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REFERENCES

Aggarwal, B., Surh, Y.-J., Shishodia, S., Menon, V. and Sudheer, A., 2007, Antioxidant and anti-inflammatory properties of curcumin *The Molecular Targets and Therapeutic Uses of Curcumin in Health and Disease.* Springer US.

Aggarwal, B. B., Kumar, A. and Bharti, A. C. 2003, Anticancer potential of curcumin: preclinical and clinical studies. *Anticancer Research,* **23,** 363-98.

Allam, A. N., Komeil, I. A., Fouda, M. A. and Abdallah, O. Y. 2015, Preparation, characterization and in vivo evaluation of curcumin self-nano phospholipid dispersion as an approach to enhance oral bioavailability. *International Journal of Pharmaceutics,* **489,** 117-123.

Amorij, J.-P. 2007, The development of stable influenza vaccine powder formulations for new needle-free dosage forms. *Dept. of Pharmaceutical Technology and Biopharmacy.* Groningen, University of Groningen.

Ampasavate, C., Sotanaphun, U., Phattanawasin, P. and Piyapolrungroj, N. 2010, Effects of Curcuma spp. on P-glycoprotein function. *Phytomedicine,* **17,** 506-512.

Anand, P., Kunnumakkara, A. B., Newman, R. A. and Aggarwal, B. B. 2007, Bioavailability of curcumin: problems and promises. *Molecular Pharmaceutics,* **4,** 807-18.

AOAC, 2012, Official Methods of Analysis of AOAC Interntional. IN George W. Latimer, J. (Ed.) *Guidelines for Standard Method Performance Requirements.* 19th ed. Gaithersburg, Maryland, USA, AOAC International.

Appiah-Opong, R., Commandeur, J. N., van Vugt-Lussenburg, B. and Vermeulen, N. P. 2007, Inhibition of human recombinant cytochrome P450s by curcumin and curcumin decomposition products. *Toxicology,* **235,** 83-91.

Artursson, P. and Karlsson, J. 1991, Correlation between oral drug absorption in humans and apparent drug permeability coefficients in human intestinal epithelial (Caco-2) cells. *Biochemical and Biophysical Research Communications,* **175,** 880-5.

Asai, A. and Miyazawa, T. 2000, Occurrence of orally administered curcuminoid as glucuronide and glucuronide/sulfate conjugates in rat plasma. *Life Sciences,* **67,** 2785-93.

Bakes, D., 2008, HPLC optimization. IN Venn, R. (Ed.) *Principles and practice of bioanalysis.* second ed., CRC Press.

Bisht, S., Feldmann, G., Soni, S., Ravi, R., Karikar, C., Maitra, A.*, et al.* 2007, Polymeric nanoparticle-encapsulated curcumin ("nanocurcumin"): a novel strategy for human cancer therapy. *Journal of Nanobiotechnology,* **5,** 3.

Bühler, V. 2005, *Polyvinylpyrrolidone Excipients for Pharmaceuticals: Povidone, Crospovidone and Copovidone*, Springer Berlin Heidelberg.

Cao, Y., Xu, R. X. and Liu, Z. 2014, A high-throughput quantification method of curcuminoids and curcumin metabolites in human plasma via high-

UNIVERSITAS GADJAH MADA
Development of Solid Dispersion Formulation Containing Curcumin and Curcuminoids of Standardized Extract to Improve Curcumin Dissolution and Relative Bioavailability
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

performance liquid chromatography/tandem mass spectrometry. *Journal of chromatography. B, Analytical technologies in the biomedical and life sciences.*, 70-78 doi:10.1016/j.jchromb.2013.12.039.

Chaubal, M. and Popescu, C. 2008, Conversion of Nanosuspensions into Dry Powders by Spray Drying: A Case Study. *Pharmaceutical Research,* **25,** 2302-2308.

Chauhan, D. P. 2002, Chemotherapeutic potential of curcumin for colorectal cancer. *Current Pharmaceutical Design,* **8,** 1695-706.

Cheng, A. L., Hsu, C. H., Lin, J. K., Hsu, M. M., Ho, Y. F., Shen, T. S.*, et al.* 2001, Phase I clinical trial of curcumin, a chemopreventive agent, in patients with high-risk or pre-malignant lesions. *Anticancer Research,* **21,** 2895-900.

Chiang, P. C., Ran, Y., Chou, K. J., Cui, Y., Sambrone, A., Chan, C.*, et al.* 2012, Evaluation of drug load and polymer by using a 96-well plate vacuum dry system for amorphous solid dispersion drug delivery. *AAPS PharmSciTech,* **13,** 713-22.

Chiou, W. L. and Riegelman, S. 1971, Pharmaceutical applications of solid dispersion systems. *Journal of Pharmaceutical Sciences,* **60,** 1281-1302.

Chuah, A. M., Jacob, B., Jie, Z., Ramesh, S., Mandal, S., Puthan, J. K.*, et al.* 2014, Enhanced bioavailability and bioefficacy of an amorphous solid dispersion of curcumin. *Food Chemistry,* **156,** 227-233.

Claassen, V. 1994, *Neglected factors in pharmacology and neuroscience research,* Amsterdam, Elsevier BV.

Collier, J. W., Shah, R. B., Bryant, A. R., Habib, M. J., Khan, M. A. and Faustino, P. J. 2011, Development and application of a validated HPLC method for the analysis of dissolution samples of levothyroxine sodium drug products. *Journal of Pharmaceutical and Biomedical Analysis,* **54,** 433-438.

Craig, D. Q. 2002, The mechanisms of drug release from solid dispersions in water-soluble polymers. *International Journal of Pharmaceutics,* **231,** 131-44.

