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Antimicrobial compounds as side products from the agricultural processing industry

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References

- Ahmad, R., Ali, A.M., Israf, D.A., Ismail, N.H., Shaari, K. and Lajis, N.H. Antioxidant radical-scavenging, anti-inflammatory, cytotoxic and antibacterial activities of methanolic extracts of some *Hedyotis* species. **Life Sci.** 2005; 76: 1953-1964
- Ameri, A. The effect of Cannabinoids on the brain. **Progr. Neurol.** 1999; 58: 315-348
- Angulo, F.J., Baker, N.L., Olsen, S.J., Anderson, A. and Barrett, T.J. Antimicrobial use in agriculture: controlling the transfer of antimicrobial resistance to humans. **Semin. Pediatric Infect. Dis.** 2004; 15: 78-85
- Appendini P. and Hotchkiss J.H. Review of antimicrobial food packaging. **Innov. Food Sci. Emerg. Technol.** 2002; 3: 113-126
- Aquino, S., Ferreira, F., Ribeiro, D.H.B., Corrêa, B., Greiner, R. and Villavicencio, A.L.C.H. Evaluation of viability of *Aspergillus flavus* and aflatoxins degradation in irradiated samples of maize. **Braz. J. Microbiol.** 2005; 36: 352-356
- Bacon, J.S., Jones, D., Farmer, V.C. and Webley, D.M. The occurrence of alpha (1,3) glucan in *Cryptococcus*, *Saccharomyces* and *Polyporus* species, and its hydrolysis by a *Streptomyces* culture filtrate lysing cell walls of *Cryptococcus*. **Biochim. Biophys. Acta** 1968; 158: 313-315
- Baker, D., Pryce, G., Giovannoni, G. and Thompson, A.J. The therapeutic potential of cannabis. **Lancet Neurol.** 2003; 2: 291-298
- Bammert, G.F. and Fostel, J.M. Genome-wide expression patterns in *Saccharomyces cerevisiae*: comparison of drug treatments and genetic alterations affecting biosynthesis of ergosterol. **Antimicrob. Agents Ch.** 2000; 44: 1255-1265 In Kagen, I.A., Michel, A., Prause, A., Scheffler, B.E., Pace, P. and Duke, S.O. Gene transcription profiles of *Saccharomyces cerevisiae* after treatment with plant protection fungicides that inhibit ergosterol biosynthesis. **Pestic. Biochem. Phys.** 2005; 82: 133-153

References

- Barnes, K., Liang, J., Wu, R., Worley, S.D., Lee, J., Broughton, R.M. and Huang, T.S. Synthesis and antimicrobial applications of 5,5'- ethylenebis[5-methyl-3-(3-triethoxysilylpropyl)hydantoin]. **Biomaterials** 2006; 27: 4825-4830
- Barrett, D. From natural products to clinically useful antifungals. **Biochim. Biophys. Acta** 2002; 1587: 224-233
- Beauvais, A. and Latgé, J.P. Membrane and cell wall targets in *Aspergillus fumigatus*. **Drug Resist. Update.** 2001; 4: 38-49
- Bennett, J.W. and Lasure, L.L. More Gene Manipulations in Fungi. Academic Press, San Diego, USA, 1991: 441-447
- Beović, B. The issue of antimicrobial resistance in human medicine. **Int. J. Food Microbiol.** 2006; 112: 280-287
- Beuchet, P., Kihel, L.E., Dherbomez, M., Charles, G. and Letourneux, Y. Synthesis of 6(α , β)-aminocholestanols as ergosterol biosynthesis inhibitors. **Bioorg. Med. Chem. Lett.** 1998; 8: 3627-3630
- Bongaerts, R.J.M. The chorismate branching point in *Catharanthus roseus*: Aspects of anthranilate synthase regulation in relation to indole alkaloid biosynthesis. PhD thesis, Leiden University, the Netherlands, 1998: 117-132
- Boxall, A.B.A., Fogg, L.A., Kay, P., Blackwell, P.A. and Pemberton, E.J., Croxford, A. Prioritisation of veterinary medicines in the UK environment. **Toxicol. lett.** 2003; 142: 207-218
- Bull, A.T. Chemical composition of wild-type and mutant *Aspergillus nidulans* cell walls. The nutrient of polysaccharide and melanin constituents. **J. Gen. Microbiol.** 1970; 63: 75-94
- Burt, S.A. Essential oils: their antibacterial properties and potential applications in foods: a review. **Int. J. Food Microbiol.** 2004; 94: 223-253

- Camporese, A., Balick, M.J., Arvigo, R., Esposito, R.G., Morsellino, N., Simone, F.D. and Tubaro, A. Screening of anti-bacterial activity of medicinal plants from Belize (Central America). **J. Ethnopharmacol.** 2003; 87: 103-107
- Carpenter, C.F. and Chambers H.F. Daptomycin: another novel agent for treating infections due to drug-resistant gram-positive pathogens. **Rev. Anti-Infect. Agents** 2004; 38: 994-1000
- Chen, C.R., Malik, M., Snyder, M. and Drlica, K. DNA gyrase and topoisomerase IV on the bacterial chromosome: quinolone-induced DNA cleavage. **J. Mol. Biol.** 1996; 258: 627-637
- Chen, S.K., Eedwards, C.A. and Subler, S. Effects of the fungicides benomyl, captan and chlorothalonil on soil microbial activity and nitrogen dynamics in laboratory incubations. **Soil Biol. Biochem.** 2001; 33: 1971-1980
- Choi, H.Y., Hazekamp, A., Peltenburg-Looman, A.M., Frederich, M., Erkelens, C., Lefeber, A.W. and Verpoorte, R. NMR assignments of the major cannabinoids and cannabiflavonoids isolated from flowers of *Cannabis sativa*. **Phytochem. Anal.** 2004; 15: 345-354
- Chomnawang, M.T., Surassmo, S., Nukoolkarn, V.S. and Gritsanapan, W. Antimicrobial effects of Thai medicinal plants against acne-inducing bacteria. **J. Ethnopharmacol.** 2005; 101: 330-333
- Chung, S.K., Ryoo, C.H., Yang, H.W., Shim, J.Y., Kang, M.G., Lee, K.W. and Kang, H.I. Synthesis and bioactivities of steroid derivatives as antifungal agents. **Tetrahedron** 1998; 54:15899-15914
- Chung, S.K., Lee, K.W., Kang, H.I., Yamashita, C., Kudo, M. and Yoshida, Y. Design and synthesis of potential inhibitors of the ergosterol biosynthesis as antifungal agents. **Bioorg. Med. Chem.** 2000; 8: 2475-2486

