



REFERENCES

- Aiba, S. and Izume, M. (1988) reprinted from the "Bulletin of Industrial products Research Institute" No. 111, June.
- Aiba, S. (1992) Studies on chitosan: 4. Lysozyme hydrolysis of partially *N*-acetylated chitosans. International Journal of Biological Macromolecules, 14, 225-228.
- Aiba, S. (1993) Studies on chitosan: 6. Relationship between *N*-acetyl group distribution pattern and chitinase digestibility of partially *N*-acetylated chitosans. International Journal of Biological Macromolecules, 15, 241-245.
- Aiba, S.I. (1994a) Preparation of *N*-acetylchitooligosaccharides from lysozymic hydrolysates of partially *N*-acetylated chitosans. Carbohydrate Research, 261, 297-306.
- Aiba, S.I. (1994b) Preparation of *N*-acetylchitooligosaccharides by hydrolysis of chitosan with chitinase followed by *N*-acetylation. Carbohydrate Research, 265, 323-328.
- Akashi, M., Niikawa, T., Serizawa, T., Hayakawa, T., and Baba, M. (1998) Capture of HIV-1 gp120 and virions by lectin-immobilized polystyrene nanospheres. Bioconjugate Chemistry, 9, 50-53.
- Allan, G.G. and Peyron, M. (1995a) Molecular weight manipulation of chitosan I: kinetics of depolymerization by nitrous acid. Carbohydrate Research, 277(2), 257-272.
- Allan, G.G. and Peyron, M. (1995b) Molecular weight manipulation of chitosan II: prediction and control of extent of depolymerization by nitrous acid. Carbohydrate Research, 277, 273-282.
- Andrady, A.L., Torikai, A., and Kobatake, T. (1996) Spectral sensitivity of chitosan photodegradation. Journal of Applied Polymer Science, 62, 1465-1471.
- Belamie, E., Domard, A., and Giraud-guille, M.M. (1997) Study of the solid state hydrolysis of chitosan in presence of HCl. Journal of Polymer Science: Part A: Polymer Chemistry, 35, 3181-3191.
- Bianchi, E., Marsano, E., Tacchino, A. (1997) Thermoreversible gels of chitin. Carbohydrate Polymers, 32, 23-26.

- Bittelli, M., Flury, M., Campbell, G.S., and Nichols, E.J. (2001) Reduction of transpiration through foliar application of chitosan. Agricultural and Forest Meteorology, 107, 167-175.
- Bodmeier, R., Chen, H., and Paeratakul, O. (1989a) A novel approach to the oral delivery of micro- or nanoparticles. Pharmacological Research, 6(5), 413-417.
- Bodmeier, R., Oh, K.H., Pramart, Y. (1989b) Preparation and evaluation of drug-containing chitosan beads. Drug Development and Industrial Pharmacy, 15 (9), 1475-1494.
- Calvo, P., Remunan-Lopez, C., Vila-Jato, J.L., Alonso, M.J. (1997) Novel hydrophilic chitosan-polyethylene oxide nanoparticles as protein carriers. Journal of Applied Polymer Science, 63, 125-132.
- Calvo, P., Bougaba, A., Appel, M., Fattal, E., Alonso, M.J., Couvreur, P. (1998) Oligonucleotide-chitosan nanoparticles as new gene therapy vector. Proceedings of the second World Meeting APGI/APV 2, Paris, France, 1111-1112.
- Chandy, T. and Sharma, C.P. (1992) Chitosan beads and granules for oral sustained delivery of nifedipine: in vitro studies. Biomaterials, 13(13), 949-952.
- Chen R.H., Chang, J.R., and Shyr, J.S. (1997) Effects of ultrasonic conditions and storage in acidic solutions on changes in molecular weight and polydispersity of treated chitosan. Carbohydrate Research, 299, 287-294.
- Chirachanchai, S., Lertworasirikul, A., and Tachaboonyakiat, W. (2001) Carbaryl insecticide conjugation onto chitosan via iodo-chitosan and chitosan carbonyl imidazolide precursors. Carbohydrate Polymers, 46, 19-27.
- Damodaran S. (1996) Removing lipids from cheese whey using chitosan. Biotechnology Advances, 14(4), 596.
- Domard, A. and Cartier, N. (1989) Glucosamine oligomers: 1. Preparation and characterization. International Journal of Biological Macromolecules, 11(5), 297-302.
- Dumitriu, S., Popa, M.I., Cringiu, A., and Stratone, A. (1989) Bioactive polymers 61. Synthesis and characterization of some retard antibiotics. Colloid and Polymer Science, 267, 595-599.