Cui, J., Yu, B., Zhao, Y., Zhu, W., Li, H., Lou, H.*, et al.* 2009, Enhancement of oral absorption of curcumin by self-microemulsifying drug delivery systems. *International Journal of Pharmaceutics,* **371,** 148-55.

de Waard, H., De Beer, T., Hinrichs, W. J., Vervaet, C., Remon, J.-P. and Frijlink, H. 2010, Controlled Crystallization of the Lipophilic Drug Fenofibrate During Freeze-Drying: Elucidation of the Mechanism by In-Line Raman Spectroscopy. *The AAPS Journal,* **12,** 569-575.

de Waard, H., Grasmeijer, N., Hinrichs, W. L. J., Eissens, A. C., Pfaffenbach, P. P. F. and Frijlink, H. W. 2009, Preparation of drug nanocrystals by controlled crystallization: Application of a 3-way nozzle to prevent premature crystallization for large scale production. *European Journal of Pharmaceutical Sciences,* **38,** 224-229.

de Waard, H., Hinrichs, W. L. and Frijlink, H. W. 2008, A novel bottom-up process to produce drug nanocrystals: controlled crystallization during freeze-drying. *Journal of Controlled Release,* **128,** 179-83.

UNIVERSITAS GADJAH MADA
Development of Solid Dispersion Formulation Containing Curcumin and Curcuminoids of Standardized Extract to Improve Curcumin Dissolution and Relative Bioavailability
DEWI SETYANINGSIH, Prof. Dr. Achmad Fudholi, DEA., Apt, Dr. rer.nat Triana Hertiani, M.Si.,Apt, Dr. W.L.J Hinrich
Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Donatus, I., Sardjoko and Vermeulen, N. 1990, Cytotoxicity and Cytoprotective Activities of Curcumin. *Biochem. Pharmacol,* **39,** 1869-1875.

Drooge, D. J. v., Hinrichs, W. L. J. and H.W.Frijlink 2004, Anomalous dissolution behaviour of tablets prepared from sugar glass based solid dispersions. *Journal of Controlled Release,* **97,** 441-452

Duret, C., Wauthoz, N., Sebti, T., Vanderbist, F. and Amighi, K. 2012, Solid dispersions of itraconazole for inhalation with enhanced dissolution, solubility and dispersion properties. *International Journal of Pharmaceutics,* **428,** 103-13.

Eerdenbrugh, B. V. and Taylor, L. 2010, Small scale screening to determine the ability of different polymers to inhibit drug crystallization upon rapid solvent evaporation. *Molecular Pharmaceutics,* **7,** 1328-1337.

Elfahmi, Woerdenbag, H. J. and Kayser, O. 2014, Jamu: Indonesian traditional herbal medicine towards rational phytopharmacological use. *Journal of Herbal Medicine,* **4,** 51-73.

Eriksson, H. J., Hinrichs, W. L., van Veen, B., Somsen, G. W., de Jong, G. J. and Frijlink, H. W. 2002, Investigations into the stabilisation of drugs by sugar glasses: I. Tablets prepared from stabilised alkaline phosphatase. *International Journal of Pharmaceutics,* **249,** 59-70.

Ermer, J., 2005, Performance parameters, calculations and tests. IN Ermer, J. & Miller, J. H. M. (Eds.) *Method validation in pharmaceutical analysis.* Weinheim, Willey-VCH Verlag GmbH & Co. KGaA.

FDA 1994, Center for Drug Evaluation and Research. Reviewer guidance validation of chromatographic methods, FDA

FDA 2001, Guidance for industry-bioanalytical method validation, Food and Drug Administration

Ferenzi-Fodor, K., Renger, B. and Vegh, Z. 2010, The frustated reviewer-recurrent failures in manuscript describing validation of quantitative TLC/HPTLC procedures of analysis of pharmaceutical. *Journal of Planar Chromatography,* **23,** 173-179.

Ferenzi-Fodor, K., Vegh, Z. and Nagi-Turak, A. 2001, Validation and quality assurance of planar chromatographic procedures in pharmaceutical analysis. *Journal of AOAC International,* **84,** 1265-1276.

Frank, K. J., Rosenblatt, K. M., Westedt, U., HÃ¶lig, P., Rosenberg, J. r., MÃ¤gerlein, M.*, et al.* 2012, Amorphous solid dispersion enhances permeation of poorly soluble ABT-102: True supersaturation vs. apparent solubility enhancement. *International Journal of Pharmaceutics,* **437,** 288-293.

Fudholi, A. 2013, *Disolusi dan pelepasan obat,* Yogyakarta, Pustaka Pelajar.

Gao, Y., Li, Z., Sun, M., Li, H., Guo, C., Cui, J.*, et al.* 2010, Preparation, characterization, pharmacokinetics, and tissue distribution of curcumin nanosuspension with TPGS as stabilizer. *Drug Development and Industrial Pharmacy,* **36,** 1225-34.

Garcea, G., Berry, D. P., Jones, D. J., Singh, R., Dennison, A. R., Farmer, P. B.*, et al.* 2005, Consumption of the putative chemopreventive agent curcumin by cancer patients: assessment of curcumin levels in the colorectum and their

Development of Solid Dispersion Formulation Containing Curcumin and Curcuminoids of Standardized
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

pharmacodynamic consequences. *Cancer Epidemiology, Biomarkers and Prevention,* **14,** 120-5.

Garcea, G., Jones, D. J., Singh, R., Dennison, A. R., Farmer, P. B., Sharma, R. A., *et al.* 2004, Detection of curcumin and its metabolites in hepatic tissue and portal blood of patients following oral administration. *British Journal of Cancer,* **90,** 1011-5.

Garofolo, F., 2004, Biaonalytical method validation. IN Chan, C. C., Lam, H., Lee, Y. & Zhang, X.-M. (Eds.) *Analytical method validation and instrument performance verification* New Jersey, John Wiley & Sons, Inc.

González, G. and Herrador, A. 2007, A practical guide to analytical method validation, including measurement uncertainty and accuracy profiles. *TrAC Trends in Analytical Chemistry,* **26,** 227-238.

Govindarajan, V. S. and Stahl, W. H. 1980, Turmeric - chemistry, technology, and quality. *CRC Critical Reviews in Food Science and Nutrition,* **12,** 199-301.

Graeser, K., Patterson, J., Zeitler, J., Gordon, K. and Rades, T. 2009, Correlating thermodynamic and kinetic parameters with amorphous stability. *European Journal of Pharmaceutical Sciences,* **37,** 492-498.

Griffin, B. and O'Driscoll, C., 2008, Models of the Small Intestine. IN Ehrhardt, C. & Kim, K.-J. (Eds.) *Drug Absorption Studies: In Situ, In Vitro and In Silico Models*. New York, Springer Science+Business Media.