References

- Codling, C.E., Hamm, A.C., Maillard, J.Y. and Russell, A.D. An investigation into the antimicrobial mechanisms of action of two contact lens biocides using electron microscopy. **Cont. Lens Anterior Eye** 2005; 28: 163-168
- Cohen, R., Suzuki, M.R. and Hammel, K.E. Processive endoglucanase active in crystalline cellulose hydrolysis by the brown rot basidiomycete *Gloeophyllum trabeum*. **Appl. Environ. Microbiol.** 2005; 71: 2412-2417
- Cos, P., Hermans, N., Bruyne, T.D., Apers, S., Sindambiwe, J.B., Vanden Berghe, D., Pieters, L. and Vlietinck, A.J. Further evaluation of Rwandan medicinal plant extracts for their antimicrobial and antiviral activities. **J. Ethnopharmacol.** 2002; 79: 155-163
- Cos, P., Vlietinck, A.J., Berghe, D.V. and Maes, L. Anti-infective potential of natural products: How to develop a stronger in vitro 'proof-of-concept'. **J. Ethnopharmacol.** 2006; 106: 290-302
- Criquet, S. Measurement and characterization of cellulase activity in sclerophyllous forest litter. **J. Microbiol. Meth.** 2002; 50: 165-173
- Dadalioglu, I. and Evrendilek, G. Chemical compositions and antibacterial effects of essential oils of Turkish oregano (*Origanum minutiflorum*), bay laurel (*Laurus nobilis*), Spanish lavender (*Lavandula stoechas* L.) and fennel (*Foeniculum vulgare*) on common foodborne pathogens. **J. Agr. Food Chem.** 2004; 52: 8255-8260
- Damveld, R.A., vanKuyk, P.A., Arentshorst, M., Klis, F.M., van der Hondel, C.A.M.J.J. and Ram, A.F.J. Expression of *ag sA*, one of five 1,3- α -D-glucanase synthase-encoding genes in *Aspergillus niger*, is induced in response to cell wall stress. **Fungal Genet. Biol.** 2005; 42: 165-177
- Daum, N., Lees, D., Bard, M. and Dickson, R. Biochemistry, cell biology, and molecular biology of lipids of *Saccharomyces cerevisiae*. **Yeast** 1998; 14: 1471-1510

- Defrancesco, K.A., Cobbold, R.N., Rice, D.H., Besser, T.E. and Hancock, D.D. Antimicrobial resistance of commensal *Escherichia coli* from dairy cattle associated with recent multi-resistant salmonellosis outbreaks. **Vet. Microbiol.** 2004; 98: 55-61
- Dhillon, A., Gupta, J.K. and Khanna, S. Enhanced production, purification and characterization of a novel cellulase-poor thermostable, alkalitolerant xylanase from *Bacillus circulans* AB 16. **Process Biochem.** 2000; 35: 849-856
- Dorman, H.J.D. and Deans, S.G. Antimicrobial agents from plants: antimicrobial activity of plant volatile oils. **J. Appl. Microbiol.** 2000; 88: 308-316
- Drlica, K. and Zhao, X. DNA gyrase, topoisomerase IV, and the 4-quinolones. **Microbiol. Mol. Biol. R.** 1997; 61: 377-392
- Dubey, N.K., Tripathi, P. and Singh, H.B. Prospects of some essential oils as antifungal agents. **J. Med. Arom. Plant Sci.** 2000; 350-354
- Eldeen, I.M.S., Elgorashi, E.E. and van Staden, J. Antimicrobial, anti-inflammatory, anti-cholinesterase and mutagenic effects of extracts obtained from some trees used in South African traditional medicine. **J. Ethnopharmacol.** 2005; 102: 457-464
- Fabricant, D.S. and Farnsworth, N.R. The value of Plants Used in Traditional Medicine for Drug Discovery. **Environ. Health Persp.** 2001; 109: 69-75
- Fazeli, M.R., Amin, G., Attari, M.M.A., Ashtiani, H., Jamalifar, H. and Samadi, N. Antimicrobial activities of Iranian sumac and avishan-e shirazi (*Zataria multiflora*) against some food-borne bacteria. **Food Control** 2007; 18: 646-649
- Foster, S. Herbs for your Health. Interwave Press, Loveland, Colorado, USA, 1996: 56-57
- Friedman, M. Antibiotic activities of plant compounds against non-resistant and antibiotic resistant food borne human pathogens. In Juneja, V.K., Cherry, J.P., Tunick, M.S. Advance in microbial food safety. American Chemical Society, Washington DC, USA, 2006: 167-183

References

- Friderich, C.L., Moyles, D., Beveridge, T.J. and Hancock, R. E. W. Antibacterial action of structurally diverse cationic peptides on gram-positive bacteria. **Antimicrob. Agents Chemother.** 2000; 44: 2086-2092
- Fujimura S. and Makamura, T. Isolation and characterization of a protease from *Bacteroides gingivalis*. *Infect Immun.* 1987; 55: 716-720 *In* Sheng, J., Nguyen, P.T.M., Baldeck, J.D., Olsson, J. and Marquis, R.E. Antimicrobial actions of benzimidazoles against the oral anaerobes *Fusobacterium nucleatum* and *Prevotella intermedia*. **Arch. Oral Biol.** 2006; 51(11): 1015-1023
- Gachotte, D., Sen, S.E., Eckstein, J., Barbuch, R., Krieger, M., Ray, B.D. and Bard, M. Characterization of the *Saccharomyces cerevisiae* ERG27 gene encoding the 3-ketoreductase involved in C-4 sterol demethylation. **Proc. Natl. Acad. Sci. USA** 1999; 96: 12655-12660
- Gafner, S., Wolfender, J.L., Nianga, M., Stoeckli-Evans, H. and Hostettmann, K. Antifungal and Antibacterial Naphthoquinones from *Newbouldia laevis* Roots. **Phytochemistry** 1996; 42: 1315-1320
- García, S., García, C., Heinzen, H. and Moyna, P. Chemical basis of the resistance of barley seeds to pathogenic fungi. **Phytochemistry** 1997; 44: 415-418
- Geiger, G., Brandl, H., Furrer, G. and Schulin, R. The effect of copper on the activity of cellulase and β -glucosidase in the presence of montmorillonite or A1-montmorillonite. **Soil Biol. Biochem.** 1998; 30: 1537-1544
- Georgopapadakou, N.H. and Tkacz, J.S. The fungi cell wall as a drug target. **Trends Microbiol.** 1995; 3: 98-104
- González, G.M., Tijerina, R., Najvar, L.K., Bocanegra, R., Luther, M., Rinaldi, M.G. and Graybill, J.R. Correlation between antifungal susceptibilities of *Coccidioides immitis* in vitro and antifungal treatment with Caspofungin in a mouse model. **Antimicrob. Agents Ch.** 2001; 45: 1854-1859