- Hirano, S., Tobetto, K., and Noishiki, Y. (1980) Journal of Biomedical Materials Research, 14, 477-486.
- Fang, Y.E., Cheng, Q., and Lu, X.B. (1998) Kinetics of in vitro drug release from chitosan/gelatin hybrid membranes. Journal of Applied polymer Science, 68, 1751-1758.
- Fernandez-Urrusuno, R., Calvo, P., Remunan-Lopez, C., Vila-Jato, J.L., Alonso, M.J. (1999) Enhancement of nasal absorption of insulin using chitosan nanoparticles. Pharmacological Research, 16, 1576-1581.
- Fujii, S., Kumagai, H., Noda, M. (1980) Preparation of poly(acyl)chitosans. Carbohydrate Research, 83, 389.
- Hirano, S., Ohe, Y., Ono, H. (1976) Selective *N*-acylation of chitosan. Carbohydrate Research, 47, 315-320.
- Hirano, S. (1978) A facile method for the preparation of novel membranes from *N*-acetyl- and *N*-acrylidend-chitosan gels. Agricultural and Biological Chemistry, 42(10), 1939-1940.
- Horton, D. and Lineback, D.R. (1965) *N*-Deacetylation (book chapter). Methods in Carbohydrate Chemistry, 5, 403-406.
- Horton, D. and Just, E.K. (1973) Preparation from chitin of (1 \rightarrow 4)-2-amino-2-deoxy- β -D-glucopyranuronan and its 2-sulfoamino analog having blood-anticoagulant properties. Carbohydrate Research, 29, 173-179.
- Hsu, S.C., Don, T.M., Chiu, W.Y. (2002) Free radical degradation of chitosan with potassium persulfate. Polymer Degradation and Stability, 75, 73-83.
- Huang, C., Chen, S., and Pan, J.R. (2000) Optimal condition for modification of chitosan: a biopolymer for coagulation of colloidal particles. Water Research 34(3),1057-1062.
- Kabalnova, N.N., Murinov, K.Y., Mullagaliev, I.R., Krasnogorskaya, N.N., Shereshovets, V.V., Monakov, Y.B., and Zaikov, G.E. (2001) Oxidative destruction of chitosan under the effect of ozone and hydrogen peroxide. Journal of Applied Polymer Science, 81, 875-881.
- Kanke, M., Katayama, H., Tsuzuki, S., Kuramoto, H. (1989) Application of chitin and chitosan to pharmaceutical preparations. I. Film preparation and *in vitro* evaluation. Chemical & Pharmaceutical Bulletin, 37(2), 523-525.

