51.90	51.62	54.48	52.67	1.58	1.68
	1.00	62.32	60.62	62.23	61.72	0.96	1.58
	1.50	79.99	77.80	79.16	78.98	1.11	1.32
	2.00	91.52	88.83	88.91	89.75	1.53	1.01
	3.00	99.67	100.13	101.03	100.28	0.69	-
F8	0.00	0.00	0.00	0.00	0.00	0.00	2.00
	0.25	27.02	28.51	25.31	26.95	1.60	1.86
	0.50	37.87	39.68	37.20	38.25	1.28	1.79
	0.75	44.75	47.94	42.44	45.04	2.76	1.74
	1.00	52.87	54.57	48.41	51.95	3.18	1.68
	1.50	62.09	64.40	56.17	60.95	4.33	1.59
	2.00	70.25	72.71	62.92	68.63	5.09	1.50
	3.00	81.19	84.90	81.43	82.51	2.08	1.24
	4.00	91.84	95.20	92.49	93.18	1.78	0.83
	5.00	99.56	105.33	98.47	101.12	3.69	-

Table 39 The percentage amount of propranolol release from microspheres

Formulation	time (hr.)	Cumulative % of drug release			Mean (%)	SD	log % drug remained
		A	B	C			
F9	0.00	0.00	0.00	0.00	0.00	0.00	2.00
	0.25	30.07	16.89	34.00	26.99	8.96	1.86
	0.50	42.85	37.33	45.13	41.77	4.01	1.77
	0.75	46.47	43.17	50.11	46.58	3.47	1.73
	1.00	49.35	46.85	54.21	50.14	3.74	1.70
	1.50	54.99	51.97	61.27	56.08	4.74	1.64
	2.00	60.33	56.03	67.36	61.24	5.72	1.59
	3.00	71.69	64.01	78.36	71.35	7.18	1.46
	4.00	80.39	88.81	86.91	85.37	4.42	1.17
	5.00	88.25	82.19	93.65	88.03	5.73	1.08
	6.00	94.07	91.06	99.33	94.82	4.19	0.71
	8.00	101.70	100.36	104.81	102.29	2.28	-
F10	0.00	0.00	0.00	0.00	0.00	0.00	2.00
	0.25	10.19	15.61	11.70	12.50	2.80	1.94
	0.50	10.19	15.61	11.70	12.50	2.80	1.94
	0.75	10.19	15.61	11.70	12.50	2.80	1.94
	1.00	10.19	15.61	11.70	12.50	2.80	1.94
	1.50	10.19	15.61	11.70	12.50	2.80	1.94
	2.00	10.19	15.61	11.70	12.50	2.80	1.94
	3.00	18.64	28.33	21.48	22.82	4.98	1.89
	4.00	30.10	41.40	31.05	34.18	6.27	1.82
	5.00	39.39	43.83	39.94	41.05	2.42	1.77
	6.00	47.59	48.89	46.64	47.71	1.13	1.72
	8.00	63.75	65.50	60.35	63.20	2.62	1.57
	10.00	77.29	80.78	72.12	76.73	4.36	1.37
	12.00	89.38	94.15	81.92	88.48	6.16	1.06
	16.00	95.24	104.35	95.59	98.39	5.16	0.21
	20.00	104.32	108.10	104.05	105.49	2.26	-
F11	0.00	0.00	0.00	0.00	0.00	0.00	2.00
	0.25	0.00	0.00	0.00	0.00	0.00	2.00
	0.50	0.00	0.00	0.00	0.00	0.00	2.00
	0.75	0.00	0.00	0.00	0.00	0.00	2.00
	1.00	0.00	0.00	0.00	0.00	0.00	2.00
	1.50	0.00	0.00	0.00	0.00	0.00	2.00
	2.00	0.00	0.00	0.00	0.00	0.00	2.00
	3.00	0.00	0.00	0.00	0.00	0.00	2.00
	4.00	14.39	12.73	11.94	13.02	1.25	1.94
	5.00	23.92	22.97	20.01	22.30	2.04	1.89
	6.00	32.71	31.93	27.44	30.69	2.84	1.84
	8.00	49.31	46.98	40.64	45.64	4.49	1.74
	10.00	63.38	59.69	52.58	58.55	5.49	1.62
	12.00	74.62	70.10	64.43	69.72	5.11	1.48
	16.00	84.39	79.23	77.52	80.38	3.58	1.29
	20.00	93.96	91.60	91.11	92.22	1.52	0.89
	24.00	100.14	99.50	105.69	101.78	3.40	-