- Guiraud, P., Steiman, R., Campos-Takaki, G.M., Seile-Murandi, F. and Simeon de Bouchberg, M. Comparison of antibacterial and antifungal activities of Lapachol and β -Lapachol. **Planta Med.** 1994; 60: 373-374
- Gülerman, N.N., Doğan, H.N., Rollas, S., Johansson, C. and Çelik, C. Synthesis and structure elucidation of some new thioether derivatives of 1,2,4-triazoline-3-thiones and their antimicrobial activities. **IL Farmaco** 2001; 56: 953-958
- Hammer, K.A., Carson, C.F. and Riley, T.V. Antimicrobial activity of essential oils and other plant extracts. **J. Appl. Microbiol.** 1999; 86: 985-990
- Hartwell, J.L. Plants used against cancer; A survey 1967-1971. **Lloydia** 1971: 30-34
- Hasegawa, N., Matsumoto, Y., Hoshino, A. and Iwashita, K. Comparison of effects of *Wasabi japonica* and allyl isothiocyanate on the growth of four strains of *Vibrio parahaemolyticus* in lean and fatty tuna meat suspensions. **Int. J. Food Microbiol.** 1999; 49: 27-34
- Hazekamp, A., Simons, R., Peltenburg-Looman, A., Sengers, M., van Zweden, R. and Verpoorte, R. Preparative isolation of cannabinoids from *Cannabis sativa* by centrifugal partition chromatography. **J. Liq. Chromatogr. Rel. Technol.** 2004; 27: 2421-2439
- Hegnauer, R. Chemotaxonomie der pflanzen VI. Birkhäuser Verlag, Berlin, Germany, 1973: 658-680
- Hermans-Lokkerbol, A.C.J. and Verpoorte, R. Development and validation of a high-performance liquid chromatography system for the analysis of hop bitter acids. **J. Chromatogr. A** 1994; 669: 65-73
- Hobbie, S.N., Bruell, C., Kalapala, S., Akshay, S., Schmidt, S., Pfister, P. and Böttger, E.C. A genetic model to investigate drug-target interactions at the ribosomal decoding site. **Biochimie** 2006; 88: 1033-1043

References

- Hochstenbach, F., Klis, M., van Den Ende, H., van Donselaar, E., Peters, P.J. and Klausner, R.D. Identification of a putative alpha-glucan synthase essential for cell wall construction and morphogenesis in fission yeast. **Proc. Natl. Acad. Sci. USA** 1998; 95: 9161-9166
- Horisberger, M., Lewis, B.A. and Smith, F. Structure of a (1-3)-alpha-D-glucan (pseudonigeran) of *Aspergillus niger* NNRL 326 cell wall. **Carbohydr. Res.** 1972; 23: 183-188
- Hugo, W.B. and Russell, A.D. *Pharmaceutical Microbiology*. Blackwell Scientific Publication, Oxford, United Kingdom, 1992: 45-46, 189-207
- Huh, W.K., Masuji, Y., Tada, J., Arata, J. and Kaniwa, M. Allergic contact dermatitis from a pyridine derivative in polyvinyl chloride leather. **Am. J. Cont. Derm.** 2001; 12: 35-37
- Iqbal, Z., Lateef, M., Akhtar, S.M., Ghayur, M.N. and Gilani, A.H. In vivo anthelmintic activity of ginger against gastrointestinal nematodes of sheep. **J. Ethnopharmacol.** 2006; 106: 285-287
- Je, J.Y. and Kim, S.K. Antimicrobial action of novel chitin derivative. **Biochim. Biophys. Acta** 2006; 1760: 104-109
- Johnston, I.R. The composition of the cell wall of *Aspergillus niger*. **Biochem. J.** 1965; 96: 651-658
- Karaman, I., Sahin, F., Güllüce, M., Ögütçü, H., Şengül, M. and Adigüzel, A. Antimicrobial activity of aqueous and methanol extracts of *Juniperus oxycedrus* L. **J. Ethnopharmacol.** 2003; 85: 231-235
- Kawamura, M., Keim, P.S., Goto, Y., Zalkin, H. and Heinrikson, R.L. Anthranilate synthetase component II from *Pseudomonas putida*. Covalent structure and identification of the cysteine residue involved in catalysis. **J. Biol. Chem.** 1978; 253: 4659-4668
- Khan, R.M. and Mlungwana, S.M. 5-Hydroxylapachol: a cytotoxic agent from *Tectona grandis*. **Phytochemistry** 1999; 50: 439-442