Grill, A., Koniar, B. and Panyam, J. 2014, Co-delivery of natural metabolic inhibitors in a self-microemulsifying drug delivery system for improved oral bioavailability of curcumin. *Drug Delivery and Translational Research,* **4,** 344-352.

Gugulothu, D. B. and Patravale, V. B. 2012, A new stability-indicating HPLC method for simultaneous determination of curcumin and celecoxib at single wavelength: an application to nanoparticulate formulation. *Pharmaceutica Analytica Acta,* **3,** http//dx.doi.org/10.4172/2153-2435.1000157.

Gunaratna, C. 2000, Pharmacokinetic and pharmacodynamic studies in rats using a new method of automated blood sampling. *Current Separations,* **18,** 153-157.

Gupta, N. K. and Dixit, V. K. 2011, Bioavailability enhancement of curcumin by complexation with phosphatidyl choline. *Journal of Pharmaceutical Sciences,* **100,** 1987-1995.

Gupta, S. C., Patchva, S. and Aggarwal, B. B. 2012, Therapeutic Roles of Curcumin: Lessons Learned from Clinical Trials. *The AAPS Journal,* **15,** 195-218.

Hassaninasab, A., Hashimoto, Y., Tomita-Yokotani, K. and Kobayashi, M. 2011, Discovery of the curcumin metabolic pathway involving a unique enzyme in an intestinal microorganism. *Proceedings of the National Academy of Sciences of the United States of America,* **108,** 6615-20.

Heath, D. D., Pruitt, M. A., Brenner, D. E. and Rock, C. L. 2003, Curcumin in plasma and urine: quantitation by high-performance liquid chromatography. *Journal of Chromatography B,* **783,** 287-295.

Hoff, J. 2000, Methods of blood collection in the mouse. *Lab Animal,* **29,** 47-53.

UNIVERSITAS GADJAH MADA
Development of Solid Dispersion Formulation Containing Curcumin and Curcuminoids of Standardized Extract to Improve Curcumin Dissolution and Relative Bioavailability
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Holder, G. M., Plummer, J. L. and Ryan, A. J. 1978, The metabolism and excretion of curcumin (1,7-bis-(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione) in the rat. *Xenobiotica,* **8,** 761-8.

Hu, L., Jia, Y., Niu, F., Jia, Z., Yang, X. and Jiao, K. 2012, Preparation and enhancement of oral bioavailability of curcumin using microemulsion vehicle. *Journal of Agricultural and Food Chemistry*.

Hu, L., Shi, Y., Li, J. H., Gao, N., Ji, J., Niu, F.*, et al.* 2015, Enhancement of Oral Bioavailability of Curcumin by a Novel Solid Dispersion System. *AAPS PharmSciTech,* **25 March 2015,** DOI: 10.1208/s12249-014-0254-0.

ICH 2005, *ICH Harmonised tripartite guideline*, Geneva.

Ireson, C., Orr, S., Jones, D. J., Verschoyle, R., Lim, C. K., Luo, J. L.*, et al.* 2001, Characterization of metabolites of the chemopreventive agent curcumin in human and rat hepatocytes and in the rat in vivo, and evaluation of their ability to inhibit phorbol ester-induced prostaglandin E2 production. *Cancer Research,* **61,** 1058-64.

Ireson, C. R., Jones, D. J., Orr, S., Coughtrie, M. W., Boocock, D. J., Williams, M. L.*, et al.* 2002, Metabolism of the cancer chemopreventive agent curcumin in human and rat intestine. *Cancer Epidemiology, Biomarkers and Prevention,* **11,** 105-11.

Jamzad, S. and Fassihi, R. 2006, Role of surfactant and pH on dissolution properties of fenofibrate and glipizide—a technical note. *AAPS PharmSciTech,* **7,** E1-E6.

Janssens, S. and Van den Mooter, G. 2009, Review: physical chemistry of solid dispersions. *Journal of Pharmacy and Pharmacology,* **61,** 1571-1586.

Jayaprakasha, G. K., Rao, L. J. M. and Sakaraiah, K. K. 2002, Improved HPLC Method for the Determination of Curcumin, Demethoxycurcumin, and Bisdemethoxycurcumin. *Journal of Agricultural and Food Chemistry,* **50,** 3668-3672.

Jovanovic, S. V., Steenken, S., Boone, C. W. and Simic, M. G. 1999, H-Atom Transfer Is A Preferred Antioxidant Mechanism of Curcumin. *Journal of the American Chemical Society,* **121,** 9677-9681.

Kakkar, V., Singh, S., Singla, D., Sahwney, S., Chauhan, A. S., Singh, G.*, et al.* 2010, Pharmacokinetic applicability of a validated liquid chromatography tandem mass spectroscopy method for orally administered curcumin loaded solid lipid nanoparticles to rats. *Journal of Chromatography. B, Analytical Technologies in the Biomedical and Life Sciences,* **878,** 3427-31.

Kanai, M., Imaizumi, A., Otsuka, Y., Sasaki, H., Hashiguchi, M., Tsujiko, K.*, et al.* 2012, Dose-escalation and pharmacokinetic study of nanoparticle curcumin, a potential anticancer agent with improved bioavailability, in healthy human volunteers. *Cancer Chemotherapy and Pharmacology,* **69,** 65-70.

Kanai, M., Otsuka, Y., Otsuka, K., Sato, M., Nishimura, T., Mori, Y.*, et al.* 2013, A phase I study investigating the safety and pharmacokinetics of highly bioavailable curcumin (Theracurmin®) in cancer patients. *Cancer Chemotherapy and Pharmacology,* **71,** 1521-1530.

UNIVERSITAS GADJAH MADA
Development of Solid Dispersion Formulation Containing Curcumin and Curcuminoids of Standardized Extract to Improve Curcumin Dissolution and Relative Bioavailability
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Kanaze, F. I., Kokkalou, E., Niopas, I., Georgarakis, M., Stergiou, A. and Bikiaris, D. 2006, Thermal analysis study of flavonoid solid dispersions having enhanced solubility. *Journal of Thermal Analysis and Calorimetry,* **83,** 283-290.