Table 40 The percentage amount of propranolol release from microspheres

Formulation	time (hr.)	Cumulative % of drug release			Mean (%)	SD	log % drug remained
		A	B	C			
F12	0.00	0.00	0.00	0.00	0.00	0.00	2.00
	0.25	0.00	0.00	0.00	0.00	0.00	2.00
	0.50	0.00	0.00	0.00	0.00	0.00	2.00
	0.75	0.00	0.00	0.00	0.00	0.00	2.00
	1.00	0.00	0.00	0.00	0.00	0.00	2.00
	1.50	0.00	0.00	0.00	0.00	0.00	2.00
	2.00	0.00	0.00	0.00	0.00	0.00	2.00
	3.00	0.00	0.00	0.00	0.00	0.00	2.00
	4.00	0.00	0.00	0.00	0.00	0.00	2.00
	5.00	0.00	0.00	0.00	0.00	0.00	2.00
	6.00	0.00	0.00	0.00	0.00	0.00	2.00
	8.00	17.99	15.77	18.54	17.43	1.47	1.92
	10.00	30.61	28.67	31.09	30.12	1.28	1.84
	12.00	42.16	39.98	41.75	41.30	1.16	1.77
	16.00	53.23	56.21	53.22	54.22	1.72	1.66
	20.00	67.44	71.68	64.30	67.81	3.70	1.51
	24.00	88.19	91.52	81.02	86.71	5.37	1.12
F13	0.00	0.00	0.00	0.00	0.00	0.00	2.00
	0.25	14.20	19.38	19.83	17.80	3.13	1.91
	0.50	23.81	27.78	31.81	27.80	4.00	1.86
	0.75	31.33	34.57	35.12	33.67	2.05	1.82
	1.00	38.10	42.61	48.90	43.20	5.42	1.75
	1.50	49.93	52.58	50.25	50.92	1.45	1.69
	2.00	59.38	61.37	60.25	60.33	1.00	1.60
	3.00	70.82	74.94	70.31	72.02	2.54	1.45
	4.00	81.75	84.63	85.63	84.00	2.01	1.20
	5.00	89.92	92.30	96.22	92.81	3.18	0.86
	6.00	96.71	99.27	100.09	98.69	1.76	0.12
	8.00	101.81	102.50	105.38	103.23	1.89	-
F14	0.00	0.00	0.00	0.00	0.00	0.00	2.00
	0.25	12.40	11.87	16.78	13.68	2.69	1.94
	0.50	22.65	21.22	27.21	23.86	3.41	1.88
	0.75	22.65	21.22	27.21	23.86	3.41	1.88
	1.00	22.65	21.22	27.21	23.86	3.41	1.88
	1.50	33.26	32.03	38.79	34.69	3.60	1.81
	2.00	43.32	40.67	48.42	44.14	3.94	1.75
	3.00	59.12	56.18	65.21	60.17	4.61	1.60
	4.00	71,01	69.41	77.77	72.73	4.44	1.44
	5.00	79.33	78.34	80.13	79.27	0.90	1.32
	6.00	87.21	86.70	87.37	87.09	0.35	1.11
	8.00	97.43	100.04	94.45	97.31	2.80	0.43
	10.00	105.16	104.99	105.40	105.18	0.21	-