- Kraemer, H. Text-Book of Botany and Pharmacognosy. J.B. Lippincott company, London, UK, 1910: 255-583
- Kubitzki, K., Rohwer, J.G. and Bittrich, V. The families and Genera of Vascular Plants Volumn II Flowering Plants · Dicotyledons. Springer-Verlag, Berlin, Germany, 1993: 204
- Kumar, V.P., Chauhan, N.S., Padh, H. and Rajani, M. Search for antibacterial and antifungal agents from selected Indian medicinal plants. **J. Ethnopharmacol.** 2006; 107: 182-188
- Lai, T.E., Pullammanappallil, P.C. and Clarke, W.P. Quantification of cellulase activity using cellulose-azure. **Talanta** 2006; 69: 68-72
- Lambert, H.P. and O'Grady, F.W. Antibiotic and Chemotherapy. Churchill Livingstone, London, UK, 1992: 291-312
- Langezaal, C.R., Chandra, A. and Scheffer, J.J.C. Antimicrobial screening of essential oils and extracts of some *Humulus lupulus* L. cultivars. **Pharm. Weekbl. Sci.** 1992; 14: 353-356
- Larcher, G., Morel, C., Tronchin, G., Landreau, A., Séraphin, D., Richomme, P. and Bouchara, J. P. Investigation of the Antifungal activity of caledonixanthone E and other xanthenes against *Aspergillus fumigatus*. **Planta Med.** 2004; 70: 569-571
- Larson, A.E., Rosa, R.Y., Yu Olga, A., Lee, S.P., Gerhard, J.H. and Eric, A.J. Antimicrobial activity of hop extracts against *Listeria monocytogenes* in media and in food. **Int. J. Food Microbiol.** 1996; 33: 195-207
- Levy, S. Antibacterial household products: cause for concern. **Emerg. Infect. Dis.** 2001; 7: 512-515
- Lewis, K. and Klibanov, A.M. Surpassing nature: rational design of sterile-surface materials. **Trends Biotechnol.** 2005; 23: 343-348
- Lim, G., Tan, T.K. and Toh, A. The fungal problem in buildings in the humid tropics. **Int. Biodeterior.** 1989; 25: 27-37

References

- Magaldi, S., Mata-Essayag, S., Capriles, C.H., Perez, C., Colella, M.T., Olaizola, C. and Ontiveros, Y. Well diffusion for antifungal susceptibility testing. **J. Infect. Dis.** 2004; 8: 39-45
- Manohar, V., Ingram, C., Gray, J., Talpur, N.A., Echard, B.W., Bagchi, D. and Preuss, H.G. Antifungal activities of origanum oil against *Candida albicans*. **Mol. Cell Biochem.** 2001; 228: 111-117
- Martin, A. Antimicrobial Antibiotics. In Delgado, J. and Remers, W. Textbook of organic medicinal and pharmaceutical chemistry. Lippincott Williams and Wilkins, Philadelphia, USA, 1998: 253-327
- Masika, P.J. and Afolayan, A.J. Antimicrobial activity of some plants used for the treatment of livestock disease in the Eastern Cape, South Africa. **J. Ethnopharmacol.** 2002; 83: 129-134
- Mawadza, C., Hatti-Kaul, R., Zvauya, R. and Mattiasson, B. Purification and characterization of cellulases produced by two *Bacillus* strains. **J. Biotechnol.** 2000; 83: 177-187
- McManus, M.C. Mechanisms of bacterial resistance to antimicrobial agents. **Am. J. Health Syst. Pharm.** 1997; 54: 1420-1433
- Mercer, E.I. Sterol biosynthesis inhibitors: their current status and modes of action. *Lipids* 1991; 26: 584-597 In Kagen, I.A., Michel, A., Prause, A., Scheffler, B.E., Pace, P. and Duke, S.O. Gene transcription profiles of *Saccharomyces cerevisiae* after treatment with plant protection fungicides that inhibit ergosterol biosynthesis. **Pestic. Biochem. Phys.** 2005; 82: 133-153
- Moore, J.E., Corcoran, D., Dooley, J.S.G., Fanning, S., Lucey, B., Matsuda, M., McDowell, D.A., Męgraud, F., Millar, B.C., O'Mahony, R., O'Riordan, L., O'Rourke, M., Rao, J.R., Rooney, P.J., Sails, A. and Whyte, P. *Campylobacter*. **Vet. Res.** 2005; 36: 351-382

- Moreno, M.I.N., Isla, M.I., Cudmani, N.G., Vattuone, M.A. and Sampietro, A.R. Screening of antibacterial activity of Amaicha del Valle (Tucumán, Argentina) propolis. **J. Ethnopharmacol.** 1999; 68: 97-102
- Mukhopadhyay, A. and Peterson, R.T. Fishing of new antimicrobials. **Curr. Opin. Chem. Biol.** 2006; 10: 327-333
- Nakayama, F.S., Vinyard, S.H., Chow, P., Bajwa, D.S., Youngquist, J.A., Muehl, J.H. and Krzysik, A.M. Guayule as a wood preservative. **Ind. Crops Prod.** 2001; 14: 105-111
- Navarro, V. and Delgado, G. Two antimicrobial alkaloids from *Bocconia arborea*. **J. Ethnopharmacol.** 1999; 66: 223-226
- Neu, H.C. The crisis in antibiotic resistance. **Science** 1992; 257: 1064-1073
- Nieva Moreno, M.I., Isla, M.I., Cudmani, N.G. and Vattuone, M.A. Screening of antibacterial activity of Amaicha del Valle (Tucumán, Argentina) propolis. **J. Ethnopharmacol.** 1999; 68: 97-102
- Niyogi, K.K. and Fink, G.R. Two anthranilate synthase genes in arabidopsis: defense-related regulation of the tryptophan pathway. **Plant Cell** 1992; 4: 721-733
- Niyogi, K.K., Last, R.L., Fink, G.R. and Keith, B. Suppressors of trp1 fluorescence identify a new arabidopsis gene, TRP4, encoding the anthranilate synthase β -subunit. **Plant Cell** 1993; 5: 1011-1027
- Nolte, A. and Holzenburg, A. Studies on the anaerobic degradation of crystalline cellulose by *Clostridium thermocellum* using a new assay. **FEMS Microbiol. Lett.** 1990; 72: 201-208
- Okemo, P.O., Bais, H.P. and Vivanco, J.M. In vitro activities of *Maesa lanceolata* extracts against fungal plant pathogens. **Fitoterapia** 2003; 74: 312-316