- Kendra, D.F. and Hadwiger, L.A. (1984) Characterization of the smallest chitosan oligomer that is maximally antifungal to *Fusarium soloni* and elicits pisatin formation in *Pisum sativum*. Experimental Mycology, 8, 276.
- Koseva, N., Manolova, N., Markova, N., Radoucheva, T., and Rashkov, I. (1999) Chitosan gel beads as drug carriers 2. Release of 8-hydroxy-7-iodoquinoline-5-sulfonic acid and 2,5-dihydroxybenzenesulfonic acid. Polymer Bulletin, 43, 101-107.
- Kume, T. and Takehisa, M. In *Chitin and Chitosan*, Proceedings of the Second International Conference on Chitin and Chitosan, July 12-14, 1982, Sapporo, Japan,
- Kurita, K., Chikaoka, S., Kamiya, M., and Koyama, Y. (1988a) Bulletin of the Chemical Society of Japan, 61, 927-930.
- Kurita, K., Koyama, Y., and Chikaoka, S. (1988b) Studies on chitin X VI. Influence of controlled side chain introduction to chitosan on the adsorption of copper (II) ion. Polymer Journal, 20(12), 1083-1089.
- Kurita, K., Yoshino, H., Yokota, K., Ando, M., Inone, S., Ishii, S., and Nishimura, S.I. (1992) Preparation of tosylchitins as precursors for facile chemical modification of chitin. Macromolecules, 25, 3786-3790.
- Lee, K.Y., Kwon, I.C., Kim, Y.-H., Jo, W.H., Jeong, S.Y. (1998a) Preparation of chitosan self-aggregates as a gene delivery system. Journal of Controlled Release, 51, 213-220.
- Lee, K.Y., Kwon, I.C., Kim, Y.-H., Jo, W.H., Jeong, S.Y. (1998b) Structure investigation of chitosan self-aggregates prepared for gene delivery. Proceeding of International Symposium on Controlled Release of Bioactive Materials, 25, 340-341.
- Lee, M.Y., Var, F., Shin-ya, Y., Kajiuchi, T., and Yang, J.W. (1999) Optimum conditions for the precipitation of chitosan oligomers with DP 5-7 in concentrated hydrochloric acid at low temperature. Process Biochemistry, 34, 493-500.
- Lim, L.Y., Khor, E., and Koo, O. (1998) γ irradiation of chitosan. Journal of Biomedical Materials Research, 43(3), 282-290.

- Matsushashi, S. and Kume, T. (1997) Enhancement of antimicrobial activity of chitosan by irradiation. Journal of the Science of Food and Agriculture, 73, 237-241.
- Mi, F.L., Wong, T.B., Shyu, S.S., Chang, S.F. (1999) Chitosan microspheres : modification of polymeric chem-physical properties of spray-dried microspheres to control the release of antibiotic drug. Journal of Applied Polymer Science, 71, 747-759.
- Mi, F.L., Shyu, S.S., Chen, C.T., and Lai, J.Y. (2002) Adsorption of indomethacin onto chemically modified chitosan beads. Polymer, 43, 757-765.
- Muzzarelli, R.A.A. (1983) Chitin and its derivatives: new trends of applied research. Carbohydrate Polymers, 3, 53-75.
- Nishi, N., Maekita, Y., Nishimura, S.I., Hasegawa, O., and Tokura, S. (1987) Highly phosphorylated derivatives of chitin, partially deacetylated chitin and chitosan as new functional polymers: metal binding property of the insolubilized materials. International Journal of Biological Macromolecules, 9, 109-114.
- Nishimura, S. I., Kohgo, O., and Kurita, K. (1991) Chemospecific manipulations of a rigid polysaccharide synthesis of novel chitosan derivatives with excellent solubility in common organic solvents by regioselective chemical modifications. Macromolecules, 24, 4745-4748.
- Nordtveit, R.J., Varum, K.M., and Smidsrod, O. (1994) Degradation of fully water-soluble, partially *N*-acetylated chitosans with lysozyme. Carbohydrate Polymers, 23, 253-260.
- Ohya, Y., Inosaka, K., and Ouchi, T. (1992) Synthesis and antitumor activity of 6-O-carboxymethyl chitin fixing 5-fluorouracils through pentamethylene, monomethylene spacer groups via amide, ester bonds. Chemical & Pharmaceutical Bulletin, 40(2), 559-561.
- Ohya, Y., Nonomura, K., and Ouchi, T. (1995) Journal of Bioactive and Compatible Polymers, 10, 223-234.