Table 41 The percentage amount of propranolol release from microspheres

Formulation	time (hr.)	Cumulative % of drug release			Mean (%)	SD	log % drug remained
		A	B	C			
F15	0.00	0.00	0.00	0.00	0.00	0.00	2.00
	0.25	0.00	0.00	0.00	0.00	0.00	2.00
	0.50	0.00	0.00	0.00	0.00	0.00	2.00
	0.75	0.00	0.00	0.00	0.00	0.00	2.00
	1.00	0.00	0.00	0.00	0.00	0.00	25.00
	1.50	10.09	8.90	11.34	10.11	1.22	1.95
	2.00	18.53	16.05	19.75	18.11	1.89	1.91
	3.00	30.58	29.05	32.38	30.67	1.67	1.84
	4.00	40.73	41.4	42.86	41.66	1.09	1.77
	5.00	50.16	52.63	52.61	51.8	1.42	1.68
	6.00	56.48	61.32	59.95	59.25	2.49	1.61
	8.00	71.64	77.63	73.95	74.41	3.02	1.41
	10.00	82.54	89.08	84.82	85.48	3.32	1.16
	12.00	91.59	93.90	93.61	90.26	1.526	0.84
	16.00	99.90	97.32	97.17	93.03	1.53	0.27
	20.00	103.69	104.86	101.33	98.13	1.80	-
	24.00	103.69	104.86	101.33	103.29	1.80	-

Table 42 The percentage amount of propranolol1oiuyta release from microspheres during storage at stability condition.

Storage time (month)	time (hr.)	Cumulative % of drug release			Mean	SD	log % drug remained
		A	B	C			
F4							
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.25	26.33	29.17	30.72	28.74	2.23	1.85
	0.5	45.24	38.29	37.43	40.32	4.28	1.78
	0.75	50.55	45.63	49.41	48.53	2.58	1.71
	1.00	60.12	52.13	52.51	54.92	4.51	1.65
	1.50	68.23	62.73	62.03	64.33	3.40	1.55
	2.00	75.67	71.27	66.00	70.98	4.84	1.46
	3.00	83.95	87.25	77.62	82.94	4.89	1.23
	4.00	90.01	92.53	83.03	88.54	4.89	1.06
	5.00	100.3	97.03	97.68	98.35	1.75	0.22
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.25	30.02	25.14	29.23	28.13	2.62	1.86
	0.5	35.14	42.63	40.85	39.54	3.91	1.80
	0.75	50.25	48.25	44.15	47.55	3.11	1.72
	1.00	56.78	58.12	50.16	55.02	4.26	1.65
	1.50	62.73	68.01	52.05	60.93	8.13	1.59
	2.00	78.79	73.67	72.96	75.14	3.18	1.40
	3.00	87.79	83.03	85.59	85.47	2.38	1.16
	4.00	89.03	96.73	84.27	90.01	6.29	1.00
	5.00	101.03	95.73	99.49	98.75	2.73	0.10
F8							
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.25	24.32	20.43	19.21	21.32	2.67	1.90
	0.5	35.45	28.14	33.32	31.97	3.76	1.83
	0.75	40.23	40.78	38.60	39.87	1.13	1.78
	1.00	38.63	45.14	47.57	43.78	4.62	1.75
	1.50	53.68	50.03	53.34	52.35	2.02	1.68
	2.00	65.17	59.27	55.92	60.12	4.68	1.60
	3.00	75.14	71.95	76.26	74.45	2.24	1.41
	4.00	86.71	90.63	80.00	85.78	5.38	1.15
	5.00	97.25	95.09	86.72	93.02	5.56	0.84
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.25	21.99	19.78	21.20	20.99	1.12	1.90
	0.5	35.18	30.29	30.98	32.15	2.65	1.83
	0.75	40.13	32.78	46.88	39.93	7.05	1.78
	1.00	45.17	40.25	47.03	44.15	3.50	1.75
	1.50	55.79	53.68	51.66	53.71	2.07	1.67
	2.00	68.63	60.95	57.11	62.23	5.87	1.58
	3.00	73.24	78.14	75.09	75.49	2.47	1.39
	4.00	85.54	80.68	83.47	83.23	2.44	1.22
	5.00	101.04	93.13	93.74	95.97	4.40	0.61

Table 43 The percentage amount of propranolol release from microspheres during storage at stability condition (cont.).