Karavas, E., Georgarakis, E., Sigalas, M. P., Avgoustakis, K. and Bikiaris, D. 2007, Investigation of the release mechanism of a sparingly water-soluble drug from solid dispersions in hydrophilic carriers based on physical state of drug, particle size distribution and drug-polymer interactions. *European Journal of Pharmaceutics and Biopharmaceutics,* **66,** 334-347.

Khurana, A. and Ho, C.-T. 1988, High Performance Liquid Chromatographic Analysis of Curcuminoids and Their Photo-oxidative Decomposition Compounds in Curcuma Longa L. *Journal of Liquid Chromatography,* **11,** 2295-2304.

Kommuru, T. R., Gurley, B., Khan, M. A. and Reddy, I. K. 2001, Self-emulsifying drug delivery systems (SEDDS) of coenzyme Q10: formulation development and bioavailability assessment. *International Journal of Pharmaceutics,* **212,** 233-246.

Lao, C. D., Ruffin, M. T. t., Normolle, D., Heath, D. D., Murray, S. I., Bailey, J. M.*, et al.* 2006, Dose escalation of a curcuminoid formulation. *BMC Complementary and Alternative Medicine,* **6,** 10.

Lestari, M. L. A. D., Indrayanto, G. and Harry, G. B., 2014, Chapter Three - Curcumin. *Profiles of Drug Substances, Excipients and Related Methodology.* Academic Press.

Leuner, C. and Dressman, J. 2000, Improving drug solubility for oral delivery using solid dispersions. *European Journal of Pharmaceutics and Biopharmaceutics,* **50,** 47-60.

Li, H., Zhao, X., Ma, Y., Zhai, G., Li, L. and Lou, H. 2009a, Enhancement of gastrointestinal absorption of quercetin by solid lipid nanoparticles. *Journal of Controlled Release,* **133,** 238-244.

Li, J., Jiang, Y., Wen, J., Fan, G., Wu, Y. and Zhang, C. 2009b, A rapid and simple HPLC method for the determination of curcumin in rat plasma: assay development, validation and application to a pharmacokinetic study of curcumin liposome. *Biomedical Chromatography,* **23,** 1201-7.

Li, L., Braiteh, F. S. and Kurzrock, R. 2005, Liposome-encapsulated curcumin: in vitro and in vivo effects on proliferation, apoptosis, signaling, and angiogenesis. *Cancer,* **104,** 1322-31.

Li, R., Qiao, X., Li, Q., He, R., Ye, M., Xiang, C.*, et al.* 2011a, Metabolic and pharmacokinetic studies of curcumin, demethoxycurcumin and bisdemethoxycurcumin in mice tumor after intragastric administration of nanoparticle formulations by liquid chromatography coupled with tandem mass spectrometry. *Journal of Chromatography. B, Analytical Technologies in the Biomedical and Life Sciences,* **879,** 2751-8.

Li, S., Yuan, W., Deng, G., Wang, P., Yang, P. and Aggarwal, B. B. 2011b, Chemical Composition and Product Quality Control of Turmeric (*Curcuma longa* L.). *Pharmaceutical Crops,* **2,** 28-54.

Development of Solid Dispersion Formulation Containing Curcumin and Curcuminoids of Standardized
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Lipinski, C. A., Lombardo, F., Dominy, B. W. and Feeney, P. J. 2001, Experimental and computational approaches to estimate solubility and permeability in drug discovery and development settings. *Advance Drug Delivery Reviews,* **46,** 3-26.

Liu, A., Lou, H., Zhao, L. and Fan, P. 2006, Validated LC/MS/MS assay for curcumin and tetrahydrocurcumin in rat plasma and application to pharmacokinetic study of phospholipid complex of curcumin. *Journal of Pharmaceutical and Biomedical Analysis,* **40,** 720-727.

Ma, Z., Shayeganpour, A., Brocks, D. R., Lavasanifar, A. and Samuel, J. 2007, High-performance liquid chromatography analysis of curcumin in rat plasma: application to pharmacokinetics of polymeric micellar formulation of curcumin. *Biomedical Chromatography,* **21,** 546-552.

Mahady, G. B., Pendland, S. L., Yun, G. and Lu, Z. Z. 2002, Turmeric (Curcuma longa) and curcumin inhibit the growth of Helicobacter pylori, a group 1 carcinogen. *Anticancer Research,* **22,** 4179-81.

Marczylo, T. H., Steward, W. P. and Gescher, A. J. 2009, Rapid analysis of curcumin and curcumin metabolites in rat biomatrices using a novel ultraperformance liquid chromatography (UPLC) method. *Journal of Agricultural and Food Chemistry,* **57,** 797-803.

Marczylo, T. H., Verschoyle, R. D., Cooke, D. N., Morazzoni, P., Steward, W. P. and Gescher, A. J. 2007, Comparison of systemic availability of curcumin with that of curcumin formulated with phosphatidylcholine. *Cancer Chemotherapy and Pharmacology,* **60,** 171-7.

Marsac, P., Konno, H., Rumondor, A. and LSTaylor 2008, Recrystallization of nifedipine and felodipine from amorphous molecular level solid dispersions containing poly(vinylpyrrolidone) and sorbed water. *Pharmaceutical Research,* **25,** 647-656.

Martin, R. C., Aiyer, H. S., Malik, D. and Li, Y. 2012, Effect on pro-inflammatory and antioxidant genes and bioavailable distribution of whole turmeric vs curcumin: Similar root but different effects. *Food and Chemical Toxicology,* **50,** 227-31.

Martinez-Oharriz, M. C., Rodriguez-Espinosa, C., Martin, C., Goni, M. M., Tros-Ilarduya, M. C. and Sanchez, M. 2002, Solid dispersions of diflunisal-PVP: polymorphic and amorphous states of the drug. *Drug Development and Industrial Pharmacy,* **28,** 717-25.

Martono, S. 1996, Penentuan kadar kurkumin secara kromatografi lapis tipis-densitometri. *Buletin ISFI Yogyakarta,* **2,** 11-21.

Martono, S. 2005, Inhibitory potency of some methoxyphenyl derivatives compounds on class mu GST activity in vitro. *Majalah Farmasi Indonesia,* **16,** 45-50.