References

- Ortelli, D., Edder, P. and Corvi, C. Pesticide residues survey in citrus fruits. **Food Addit. Contam.** 2005; 22: 423-428
- Osiewacz, H.D. *The Mycota*. Springer, Heidelberg, Germany, 2002: 303-341
- Padua, L.S., Bunyaphatsara, N. and Lemmens, R.H.M.J. *Plant Resources of South-East Asia*. Backhuys Publishers, Leiden, the Netherlands, 1999: 167-175
- Patton, T., Barrett, J., Brennan, J. and Moran, N. Use of a spectrophotometric bioassay for determination of microbial sensitivity to manuka honey. **J. Microbiol. Meth.** 2006; 64: 84-95
- Pauli, A. Alpha-Bisabolol from Chamomile-A specific ergosterol biosynthesis inhibitor? **Int. J. Aromather.** 2006; 16: 21-25
- Pennati, R., Gropelli, S., Zega, Giuliana, Z., Biggiogero, M., Bernardi, F.D. and Sotgia, C. Toxic effects of two pepticides, Imazalil and Triadimefon, on the early development of the ascidian *Phallusia mammillata* (Chordata, Ascidiacea). **Aquat. Toxicol.** 2006; 79: 205-212
- Petri, W.A.J. Antimicrobial agents: sulfonamides, trimethoprim-sulfamethoxazole, quinolones, and agents for urinary tract infections. In Brunton, L.L., Lazo, J.S. and Parker, K.L. Goodman and Gilman's the Pharmacological Basis of therapeutics, 11th ed. McGraw-Hill, New York, USA, 2006: 1111-1126
- Polak-Wyss, A. Mechanism of action of antifungals and combination therapy. **J. Eur. Acad. Dermatol. Venereol.** 1995; 4: S11-S16
- Polunin, O. *Flowers of Europe: a field guide*. Oxford University Press, London, UK, 1969: 56-57
- Poulsen, C., Pennings, E.J.M. and Verpoorte, R. High performance liquid chromatography assay of anthranilate synthase from plant cell cultures. **J. Chromatogr.** 1991; 547: 155-160
- Poulsen, C., Bongaerts, R.J.M. and Verpoorte, R. Purification and characterization of anthranilate synthase from *Catharanthus roseus*. **Eur. J. Biochem.** 1993; 212: 431-440

- Pyun, M.S. and Shin, S. Antifungal effects of the volatile oils from *Allium* plants against Trichophyton species and synergism of the oils with ketoconazole. **Phytomedicine** 2005; 13: 394-400
- Quiroga, E.N., Sampietro, A.R. and Vattuone, M.A. Screening antifungal activities of selected medicinal plants. **J. Ethnopharmacol.** 2000; 74: 89-96
- Rai, A.K., Ria, S.B. and Ria, D.K. Quantum chemical studies on the conformational structure of bacterial peptidoglycans and action of penicillin on cell wall. **J. Mol. Struct.** 2003; 626: 53-61
- Rao, K.V., McBride, T.J. and Oleson, J.J. Recognition and evaluation of lapachol as an antitumor agent. **Cancer Res.** 1968; 28: 1952-1954
- Rao, M.M. and Kingston, D.G.I. Plant anticancer agents. XII. ¹ isolation and structure elucidation of new cytotoxic quinones from *Tabebuia cassinoides*. **J. Nat. Prod.** 1982; 45: 600-604
- Ríos, J.L. and Recio, M.C. Medicinal plants and antimicrobial activity. **J. Ethnopharmacol.** 2005; 100: 80-84
- Robison, P.D. and Levy, H.R. Metal ion requirement and tryptophan inhibition of normal and variant anthranilate synthase-anthranilate 5-phosphoribosylpyrophosphate phosphoribosyltransferase complexes from *Salmonella typhimurium*. **Biochim. Biophys. Acta** 1976; 445: 475-485
- Romero, R.M., Roberts, M.F. and Phillipson, J.D. Anthranilate synthase in microorganisms and plants. **Phytochemistry** 1994; 39: 263-276
- Rooklidge, S. J. Environmental antimicrobial contamination from terraccumulation and diffuse pollution pathways. **Sci. Total Environ.** 2004; 325: 1-13
- Rooney, M.L. Active food packaging. Blackie Academic and professional, Glasgow, Ireland, 1995: 1-37

References

- Sakamoto, K. and Konings, W.N. Beer spoilage bacteria and hop resistance. **Int. J. Food Microbiol.** 2003; 89: 105-124
- Salie, F., Eagles, P.F.K. and Leng, H.M.J. Preliminary antimicrobial screening of four African Asteraceae species. **J. Ethnopharmacol.** 1996; 52: 27-33
- Sato, J., Goto, K., Nanjo, F., Kawai, S. and Murata, K. Antifungal activity of plant extracts against *Arthrimum sacchari* and *Chaetomium funicola*. **J. Biosci. Bioeng.** 2000; 90: 442-446
- Schmourlo, G., Mendonça-Filho, R.R., Alviano, C.S. and Costa, S.S. Screening of antifungal agents using ethanol precipitation and bioautography of medicinal and food plants. **J. Ethnopharmacol.** 2005; 96: 563-568
- Schultz, T.P. and Nicholas, D.D. Development of environmentally-benign wood preservatives based on the combination of organic biocides with antioxidants and metal chelators. **Phytochemistry** 2002; 61: 555-560
- Schwartz, R.E. Cell wall active antifungal agents. **Expert Opin. Ther. Pat.** 2001; 11: 1761-1772
- Semenov, A.M., Batomunkueva, B.P., Nizovtseva, D.V. and Panikov, N.S. Method of determination of cellulase activity in soils and in microbial cultures, and its calibration. **J. Microbiol. Meth.** 1996; 24: 259-267
- Seydim, A.C. and Sarikus, G. Antimicrobial activity of whey protein based edible films incorporated with oregano, rosemary and garlic essential oils. **Food Res. Int.** 2006; 39: 639-644
- Sharrock, K.R. Cellulase assay methods: a review. **J. Biochem. Biophys. Meth.** 1988; 17: 81-106
- Shea, K. Antibiotic resistance: what is the impact of agricultural uses of antibiotics on children's health? **Pediatrics** 2003; 112: 253-258