Storage time (month)	time (hr.)	Cumulative % of drug release			Mean	SD	log % drug remained
		A	B	C			
F12							
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.25	0.00	0.00	0.00	0.00	0.00	0.00
	0.5	0.00	0.00	0.00	0.00	0.00	0.00
	0.75	0.00	0.00	0.00	0.00	0.00	0.00
	1.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.50	0.00	0.00	0.00	0.00	0.00	0.00
	2.00	0.00	0.00	0.00	0.00	0.00	0.00
	3.00	0.00	0.00	0.00	0.00	0.00	0.00
	4.00	0.00	0.00	0.00	0.00	0.00	0.00
	5.00	0.00	0.00	0.00	0.00	0.00	0.00
	6.00	0.00	0.00	0.00	0.00	0.00	0.00
	8.00	20.25	15.03	22.47	19.25	3.82	1.91
	10.00	37.67	30.51	33.19	33.79	3.62	1.82
	12.00	39.03	39.46	40.13	39.54	0.55	1.78
	16.00	54.22	52.73	58.74	55.23	3.13	1.65
	20.00	63.48	66.29	67.60	65.79	2.11	1.53
	24.00	90.03	93.12	86.76	89.97	3.18	1.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.25	0.00	0.00	0.00	0.00	0.00	0.00
	0.5	0.00	0.00	0.00	0.00	0.00	0.00
	0.75	0.00	0.00	0.00	0.00	0.00	0.00
	1.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.50	0.00	0.00	0.00	0.00	0.00	0.00
	2.00	0.00	0.00	0.00	0.00	0.00	0.00
	3.00	0.00	0.00	0.00	0.00	0.00	0.00
	4.00	0.00	0.00	0.00	0.00	0.00	0.00
	5.00	0.00	0.00	0.00	0.00	0.00	0.00
	6.00	0.00	0.00	0.00	0.00	0.00	0.00
	8.00	16.78	15.28	15.85	15.97	0.76	1.92
	10.00	30.12	25.78	31.49	29.13	2.98	1.85
	12.00	40.29	33.09	32.79	35.39	4.25	1.81
	16.00	55.67	50.64	55.03	53.78	2.74	1.66
	20.00	70.29	65.02	70.31	68.54	3.05	1.50
	24.00	85.79	93.87	91.27	90.31	4.12	0.99

Table 44 The percentage amount of propranolol release from microspheres during storage at stability condition (cont.).

Storage time (month)	time (hr.)	Cumulative % of drug release			Mean	SD	log % drug remained
		A	B	C			
F15							
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.25	0.00	0.00	0.00	0.00	0.00	0.00
	0.5	0.00	0.00	0.00	0.00	0.00	0.00
	0.75	0.00	0.00	0.00	0.00	0.00	0.00
	1.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.50	18.97	14.39	11.73	15.03	3.66	1.93
	2.00	19.12	22.26	25.01	22.13	2.95	1.89
	3.00	40.25	35.04	30.13	35.14	5.06	1.81
	4.00	44.14	38.12	46.57	42.95	4.35	1.76
	5.00	53.74	60.03	56.60	56.79	3.15	1.64
	6.00	60.43	67.11	70.79	66.11	5.25	1.53
	8.00	80.12	75.24	83.26	79.54	4.04	1.31
	10.00	85.78	89.91	91.22	88.97	2.84	1.04
	12.00	95.79	88.23	92.28	92.10	3.78	0.90
	16.00	100.01	92.32	93.63	95.32	4.11	0.67
	20.00	99.07	95.78	99.18	98.01	1.93	0.30
	24.00	105.48	97.97	99.94	101.13	3.89	
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.25	0.00	0.00	0.00	0.00	0.00	0.00
	0.5	0.00	0.00	0.00	0.00	0.00	0.00
	0.75	0.00	0.00	0.00	0.00	0.00	0.00
	1.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.50	18.34	12.12	14.96	15.14	3.11	1.93
	2.00	25.01	19.03	22.98	22.34	3.04	1.90
	3.00	35.04	29.29	37.61	33.98	4.26	1.82
	4.00	48.27	40.12	48.92	45.77	4.90	1.73
	5.00	55.12	52.78	57.49	55.13	2.36	1.65
	6.00	65.34	59.37	67.08	63.93	4.04	1.56
	8.00	81.02	72.97	82.92	78.97	5.28	1.32
	10.00	89.76	85.63	81.03	87.14	4.37	1.11
	12.00	95.79	89.06	91.24	92.03	3.43	0.90
	16.00	99.78	90.25	95.30	95.11	4.77	0.69
	20.00	98.01	94.13	101.83	97.99	3.85	0.30
	24.00	102.00	99.32	100.03	100.45	1.39	