McClements, D. J. and Li, Y. 2010a, Review of in vitro digestion models for rapid screening of emulsion-based systems. *Food & Function,* **1,** 32-59.

McClements, D. J. and Li, Y. 2010b, Structured emulsion-based delivery systems: Controlling the digestion and release of lipophilic food components. *Advances in Colloid and Interface Science,* **159,** 213-228.

Development of Solid Dispersion Formulation Containing Curcumin and Curcuminoids of Standardized
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Menaa, F. 2015, Curcumin Nano-Sized Delivery Systems against Cancers: From Bench to Clinics. *Journal of Pharmaceutical Care & Health Systems,* **2,** e135 10.4172/2376-0419.1000e135.

Mihranyan, A. and Strømme, M. 2007, Solubility of fractal nanoparticles. *Surface Science,* **601,** 315-319.

Mosharraf, M. and Nyström, C. 1995, The effect of particle size and shape on the surface specific dissolution rate of microsized practically insoluble drugs. *International Journal of Pharmaceutics,* **122,** 35-47.

Mukerjee, A. and Vishwanatha, J. K. 2009, Formulation, characterization and evaluation of curcumin-loaded PLGA nanospheres for cancer therapy. *Anticancer Research,* **29,** 3867-75.

Nakamura, Y., Ohto, Y., Murakami, A., Osawa, T. and Ohigashi, H. 1998, Inhibitory effects of curcumin and tetrahydrocurcuminoids on the tumor promoter-induced reactive oxygen species generation in leukocytes in vitro and in vivo. *Japanese Journal of Cancer Research,* **89,** 361-70.

Noyes, A. A. and Whitney, W. R. 1897, The rate of solution of solid substances in their own solutions. *Journal of the American Chemical Society,* **19,** 930-934.

O'Neil, M. J. 2013 The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals*,* Cambridge UK, Royal Society of Chemistry, p. 474.

Okonogi, S. and Puttipipatkhachorn, S. 2006, Dissolution improvement of high drug-loaded solid dispersion. *AAPS PharmSciTech,* **7,** E52.

Onoue, S., Takahashi, H., Kawabata, Y., Seto, Y., Hatanaka, J., Timmermann, B.*, et al.* 2010, Formulation design and photochemical studies on nanocrystal solid dispersion of curcumin with improved oral bioavailability. *Journal of Pharmaceutical Sciences,* **99,** 1871-81.

Osawa, T., Sugiyama, Y., Inayoshi, M. and Kawakishi, S. 1995, Antioxidative activity of tetrahydrocurcuminoids. *Bioscience, Biotechnology, and Biochemistry,* **59,** 1609-12.

Pak, Y., Patek, R. and Mayersohn, M. 2003, Sensitive and rapid isocratic liquid chromatography method for the quantitation of curcumin in plasma. *Journal of Chromatography B,* **796,** 339–346.

Pal, A., Sung, B., Bhanu Prasad, B. A., Schuber Jr, P. T., Prasad, S., Aggarwal, B. B.*, et al.* 2014, Curcumin glucuronides: Assessing the proliferative activity against human cell lines. *Bioorganic & Medicinal Chemistry,* **22,** 435-439.

Pan, M. H., Huang, T. M. and Lin, J. K. 1999, Biotransformation of curcumin through reduction and glucuronidation in mice. *Drug Metabolism and Disposition,* **27,** 486-94.

Pan, M. H., Lin-Shiau, S. Y. and Lin, J. K. 2000, Comparative studies on the suppression of nitric oxide synthase by curcumin and its hydrogenated metabolites through down-regulation of IkappaB kinase and NFkappaB activation in macrophages. *Biochemical Pharmacology,* **60,** 1665-76.

Paradkar, A., Ambike, A. A., Jadhav, B. K. and Mahadik, K. R. 2004, Characterization of curcumin-PVP solid dispersion obtained by spray drying. *International Journal of Pharmaceutics,* **271,** 281-286.

UNIVERSITAS GADJAH MADA
Development of Solid Dispersion Formulation Containing Curcumin and Curcuminoids of Standardized Extract to Improve Curcumin Dissolution and Relative Bioavailability
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Parasuraman, S., Raveendran, R. and Kesavan, R. 2010, Blood sample collection in small laboratory animals. *Journal of Pharmacology & Pharmacotherapeutics,* **1,** 87-93.

Park, J. H. and Choi, H. K. 2015, Enhancement of solubility and dissolution of cilostazol by solid dispersion technique. *Archives of Pharmacal Research,* **38,** 1336-44.

Patil, B. S., Jayaprakasha, G. K., Chidambara Murthy, K. N. and Vikram, A. 2009, Bioactive Compounds: Historical Perspectives, Opportunities, and Challenges. *Journal of Agricultural and Food Chemistry,* **57,** 8142-8160.

Paudel, A., Worku, Z. A., Meeus, J., Guns, S. and Van den Mooter, G. 2012, Manufacturing of solid dispersions of poorly water soluble drugs by spray drying: formulation and process considerations. *International Journal of Pharmaceutics,* **453,** 253-84.

Payton, F., Sandusky, P. and Alworth, W. L. 2007, NMR Study of the Solution Structure of Curcumin. *Journal of Natural Products,* **70,** 143-146.

Pisal, S., Wawde, G., Salvankar, S., Lade, S. and Kadam, S. 2006, Vacuum foam drying for preservation of LaSota virus: effect of additives. *AAPS PharmSciTech,* **7,** 60.

Prabhu, S., Brocks, D. R. and Betageri, G. V. 2001, Enhancement of dissolution of ethopropazine using solid dispersions prepared with phospholipid and/or polyethylene glycol. *Drug Development and Industrial Pharmacy,* **27,** 413-8.

Rachmawati, H., Shaal, L. A., Müller, R. H. and Keck, C. M. 2012, Development of curcumin nanocrystal: Physical aspects. *Journal of Pharmaceutical Sciences,* **102,** 204-214.

Ramsewak, R. S., DeWitt, D. L. and Nair, M. G. 2000, Cytotoxicity, antioxidant and anti-inflammatory activities of curcumins I-III from *Curcuma longa*. *Phytomedicine,* **7,** 303-8.