- Sheng, J., Nguyen, P.T.M., Baldeck, J.D., Olsson, J. and Marquis, R.E. Antimicrobial actions of benzimidazoles against the oral anaerobes *Fusobacterium nucleatum* and *Prevotella intermedia*. **Arch. Oral Biol.** 2006; 51: 1015-1023
- Sherma, J. and Fried, B. Handbook of Thin-Layer Chromatography. Marcel Dekker, Inc., New York, USA, 1991: 649-661
- Shultz, M.D., Lassig, J.P., Gooch, M.G., Evans, B.R. and Woodward, J. Palladium-a new inhibitor of cellulase activities. **Biochem. Biophys. Res. Commun.** 1995; 26: 1046-1052
- Sietsma, J.H. and Wessels, J.G. The occurrence of glucosaminoglycan in the wall of *Schizosaccharomyces pombe*. **J. Gen. Microbiol.** 1990; 136: 2261-2265
- Silva, O., Duarte, A., Cabrita, J., Pimentel, M., Diniz, A. and Gomes, E. Antimicrobial activity of Guinea-Bissau traditional remedies. **J. Ethnopharmacol.** 1996; 50: 55-59
- Simpson, W.J. and Smith, A.R.W. Factors affecting antibacterial activity of hop compounds and their derivatives. **J. Appl. Bacteriol.** 1992; 72: 327-334
- Singh, M.P. Rapid test for distinguishing membrane-active antibacterial agents. **J. Microbiol. Meth.** 2006; 67: 125-130
- Singh, P., Jain, S. and Bhargava, S. A 1,4-Anthraquinone derivative from *Tectona grandis*. **Phytochemistry** 1989; 28: 1258-1259
- Singh, S.P., Rao, G.P. and Upadhyaya, P.P., Fungitoxicity of essential oils of some aromatic plants against sugarcane pathogens. **Sugar Cane** 1998; 2: 14-17
- Soerianegara, I. and Lemmens, R.H.M.J. Plant Resources of South-East Asia No 5(1): Timber trees: major commercial timbers. Pudoc Scientific Publishers, Wageningen, The Netherlands, 1993: 251-454

References

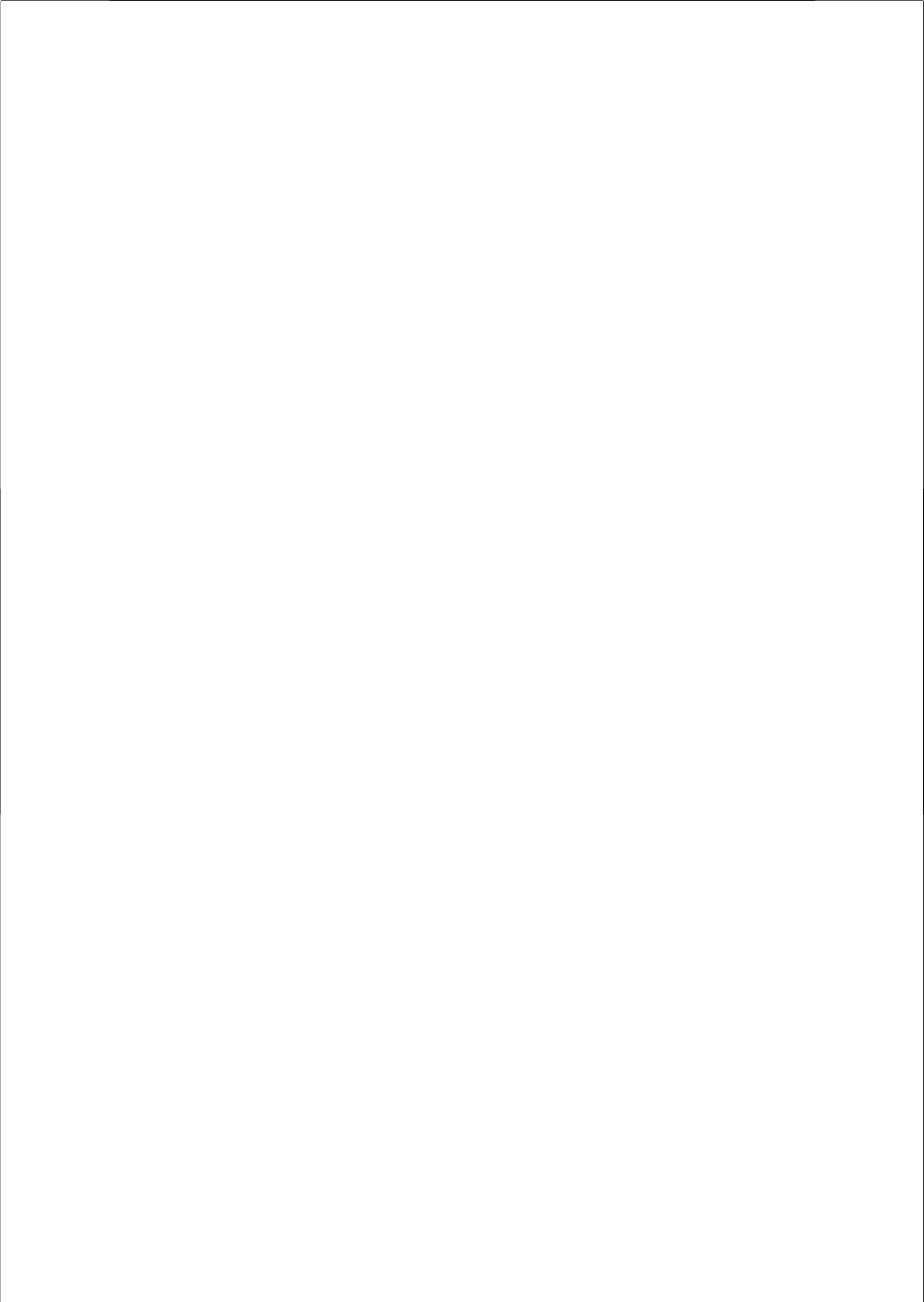
- Sosef, M.S.M., Hong, L.T. and Prawirohatmodjo, S. Plant Resources of South-East Asia No 5(3): Timber trees: Lesser-known timbers. Backhuys Publishers, Leiden, the Netherlands, 1998: 590-591
- Stone, E.A., Fung, H.B. and Kirschenbaum, H.L. Caspofungin: An Echinocandin antifungal agent. **Clin. Ther.** 2002; 24: 351-377
- Storm, D.R., Rosenthal, K.S. and Swanson, P.E. Polymyxin and related peptide antibiotics. **Annu. Rev. Biochem.** 1977; 46: 723-763
- Straus, S.K. and Hancock, R.E.W. Mode of action of the new antibiotic for Gram-positive pathogens daptomycin: Comparison with cationic antimicrobial peptides and lipopeptides. **Biochim. Biophys. Acta** 2006; 1758: 1215-1223
- Tabuti, J.R.S., Dhillon, S.S. and Lye, K.A. Ethnoveterinary medicines for cattle (*Bos indicus*) in Bulamogi county of Uganda: plant species and mode of use. **J. Ethnopharmacol.** 2003; 88: 279-286
- Tadeg, H., Mohammed, E., Asres, K. and Gebre-Mariam, T. Antimicrobial activities of some selected traditional ethiopian medicinal plants used in the treatment of skin disorders. **J. Ethnopharmacol.** 2005; 100: 168-175
- Tenover, F.C. Mechanisms of antimicrobial resistance in bacteria. **Am. J. Med.** 2006; 34: S3-S10
- Tharanathan R.N. Biodegradable films and composite coatings: past, present and future. **Trends Food Sci. Tech.** 2003; 14: 71-78
- The Biocide Information Services (BIS). Antimicrobials in plastics: a global review. **Plast. Add. Comp.** 2001: 12-13
- Thomson, R.H. Naturally Occurring Quinones. Butter Worths Scientific Publications, London, England, 1957: 160-161