Table 45 The percentage amount of propranolol release from microspheres

Formulation	time (hr.)	Cumulative % of drug release			Mean (%)	SD	log % drug remained
		A	B	C			
Blank	0.00	0.00	0.00	0.00	0.00	0.00	2.00
	0.25	52.53	47.71	52.21	50.82	2.70	1.69
	0.50	80.47	80.29	76.18	78.98	2.43	1.32
	0.75	88.13	88.01	85.80	87.31	1.31	1.10
	1.00	98.53	98.30	97.10	97.98	0.77	0.31

Table 46 Values for rate , amount release , and the corresponding Reciprocal for the release of formulations F1 – F4.

Formulation	(dq / dt) Release rate	(Q) Amount of release	(1 / Q) Reciprocal of release
F1	155.56	38.89	0.0257
	83.12	59.67	0.0168
	36.96	68.91	0.0145
	23.61	74.70	0.0134
	13.36	81.38	0.0123
F2	187.92	46.98	0.0213
	81.92	67.46	0.0148
	37.04	76.72	0.0130
	23.28	82.54	0.0121
	11.92	88.50	0.0113
F3	164.64	41.16	0.0243
	74.48	59.78	0.0167
	46.76	71.47	0.0140
	41.36	81.81	0.0122
	19.94	91.78	0.0109
	13.42	98.49	0.0102
F4	102.24	25.56	0.0391
	45.80	37.01	0.0270
	34.16	45.55	0.0220
	29.56	52.94	0.0189
	18.10	61.99	0.0161
	15.88	69.93	0.0143
	10.30	80.23	0.0125
	8	88.68	0.0113
	6.42	95.10	0.0105
F5	252.64	63.16	0.0158
	99.06	80.00	0.0125
	98.40	87.76	0.0114
	32.08	95.78	0.0104
	16.32	99.86	0.0100

Table 47 Values for rate , amount released , and the corresponding reciprocal for the release of formulation F5 – F8.

Formulation	(dq / dt) Release rate	(Q) Amount of release	(1 / Q) Reciprocal of release
F6	158.48	39.62	0.0252
	63.24	55.43	0.0180
	39.44	65.29	0.0153
	35.08	74.06	0.0135
	30.02	80	0.0125
	24.60	86.36	0.0116
	28.48	100.60	0.0099
F7	101.12	25.88	0.0396
	63.96	41.27	0.0242
	45.60	52.67	0.0190
	36.20	61.72	0.0162
	34.52	78.98	0.0127
	21.54	89.75	0.0111
	10.53	100.28	0.0100
F8	107.80	26.95	0.0371
	45.20	38.25	0.0261
	27.16	45.04	0.0222
	27.64	51.95	0.0192
	18.00	60.95	0.0164
F9	107.96	26.99	0.0371
	59.12	41.77	0.0239
	19.24	46.58	0.0215
	14.24	50.14	0.0199
	11.88	56.08	0.0178
	10.32	61.24	0.0163
	10.11	71.35	0.0140
	12.52	80.00	0.0125
	14.02	85.37	0.0117
	2.66	88.03	0.0114
	6.79	94.82	0.0105
	3.74	102.29	0.0098

Table 48 Values for rate , amount released , and the corresponding reciprocal for the release of formulation F9 – F12.