- Ohya, Y., Cai, R., Nishizawa, H., Hara, K., Ouchi, T. (1999) Preparation of PEG-grafted chitosan nano-particle for peptide drug carrier. Proceeding of International Symposium on Controlled Release of Bioactive Materials, 26, 655-656.
- Ouchi, T., Nishizawa, H., and Ohya, Y. (1998) Aggregation phenomenon of PEG-grafted chitosan in aqueous solution. Polymer, 39(21), 5171-5175.
- Pellegrino, J.J., Geer, S., Maegley, K., Rivera, R., Steward, D., and Ko, M. (1990) Chitin/Chitosan Membranes: Amino Acid and Polypeptide Separations. Proceedings of Biochemical Eng VI, W. E. Goldstein, D. Dibiasio, and H. Pedersen, Ann. N.Y. Acad. Sci., Vol. 589.
- Richardson, S.C., Kolbe, H.V., and Duncan, R. (1999) Potential of low molecular mass chitosan as a DNA delivery system: biocompatibility, body distribution and ability to complex and protect DNA. International Journal of Pharmaceutics, 178(2), 231-243.
- Risbud, M.V. and Bhonde, R.R. (2000) Polyacrylamide-chitosan hydrogel: In vitro biocompatibility and sustained antibiotic release studies. Drug Delivery, 7(2), 69-75.
- Sakaguchi, T., Horikoshi, T., and Nakajima, A. (1981) Agricultural and Biological Chemistry, 45, 2191.
- Sashiwa, H. and Shigemas, Y. (1999) Chemical modification of chitin and chitosan 2: preparation and water soluble property of *N*-acylated or *N*-alkylated partially deacetylated chitins. Carbohydrate Polymers, 39, 127-138.
- Sawayanagi, Y., Numbu, N., and Nagai, T. (1982) Use of chitosan for sustained-release preparations of water-soluble drug. Chemical and Pharmaceutical Bulletin, 30(11), 4213-4215.
- Selmer-Olsen, E., Ratnaweera, H.C., and Pehrson, R. (1996) A novel treatment process for dairy wastewater with chitosan produced from shrimp-shell waste. Water Science and Technology, 34(11), 33-40.
- Sezer, A.D. and Akbuga, J. (1995) Controlled release of piroxicam from chitosan beads. International Journal of Pharmaceutics, 121, 113-116.
- Shan-Yang, L. and Ren-Ing, P. (1992) Chemical and Pharmaceutical Bulletin, 40(4), 1058-1060.

- Shimizu, Y., Kono, K., Kim, I.S., and Takagishi, T. (1995) Journal of Applied Polymer Science, 55, 255-261.
- Suntornsuk, W., Pochanavanich, P., and Suntornsuk, L. (2002) Fungal chitosan production on food processing by-products. Process Biochemistry, 37, 727-729.
- Suzuki, S., Watanabe, T., Mikami, T., and Suzuki, M. (1986) Chitin in Nature and Technology, Plenum Press, New York and London.
- Thanoo, B.C., Sunny, M.C., Jayakrishnan, A. (1992) Cross-linked chitosan microspheres: preparation and evaluation as a matrix for the controlled release of pharmaceuticals. Journal of Pharmacy and Pharmacology, 44, 283-286.
- Tokura, S., Nishimura, N., and Noguchi, J. (1979) Study on chitin III. Preparation of chitin fibers. Polymer Journal, 11(10), 781-786.
- Tomihata, K. and Ikada, Y. (1997) In vitro and in vivo degradation of films of chitin and its deacetylated derivatives. Biomaterials, 18, 567-575.
- Tsigos, I., Martinou, A., Kafetzopoulos, D., and Bouriotis, V. (2000) Chitin deacetylases: new, versatile tools in biotechnology. Trends in Biotechnology, 18(7), 305-312.
- Ulanski, P. and Rosiak, J. (1992) Preliminary studies on radiation-induced changes in chitosan. Radiation Physics and Chemistry, 39(1), 53-57.
- Uragami, T., Yoshida, F., Sugihara, M. (1983) Journal of Applied Polymer Science, 28, 1361-1370.
- Watanabe, K., Saiki, I., Uraki, Y., Tokura, S., and Azuma, I. (1990) 6-O-carboxy methyl chitin (CM chitin) as a drug carrier. Chemical & Pharmaceutical Bulletin, 38(2), 506-509.
- Wenwei, Z., Xiaoguang, Z., Li, Y., Yuefang, Z., and Jiaazhen, S. (1993) Some chemical changes in chitosan induced by γ -ray irradiation. Polymer Degradation and Stability, 41, 83-84.
- Williamson, K.L., Lanford, C.A., and Nicholson, C.R. (1964) Journal of American Chemical Society, 86, 762-765.
- Xu, J., McCarthy, S.P., and Gross, R.A. (1996) Chitosan film acylation and effects of biodegradability. Macromolecules, 29, 3436-3440.