Ramshankar, Y. V., Suresh, S., Pandit, V. and Puranik, S. B. 2009, Reverse phase high performance liquid chromatographic method for the estimation of curcumin. *Oriental Journal of Chemistry,* **25,** 105-110.

Rashmin, P., Mrunali, P., Nitin, D., Nidhi, D. and Bharat, P. 2012, HPTLC method development and validation: strategy to minimize methodological failures. *Journal of Food and Drug Analysis,* **20,** 794-804.

Riswan, S. and Sangat-Roemantyo, H. 2002, Jamu as traditional medicine in Java, Indonesia. *South Pacific Study,* **23,** 1-10.

Rowe, R. C., Sheskey, P. J., Cook, W. G. and Fenton, M. E. 2012 Handbook of Pharmaceutical Excipients*,* London, Pharmaceutical Press.

Rumondor, A., Marsac, P., Stanford, L. and Taylor, L. 2009, Phase behavior of poly(vinylpyrrolidone) containing amorphous solid dispersions in the presence of moisture. *Molecular Pharmaceutics,* **6,** 1492-1505.

The Royal Society of Chemistry 2011, New polymorphs of curcumin, *Electronic Supplementary Information*,

Sasaki, H., Sunagawa, Y., Takahashi, K., Imaizumi, A., Fukuda, H., Hashimoto, T.*, et al.* 2011, Innovative preparation of curcumin for improved oral bioavailability. *Biological & Pharmaceutical Bulletin,* **34,** 660-5.

UNIVERSITAS GADJAH MADA
Development of Solid Dispersion Formulation Containing Curcumin and Curcuminoids of Standardized Extract to Improve Curcumin Dissolution and Relative Bioavailability
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Schiborr, C., Eckert, G. P., Rimbach, G. and Frank, J. 2010, A validated method for the quantification of curcumin in plasma and brain tissue by fast narrow-bore high-performance liquid chromatography with fluorescence detection. *Analytical and Bioanalytical Chemistry,* **397,** 1917-1925 DOI 10.1007/s00216-010-3719-3.

Seo, S. W., Han, H. K., Chun, M. K. and Choi, H. K. 2012, Preparation and pharmacokinetic evaluation of curcumin solid dispersion using Solutol(R) HS15 as a carrier. *International Journal of Pharmaceutics,* **424,** 18-25.

Serajuddin, A. T. 1999, Solid dispersion of poorly water-soluble drugs: early promises, subsequent problems, and recent breakthroughs. *Journal of Pharmaceutical Sciences,* **88,** 1058-66.

Sethia, S. and Squillante, E. 2004, Solid dispersion of carbamazepine in PVP K30 by conventional solvent evaporation and supercritical methods. *International Journal of Pharmaceutics,* **272,** 1-10.

Setyaningsih, D., Radifar, M., Murti, Y. B. and Istyastono, E. P. 2013, Construction of In Silico Structure-Based Screening Tools to Study the Oxidative Metabolites Formation of Curcumin by Human Cytochrom 450 3A4. *Indonesian Journal of Pharmacy,* **24,** 75-85.

Shah, V., Konecny, J., Everett, R., McCullough, B., Noorizadeh, A. and Skelly, J. 1989, In vitro dissolution profile of water-insoluble drug dosage forms in the presence of surfactants. *Pharmaceutical Reserach,* **6,** 612-618.

Shaikh, J., Ankola, D. D., Beniwal, V., Singh, D. and Kumar, M. N. 2009, Nanoparticle encapsulation improves oral bioavailability of curcumin by at least 9-fold when compared to curcumin administered with piperine as absorption enhancer. *European Journal of Pharmaceutical Sciences,* **37,** 223-30.

Sharma, O. P. 1976, Antioxidant activity of curcumin and related compounds. *Biochemical Pharmacology,* **25,** 1811-1812.

Shehzad, A., Wahid, F. and Lee, Y. S. 2010, Curcumin in cancer chemoprevention: molecular targets, pharmacokinetics, bioavailability, and clinical trials. *Archiv der Pharmazie (Weinheim),* **343,** 489-99.

Shimadzu 2009, *Shimadzu instrument manual & maintenance manual in safety intructions,* Kyoto, Shimadzu Corporation Analytical and Measuring Instruments Division.

Shoba, G., Joy, D., Joseph, T., Majeed, M., Rajendran, R. and Srinivas, P. S. 1998, Influence of Piperine on the Parmacokinetics of Curcumin in Animals and Human Volunteers. *Planta Medica,* **64,** 353-6.

Shoji, M., Nakagawa, K., Watanabe, A., Tsuduki, T., Yamada, T., Kuwahara, S., *et al.* 2014, Comparison of the effects of curcumin and curcumin glucuronide in human hepatocellular carcinoma HepG2 cells. *Food Chemistry,* **151,** 126-132.

Siewert, M., Dressman, J., Brown, C. and Shah, V. 2003, FIP/AAPS guidelines for dissolution/in vitro release testing of novel/special dosage forms. *Dissolution Technologies.*

Singh, S. P., Wahajuddin and Jain, G. K. 2012, Determination of curcumin in rat plasma by liquid–liquid extraction using LC–MS/MS with electrospray

UNIVERSITAS GADJAH MADA
Development of Solid Dispersion Formulation Containing Curcumin and Curcuminoids of Standardized Extract to Improve Curcumin Dissolution and Relative Bioavailability
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

ionization: assay development, validation and application to a pharmacokinetic study. *Journal of Bioanalysis & Biomedicine,* **2,** 079-084. doi:10.4172/1948-593X.1000027

Snyder, L. R., Kirkland, J. J. and Glajch, J. L. 1997 Non-ionic samples: reversed- and normal-phase HPLC*, Practical HPLC method vevelopment*, John Wiley & Sons, Inc.

Spangenberg, B., Poole, C. F. and Weins, C. 2010, *Quantitatif thin-layer chromatography: A practical survay,* Heidelberg, Dordrecht, London, New York, Springer.

Srinarong, P., de Waard, H., Frijlink, H. W. and Hinrichs, W. L. 2011, Improved Dissolution Behavior of Lipophilic Drugs by Solid Dispersions: the Production Process as Starting Point for Formulation Considerations. *Expert Opinion on Drug Delivery,* **8,** 1121-40.