Formulation	(dq / dt) Release rate	(Q) Amount of release	(1 / Q) Reciprocal of release
F10	10.32	22.82	0.0438
	11.36	34.18	0.0293
	6.87	41.05	0.0244
	6.66	47.71	0.0210
	7.75	63.20	0.0158
	6.77	76.73	0.0130
	6.52	80.00	0.0125
	5.88	88.48	0.0113
	2.48	98.39	0.0102
	1.78	105.49	0.0095
F11	13.02	13.02	0.0768
	9.28	22.30	0.0448
	8.39	30.69	0.0326
	7.48	45.64	0.0219
	6.46	58.55	0.0171
	5.59	69.72	0.0143
	2.67	80.38	0.0124
	2.96	92.22	0.0108
	2.39	101.78	0.0098
F12	8.72	17.43	0.0574
	6.35	30.12	0.0332
	5.59	41.30	0.0242
	3.23	54.22	0.0184
	3.40	67.81	0.0147
	4.28	80.00	0.0125
	4.78	86.91	0.0115

Table 49 Values for rate , amount released , and the corresponding reciprocal for the release of formulation F13 – F15.

Formulation	(dq / dt) Release rate	(Q) Amount of release	(1 / Q) Reciprocal of release
F13	71.20	17.80	0.0562
	40.00	27.80	0.0360
	23.48	33.67	0.0297
	38.12	43.20	0.0231
	15.44	50.92	0.0196
	18.82	60.33	0.0166
	11.69	72.02	0.0139
	11.88	80.00	0.0125
	11.98	84.00	0.0119
	8.81	92.81	0.0108
	5.88	98.69	0.0101
	2.27	103.23	0.0097
F14	21.66	34.69	0.0228
	18.90	44.14	0.0227
	16.03	60.14	0.0166
	12.56	72.73	0.0137
	6.54	79.27	0.0126
	7.82	87.09	0.0115
	5.11	97.31	0.0103
	3.94	105.18	0.0095
F15	20.22	10.11	0.0989
	16.00	18.11	0.0552
	12.56	30.67	0.0326
	10.99	41.66	0.0240
	10.14	51.80	0.0193
	7.45	59.25	0.0169
	6.55	74.41	0.0134
	5.54	80.00	0.0125
	3.78	85.48	0.0117
	1.28	93.03	0.0107
	1.29	98.13	0.0102
	0	103.29	

Table 50 The percentage of swelling from formulation F1 – F4

Time (Sec)	% Swelling			
	Formulation F1	Formulation F2	Formulation F3	Formulation F4
0	0	0	0	0
1	2.28	5.89	14.95	25.50
2	6.01	8.78	30.51	38.43
3	10.64	12.99	44.21	63.23

Table 51 The percentage of swelling from formulation F5 – F8

Time (Sec)	% Swelling			
	Formulation F5	Formulation F6	Formulation F7	Formulation F8
0	0	0	0	0
1	12.62	25.99	65.99	51.64
2	23.99	40.79	89.01	133.62
3	31.35	73.67	113.22	201.25
4	57.74	99.18	210.81	283.71
5	68.81	136.60	297.81	372.83
6	99.94	178.12	348.93	440.85
7		238.14	399.04	536.84
8				562.53

Table 52 The percentage of swelling from formulation F9 – F12

Time (Sec)	% Swelling			
	Formulation F9	Formulation F10	Formulation F11	Formulation F12
0	0	0	0	0
1	42.38	50.98	98.58	129.63
2	39.58	65.99	145.69	260.66
3	164.39	204.73	388.60	466.01
4	246.50	310.23	561.94	518.75
5	265.82	338.94	603.36	574.86
6				618.25

Table 53 The percentage of swelling from formulation F13 – F15

Time (Sec)	% Swelling		
	Formulation F13	Formulation F14	Formulation F15
0	0	0	0
1	18.77	35.26	74.36
2	30.94	68.95	199.40
3	52.81	105.27	299.78
4			432.61
5			533.80

VITA

Miss Saraporn Harikarnpakdee was born on 10th December 1970 in Bangkok, Thailand. She got her bachelor degree in Pharmacy from Faculty of Pharmaceutical Science, Rangsit University in 1994. After finished from Rangsit University, she started studying at Chulalongkorn University and received her Masters degree in the field of Manufacturing Pharmacy in 1996 from the Faculty of Pharmaceutical Sciences. She worked as a lecturer at Faculty of Pharmaceutical Sciences, Rangsit University between 1996 to present.