- Yamamoto, H. and Amaike, M. (1997) Biodegradation of cross-linked chitosan gels by a microorganism. Macromolecules, 30(13), 3936-3937.
- Yang, Z., Yuan, Y., and Wang, Y. (2000) Synthesis and evaluation of chitosan aryl azacrown ethers as adsorbents for metal ions. Journal of Applied Polymer Science, 77, 3093-3098.
- Yao, K.D., Peng, T., Feng, H.B., and He, Y.Y. (1994) Swelling kinetics and release characteristic of crosslinked chitosan: polyether polymer network (semi-IPN) hydrogels. Journal of Polymer Science: Part A: Polymer Chemistry, 32, 1213-1223.

CURRICULUM VITAE

Name: Rangrong Yoksan

Date of Birth: 26 May 1976

Nationality: Thai

University Education:

1998-2000 Master Degree of Science in Polymer Science, The Petroleum and Petrochemical College, Chulalongkorn University, Bangkok, Thailand.

1994-1997 Bachelor Degree of Science in Chemistry, King Mongkut's University of Technology Thonburi, Bangkok, Thailand.

Award:

First Prize Micrograph Award; SEM Micrograph "Changing chitosan flake to nanosphere", The 20th Electron Microscopy Society of Thailand (EMST) Annual Conference, Bangkok, Thailand, January 29-31, 2003.

Publications:

1. Yoksan, R.; Akashi, M.; Biramontri, S.; Chirachanchai, S "Hydrophobic Chain Conjugation at Hydroxyl Group onto γ -Ray Irradiated Chitosan", *Biomacromolecules*, **2001**, *2*, 1038-1044.
2. Yoksan R.; Akashi, M.; Hiwatari, K.; Chirachanchai, S. "Controlled Hydrophobic/hydrophilicity of Chitosan for Spheres without Specific Processing Technique", *Biopolymers*, **2003**, *69*(3), 386-390.
3. Yoksan, R.; Matsusaki, M.; Akashi, M.; Chirachanchai, S "Controlled Hydrophobic/Hydrophilic Chitosan: Colloidal Phenomena and Nanosphere Formation" (Accepted in *Colloid and Polymer Science*, 2003).
4. Yoksan, R.; Akashi M.; Miyata, M; Biramontri, S.; Chirachanchai, S. "Practical γ -Ray Irradiation for Chitosan: An Approach to Control Molecular Weight" (Submitted in *Radiation Research*, May, 2003).



5. Yoksan, R.; Akashi M.; Chirachanchai, S. "Self-Assembly Nanosphere Induction via Controlled Structure Chitosan" (in preparation and to be submitted in *Macromolecules*, 2003)

Proceedings:

1. Yoksan, R.; Chirachanchai, S.; Akashi, M. "Introduction of Hydrophobic Chain onto Low Molecular Weight Chitosan Induced from γ -ray Irradiation", *8th International Chitin&Chitosan Conference (8th ICC) and 4th Asia Pacific Chitin&Chitosan Symposium (4th APCCS)*, Yamaguchi, Japan, September 21-23, 2000, 378-379.
2. Yoksan, R.; Biramontri, S.; Chirachanchai, S. "Structural Characterization of γ -Ray Irradiated Chitosan", *Proceedings of the 5th Asia Pacific Chitin and Chitosan Symposium&Exhibition*, Bangkok, Thailand, March 13-15, 2002, 180-184.
3. Yoksan, R.; Hiwatari, K.; Akashi, M.; Chirachanchai, S. "Controlled Sphere-like Chitosan from Balancing of Hydrophobic and Hydrophilic Chain Modification", *Proceedings of the 5th Asia Pacific Chitin-Chitosan Symposium&Exhibition*, Bangkok, Thailand, March 13-15, 2002, 368-372.
4. Yoksan, R.; Akashi, M.; Chirachanchai, S. "Changing Chitosan Powder to Micro/Nanospheres", *Journal of Electron Microscopy Society of Thailand 2003, 17(1)*, 93-94.