Srinarong, P., Faber, J. H., Visser, M. R., Hinrichs, W. L. J. and Frijlink, H. W. 2009a, Strongly enhanced dissolution rate of fenofibrate solid dispersion tablets by incorporation of superdisintegrants. *European Journal of Pharmaceutics and Biopharmaceutics,* **73,** 154-161.

Srinarong, P., Kouwen, S., Visser, M. R., Hinrichs, W. L. and Frijlink, H. W. 2009b, Effect of drug-carrier interaction on the dissolution behavior of solid dispersion tablets. *Pharmaceutical Development and Technology,* **15,** 460-8.

Stankovic, I. 2004, Curcumin chemical and technical assessment (CTA) 61st JECFA, Food and Agriculture Organization of the United Nations

Sugiyama, T., Nagata, J., Yamagishi, A., Endoh, K., Saito, M., Yamada, K.*, et al.* 2006, Selective protection of curcumin against carbon tetrachloride-induced inactivation of hepatic cytochrome P450 isozymes in rats. *Life Sciences,* **78,** 2188-93.

Sugiyama, Y., Kawakishi, S. and Osawa, T. 1996, Involvement of the beta-diketone moiety in the antioxidative mechanism of tetrahydrocurcumin. *Biochemical Pharmacology,* **52,** 519-25.

Supardjan, A. M. 2001, Chemical Content of Turmeric, Curcumin, and Its Derivatives. *Majalah Farmasi Indonesia,* **12,** 115-119.

Tamvakopoulos, C., Sofianos, Z. D., Garbis, S. D. and Pantazis, P. 2007, Analysis of the in vitro metabolites of diferuloylmethane (curcumin) by liquid chromatography--tandem mass spectrometry on a hybrid quadrupole linear ion trap system: newly identified metabolites. *European Journal of Drug Metabolism and Pharmacokinetics,* **32,** 51-7.

Taylor, L. and Zografi, G. 1997, Spectroscopic Characterization of Interactions Between PVP and Indomethacin in Amorphous Molecular Dispersions. *Pharmaceutical Research,* **14,** 1691-1698.

Teixeira, C. C. C., MendonÃ§a, L. M., Bergamaschi, M. M., Queiroz, R. H. C., Souza, G. E. P., Antunes, L. M. G.*, et al.* 2015, Microparticles Containing Curcumin Solid Dispersion: Stability, Bioavailability and Anti-Inflammatory Activity. *AAPS PharmSciTech***,** 1-10.

Development of Solid Dispersion Formulation Containing Curcumin and Curcuminoids of Standardized
Extract to Improve Curcumin Dissolution and Relative Bioavailability
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Ting, Y., Jiang, Y., Ho, C.-T. and Huang, Q. 2014, Common delivery systems for enhancing in vivo bioavailability and biological efficacy of nutraceuticals. *Journal of Functional Foods,* **7,** 112-128.

Tiyaboonchai, W., Tungpradit, W. and Plianbangchang, P. 2007, Formulation and characterization of curcuminoids loaded solid lipid nanoparticles. *International Journal of Pharmaceutics,* **337,** 299-306.

Tonnesen, H. 2002a, Solubility, chemical, and photochemical stability of curcumin in surfactant solutions. Studies of curcumin and curcuminoids, XXVIII. *Pharmazie,* **57,** 820-824.

Tonnesen, H. and Karlsen, J. 1985a, Studies on curcumin and curcuminoids VI. Kinetics of curcumin degradation in aqueous solution. *Zeitschrift fur Lebensmittel-Untersuchung und -Forschung,* **180,** 402-404.

Tonnesen, H. and Karlsen, J. 1986, Studies on curcumin and curcuminoids VII. Chromatographic separation and quantitative analysis of curcumin and related compounds. *Zeitschrift fur Lebensmittel-Untersuchung und -Forschung,* **182,** 215-218.

Tonnesen, H. H. 2002b, Solubility, chemical and photochemical stability of curcumin in surfactant solutions. Studies of curcumin and curcuminoids, XXVIII. *Pharmazie,* **57,** 820-4.

Tonnesen, H. H. and Karlsen, J. 1985b, Studies of curcumin and curcuminoids V. Alkaline degradation of curcumin. *Zeitschrift fur Lebensmittel-Untersuchung und -Forschung,* **180,** 132-134.

Tonnesen, H. H., Karlsen, J. and van Henegouwen, G. B. 1986, Studies on curcumin and curcuminoids. VIII. Photochemical stability of curcumin. *Zeitschrift fur Lebensmittel-Untersuchung und -Forschung,* **183,** 116-22.

Tonnesen, H. H., Masson, M. and Loftsson, T. 2002, Studies of curcumin and curcuminoids. XXVII. Cyclodextrin complexation: solubility, chemical and photochemical stability. *International Journal of Pharmaceutics,* **244,** 127-35.

USP, 2009, <621> Chromatography. *USP Pharmacists' pharmacopeia.* Rockville, U.S Pharmacopeia.

USP, 2011, General chapter <1092> The Dissolution Procedure: Development and Validation. *The dissolution procedure: development and validation.* Rockville, The United State Pharmacopeal Convention, Inc. .

Van den Mooter, G., Augustijns, P., Blaton, N. and Kinget, R. 1998, Physico-chemical characterization of solid dispersions of temazepam with polyethylene glycol 6000 and PVP K30. *International Journal of Pharmaceutics,* **164,** 67-80.

Van Drooge, D. J., Hinrichs, W. L., Dickhoff, B. H., Elli, M. N., Visser, M. R., Zijlstra, G. S., *et al.* 2005, Spray freeze drying to produce a stable Delta(9)-tetrahydrocannabinol containing inulin-based solid dispersion powder suitable for inhalation. *European Journal of Pharmaceutical Sciences,* **26,** 231-40.

Van Drooge, D. J., Hinrichs, W. L. and Frijlink, H. W. 2004a, Anomalous dissolution behaviour of tablets prepared from sugar glass-based solid dispersions. *Journal of Controlled Release,* **97,** 441-52.