- Threlfall, E.J. Antimicrobial drug resistance in Salmonella: problems and perspectives in food- and water-borne infections, **FEMS Microbiol. Rev.** 2002; 26: 141-148
- USEPA. Environmental and Economic Benefit Analysis of Final Revisions to the National Pollutant Discharge Elimination System Regulation and the Effluent Guidelines for concentrated Animal Feeding Operations. US Environmental Protection Agency Office of Water, EPA 821-R-03-003, 2002: 2-19
- Valášková, V. and Baldrian, P. Estimation of bound and free fractions of lignocellulose-degrading enzymes of wood-rotting fungi *Pleurotus ostreatus*, *Trametes versicolor*, *Piptoporus betulinus*. **Res. Microbiol.** 2005; 30: 119-124
- van Beek, T.A., Silva, I.M.M.S., Posthumus, M.A. and Melo, R. Partial elucidation of *Trichogramma* putative sex pheromone at trace levels by solid-phase microextraction and gas chromatography-mass spectrometry studies. **J. Chromatogr. A** 2005; 1067: 311-321
- Vanden Bossche, H., Marichal, P., Gorrens, J., Coene, M.C., Willemsens, G., Bellens, D., Roels, I., Moereels, H. and Janssen, P.A. Biochemical approaches to selective antifungal activity: focus on azole antifungals. **Mycoses** 1989; 32: 35-52
- Velasco-García, R., Machorro, V.J.Z., Jiménez, C.M., Segura, L.G. and Clares, R.A.M. Disulfiram irreversibly aggregates betaine aldehyde dehydrogenase-A potential target for antimicrobial agents against *Pseudomonas aeruginosa*. **Biochem. Biophys. Res. Commun.** 2006; 341: 408-415
- Verástegui, M.A., Sánchez, C.A., Heredia, N.L. and García-Alvarado, J.S. Antimicrobial activity of extracts of three major plants from the Chihuahuan desert. **J. Ethnopharmacol.** 1996; 52: 175-177
- Verpoorte R. Pharmacognosy in the new millennium: lead finding and biotechnology. **J. Pharm. Pharmacol.** 2000; 52: 253-262