Poster Presentations:

1. Yoksan, R.; Chirachanchai, S.; Akashi, M. "Introduction of Hydrophobic Chain onto Low Molecular Weight Chitosan Induced from γ -ray Irradiation", *8th International Chitin&Chitosan Conference (8th ICC) and 4th Asia Pacific Chitin&Chitosan Symposium (4th APCCS)*, Yamaguchi, Japan, September 21-23, 2000.
2. Yoksan, R.; Akashi, M.; Hiwatari, K.; Chirachanchai, S. "Controlled Structure of Sphere-like Chitosan", *IUPAC Polymer Conference (IUPAC-PC2002)*, Kyoto, Japan, December 2-5, 2002.

3. Yoksan, R.; Biramontri, S.; Chirachanchai, S. "Practical γ -Ray Level for Low Molecular Weight Chitosan", *NU-TECH THAILAND 2003*, Bangkok, Thailand, June 19-21, 2003.
4. Yoksan, R.; Biramontri, S.; Akashi, M.; Chirachanchai, S. "Stability of Chitosan under γ -Ray Energy", *The National Chitin-Chitosan Conference*, Bangkok, Thailand, July 17-18, 2003.

Oral Presentation:

1. Chirachanchai, S.; Yoksan, R.; Biramontri, S.; Akashi, M. "Hydrophobic Chain Modification of Chitosan obtained from γ -Irradiation Process", *26th Congress on Science and Technology of Thailand: Division of Polymer Science and Technology*, Bangkok, Thailand, October 18-20, 2000.
2. Yoksan, R.; Chirachanchai, S.; Hiwatari, K. I.; Akashi, M. "Functionalization of Chitosan; an Approach for a Novel Nanospheres", *27th Congress on Science and Technology of Thailand: Division of Polymer Science and Technology*, Bangkok, Thailand, October 16-18, 2001.
3. Yoksan, R.; Chirachanchai, S. "Structural Characterization of γ -Ray Irradiated Chitosan", *5th Asia Pacific Chitin-Chitosan Symposium&Exhibition*, Bangkok, Thailand, March 13-15, 2002.
4. Yoksan, R.; Hiwatari, K.; Akashi, M.; Chirachanchai, S. "Controlled Sphere-like Chitosan from Balancing of Hydrophobic and Hydrophilic Chain Modification", *5th Asia Pacific Chitin-Chitosan Symposium&Exhibition*, Bangkok, Thailand, March 13-15, 2002.
5. Yoksan, R.; Biramontri, S.; Chirachanchai, S., "Effects of γ -Irradiation onto Chitosan in terms of Physical and Chemical Properties: A Guideline for Optimum Condition to obtain Irradiated Chitosan without Changing in Structure", *International Atomic Energy Agency*, Bangkok, Thailand, March 18-20, 2002.
6. Yoksan, R.; Akashi, M.; Chirachanchai, S. "Changing Chitosan Powder to Micro/Nanospheres", *The 20th Electron Microscopy Society of Thailand (EMST) Annual Conference*, Bangkok, Thailand, January 29-31, 2003.

7. Chirachanchai, S.; Yoksan, R.; Akashi, M. "Chitosan Spheres Water-Suspension: An Approach for Agricultural Applications", *The 1st International 21 Century COE Symposium on Integrated EcoChemistry*, Osaka, Japan, February 21-23, 2003.
8. Yoksan, R.; Matsusaki, M.; Akashi, M.; Chirachanchai, S. "Controlled Structure Chitosan Nanospheres", *The National Chitin-Chitosan Conference*, Bangkok, Thailand, July 17-18, 2003.
9. Yoksan, R.; Akashi, M.; Chirachanchai, S. " Colloidal Chitosan Spheres via Controlling of Hydrophobic/Hydrophilicity", *An International Conference on Advances in Petrochemicals and Polymers in the New Millennium*, Bangkok, Thailand, July 22-25, 2003.