UNIVERSITAS GADJAH MADA
Development of Solid Dispersion Formulation Containing Curcumin and Curcuminoids of Standardized Extract to Improve Curcumin Dissolution and Relative Bioavailability
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Van Drooge, D. J., Hinrichs, W. L. and Frijlink, H. W. 2004b, Incorporation of lipophilic drugs in sugar glasses by lyophilization using a mixture of water and tertiary butyl alcohol as solvent. *Journal of Pharmaceutical Sciences,* **93,** 713-25.

Van Drooge, D. J., Hinrichs, W. L., Visser, M. R. and Frijlink, H. W. 2006, Characterization of the molecular distribution of drugs in glassy solid dispersions at the nano-meter scale, using differential scanning calorimetry and gravimetric water vapour sorption techniques. *International Journal of Pharmaceutics,* **310,** 220-9.

van Drooge, D. J., Hinrichs, W. L. J. and Frijlink, H. W. 2004c, Anomalous dissolution behaviour of tablets prepared from sugar glass-based solid dispersions. *Journal of Controlled Release,* **97,** 441-452.

Vasconcelos, T. f., Sarmento, B. and Costa, P. 2007, Solid dispersions as strategy to improve oral bioavailability of poor water soluble drugs. *Drug Discovery Today,* **12,** 1068-1075.

Vijaya Kumar, S. G. and Mishra, D. N. 2006, Preparation and evaluation of solid dispersion of meloxicam with skimmed milk. *Yakugaku Zasshi,* **126,** 93-7.

Volak, L. P., Ghirmai, S., Cashman, J. R. and Court, M. H. 2008, Curcuminoids inhibit multiple human cytochromes P450, UDP-glucuronosyltransferase, and sulfotransferase enzymes, whereas piperine is a relatively selective CYP3A4 inhibitor. *Drug Metabolism and Disposition,* **36,** 1594-605.

Wahlang, B., Pawar, Y. B. and Bansal, A. K. 2011, Identification of permeability-related hurdles in oral delivery of curcumin using the Caco-2 cell model. *European Journal of Pharmaceutics and Biopharmaceutics,* **77,** 275-282.

Wahlström, B. and Blennow, G. 1978, A study on the fate of curcumin in the rat. *Acta Pharmacologica et Toxicologica,* **43,** 86-92.

Wan, S., Sun, Y., Qi, X. and Tan, F. 2012, Improved bioavailability of poorly water-soluble drug curcumin in cellulose acetate solid dispersion. *AAPS PharmSciTech.,* **13,** 159-66.

Wang, X.-M., Zhang, Q.-Z., Yang, J., Zhu, R.-H., Zhang, J., Cai, L.-J.*, et al.* 2012, Validated HPLC–MS/MS method for simultaneous determination of curcumin and piperine in human plasma. *Tropical Journal of Pharmaceutical Research,* **11,** 621-629.

Wang, Y. J., Pan, M. H., Cheng, A. L., Lin, L. I., Ho, Y. S., Hsieh, C. Y.*, et al.* 1997, Stability of curcumin in buffer solutions and characterization of its degradation products. *Journal of Pharmaceutical and Biomedical Analysis,* **15,** 1867-76.

Wu, K., Li, J., Wang, W. and Winstead, D. A. 2009, Formation and characterization of solid dispersions of piroxicam and polyvinylpyrrolidone using spray drying and precipitation with compressed antisolvent. *Journal of Pharmaceutical Sciences,* **98,** 2422-2431.

Xu, D.-H., Wang, S., Jin, J., Mei, X.-T. and Xu, S.-B. 2006, Dissolution and absorption researches of curcumin in solid dispersions with the polymers PVP. *Asian Journal of Pharmacodynamics and Pharmacokinetics,* **6,** 343-349.

Development of Solid Dispersion Formulation Containing Curcumin and Curcuminoids of Standardized
Extract to Improve Curcumin Dissolution and Relative Bioavailability
DEWI SETYANINGSIH, Prof. Dr. Achmad Fudholi, DEA., Apt, Dr. rer.nat Triana Hertiani, M.Si.,Apt, Dr. W.L.J Hinrich
Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Yadav, V. R., Suresh, S., Devi, K. and Yadav, S. 2009, Novel formulation of solid lipid microparticles of curcumin for anti-angiogenic and anti-inflammatory activity for optimization of therapy of inflammatory bowel disease. *Journal of Pharmacy and Pharmacology,* **61,** 311-21.

Yallapu, M. M., Ebeling, M. C., Chauhan, N., Jaggi, M. and Chauhan, S. C. 2011, Interaction of curcumin nanoformulations with human plasma proteins and erythrocytes. *International Journal of Nanomedicine,* **6,** 2779-2790. http:dx.doi.org/10.2147/IJN.S25534.

Yallapu, M. M., Jaggi, M. and Chauhan, S. C. 2012, Curcumin nanoformulations: a future nanomedicine for cancer. *Drug Discovery Today,* **17,** 71-80.

Yu, H. and Huang, Q. 2011, Investigation of the Absorption Mechanism of Solubilized Curcumin Using Caco-2 Cell Monolayers. *Journal of Agricultural and Food Chemistry,* **59,** 9120-9126.

Zajc, N., Obreza, A., Bele, M. and SrÄ iÄ , S. 2005, Physical properties and dissolution behaviour of nifedipine/mannitol solid dispersions prepared by hot melt method. *International Journal of Pharmaceutics,* **291,** 51-58.

Zhang, W., Tan, T. M. and Lim, L. Y. 2007, Impact of curcumin-induced changes in P-glycoprotein and CYP3A expression on the pharmacokinetics of peroral celiprolol and midazolam in rats. *Drug Metabolism and Disposition,* **35,** 110-5.

Zhanga, Y., Huoa, M., Zhoua, J. and Xieb, S. 2010, PKSolver: An add-in program for pharmacokinetic and pharmacodynamic data analysis in Microsoft Excel. *Computer Methods and Programs in Biomedicine,* **99,** 306-314.

Zhou, D., Zhang, G., Law, D., Grant, D. and Schmitt, E. 2002, Physical stability of amorphous pharmaceuticals: importance of configurational thermodynamic quantities and molecular mobility. *Journal of Pharmaceutical Sciences,* **91,** 1863-1872.