References

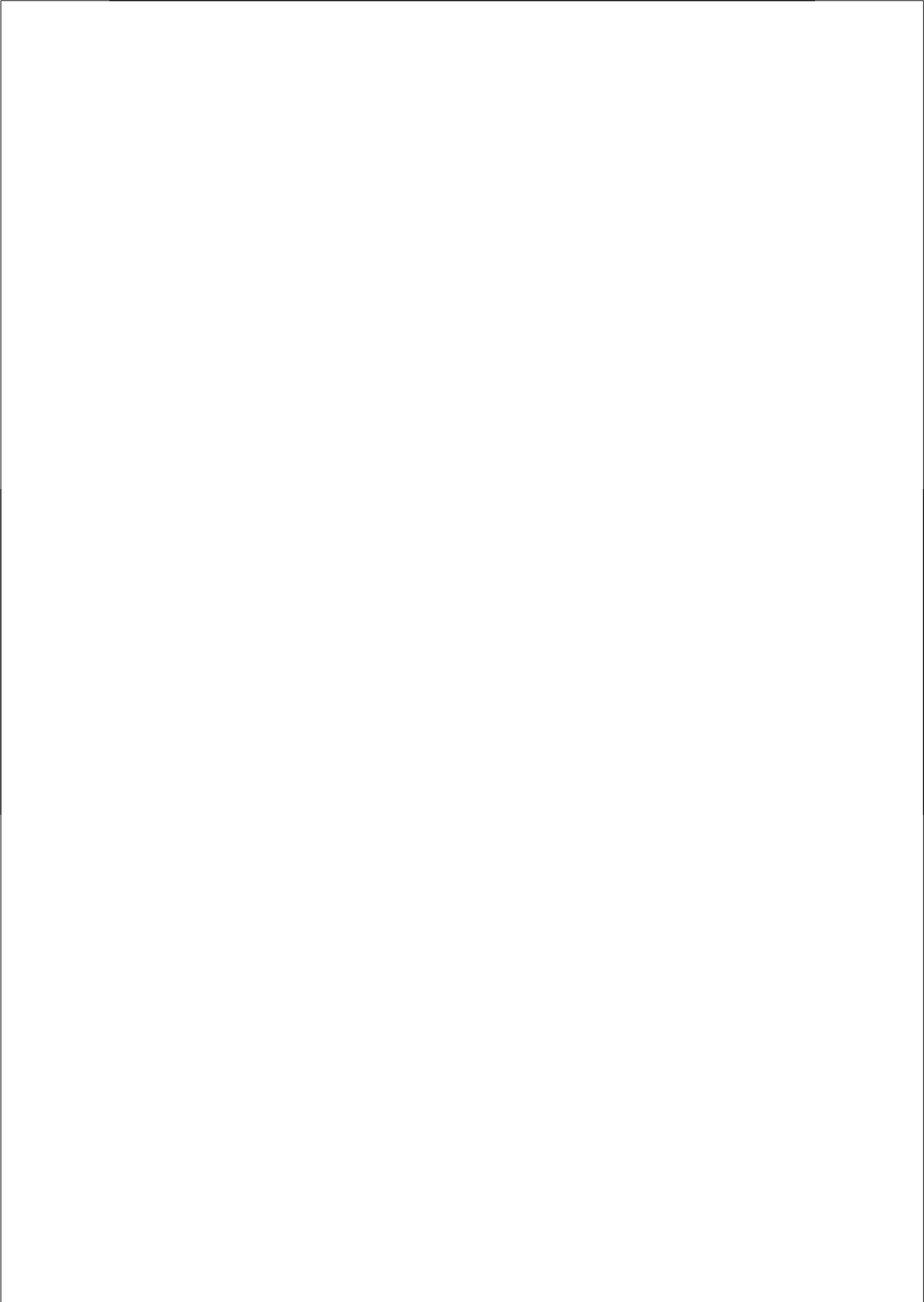
- Viegi, L., Pieroni, A., Guarrera, P.M. and Vangelisti, R. A review of plants used in folk veterinary medicine in Italy as basis for a databank. **J. Ethnopharmacol.** 2003; 89: 221-244
- Vlietinck, A.J., Hoof, L.V., Totté, J., Lasure, A., Berghe, D.V. and Rwangabo, P.C., Mvukiyumwami, J. Screening of hundred Rwandese medicinal plants for antimicrobial and antiviral properties. **J. Ethnopharmacol.** 1995; 46: 31-47
- Weiss, R.F. Herbal Medicine. Gothenburg, Sweden, Ab Arcanum, 1988: 285-286
- Weng, Y.M. and Hotchkiss, J.S. Inhibition of surface molds on cheese by polyethylene containing the antimycotic imazalil. **J. Food Protect.** 1992; 55: 367-369
- Wilson E., Khatib A., Zhang H.R. and Verpoorte R. Method of improving the stability of hop extracts and hop flavored beverages. International Patent No: WO 2006/065131 A1, 2006
- Yang, S.T., Shin, S.Y., Hahm, K.S. and Kim, J.I. Different modes in antibiotic action of tritripticin analogs, cathelicidin-derived Trp-rich and Pro/Arg-rich peptides. **Biochim. Biophys. Acta** 2006; 1758: 1580-1586
- Yano, Y., Satomi, M. and Oikawa, H. Antimicrobial effect of spices and herbs on *Vibrio parahaemolyticus*. **Int. J. Food Microbiol.** 2006; 111: 6-11
- Yao, J. and Moellering, R.J. Antibacterial agents. *In*: Murray, P.R., Baron, E.J., Jorgensen, J.H., Tenover, M.C. and Tenover, R.H. Manual of Clinical Microbiology, 8th ed. ASM press, Washington, DC, USA, 2003: 1039-1073
- Yff, B.T.S., Lindsey, L., Taylor, M.B., Erasmus, D.G. and Jäger, A.K. The pharmacological screening of *Pentanisia prunelloides* and the isolation of the antibacterial compound palmitic acid. **J. Ethnopharmacol.** 2002; 79: 101-107
- Yildiz, U.C., Temiz, A., Gezer, E.D. and Yildiz, S. Effects of the wood preservatives on mechanical properties of yellow pine (*Pinus sylvestris* L.) wood. **Build. Environ.** 2004; 39: 1071-1075

- Yin, M.C. and Tsao, S.M. Inhibitory effect of seven *Allium* plants upon three *Aspergillus* species. **J. Food Microbiol.** 1999; 49: 49-56
- Zhang, Y., Yang, F., Koa, Y.C., Kurilla M.G., Pompliano D.L. and Dicker, I.B. Homogenous assays for escherichia coli DnaB-stimulated DnaG primase and DnaB helicase and their use in screening for chemical inhibitors. **Anal. Biochem.** 2002; 304: 174-179
- Zhang, Q., Sahin, O., McDermott, P.F. and Payot, S. Fitness of antimicrobial-resistant *Campylobacter* and *Salmonella*. **Microbes Infect.** 2006; 1972-1978
- Zhu, W.L., Lan, H., Park, I.S., Kim, J.I., Jin, H.Z., Hahm, K.S. and Shin, S.Y. Design and mechanism of action of a novel bacteria-selective antimicrobial peptide from the cell-penetrating peptide Pep-1. **Biochem. Biophys. Res. Commun.** 2006; 349: 769-774
- Zonneveld, B.J. Morphogenesis in *Aspergillus nidulans*. The significance of an alpha-1,3-glucan of the cell wall and alpha-1,3-glucanase for cleistothecium development. **Biochim. Biophys. Acta** 1972; 273: 174-187
- Zygadlo, J.A. and Grosso, N.R. Comparative study of the antifungal activity of essential oils from aromatic plants growing wild in the central region of Argentina. **Flav. Fragr. J.** 1995; 10: 113-118



Curriculum vitae

Ms. Pattarawadee Sumthong was born on the 22nd of August 1976 in Bangkok, Thailand. She received her bachelor's degree of science in 1997 from the Department of Biology, Faculty of Science, Burapha University, Chonburi, Thailand. Her research project was about "Effects of plant growth regulators on growth of *Geranium* sp. by plant tissue culture technique". She completed her master's degree of Science in the Department of Botany, Faculty of Science, Kasetsart University, Thailand. She graduated in 2000 with high distinction with a thesis entitled "Effects of vesicular-arbuscular mycorrhizal fungi and phosphate fertilizer levels on growth of vetiver grass (*Vetiveria zizanioides* L. Nash.) Surat Thani ecotype". After that she was employed by Kasetsart University, Sri Racha Campus, Chonburi as a lecturer in the faculty of Resources and Environment. In 2003, she was accepted as a PhD student in department of Pharmacognosy, Leiden University, The Netherlands. Her research project focused on antimicrobial compounds from plants.



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