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# DIVERSIDADE E POTENCIAL BIOTECNOLÓGICO DE *Pseudomonas* spp. DE SEDIMENTOS DE MANGUEZAIS

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**RESUMO**

**AVILA, L. A. Diversidade e potencial biotecnológico de *Pseudomonas* spp. de sedimentos de manguezais.** 2012. 129 f. Tese (Doutorado em Biotecnologia). Instituto de Ciências Biomédicas, Universidade de São Paulo, São Paulo, 2012.

Os manguezais possuem condições ambientais únicas, sendo composto por espécies particulares de plantas, animais e micro-organismos, que interagem neste ambiente caracterizado pela interface entre o continente e o oceano em regiões intertropicais. O objetivo deste trabalho foi avaliar a diversidade e o potencial biotecnológico da comunidade de *Pseudomonas* spp. em sedimentos de manguezais do Estado de São Paulo. Para tanto, amostras de sedimentos de distintos manguezais foram avaliadas, sendo; *i*) manguezal contaminado com petróleo em Bertioga, *ii*) manguezal sem contaminação em Bertioga *iii*) manguezal preservado de Cananéia. Inicialmente foi realizada uma prospecção do gene *gacA* entre os isolados de sedimentos de manguezais e então, avaliação da atividade antimicrobiana e síntese de enzimas pelas linhagens selecionadas. A diversidade de *Pseudomonas* spp. foi avaliada por meio da detecção do gene 16S rRNA e do gene *gac*A de isolados de *Pseudomonas*, como também por métodos independentes de cultivo (eletroforese em gel com gradiente de desnaturação - DGGE e construção de biblioteca de clones). Estudos foram realizados para avaliar o potencial de *Pseudomonas* para promoção de crescimento de milho e redução dos efeitos do estresse salino sobre a planta. Dos 83 isolados obtidos, 55 (66,27%) foram positivos para o gene *gacA*. Com base no gene 16S rRNA e perfil de ácidos graxos da membrana celular somente 29 isolados puderam ser caracterizados em espécie e outros 13 caracterizadas como *Pseudomonas* sp. Extratos bruto de linhagens de *Pseudomonas* sp. demonstraram atividade antifúngica e antibacteriana de amplo espectro. Todas as linhagens selecionadas produziram as enzimas catalase, celulase, lacase e lipase. No estudo da estrutura da comunidade de *Pseudomonas* spp. pela análise do DGGE do 16S rRNA, foi possível observar perfis de bandas distintos em cada um dos manguezais e pontos amostrados, enquanto que para a análise baseada no gene *gacA*, as bandas mostraram-se distribuídas de maneira aleatória entre as amostras analisadas. De acordo com a análise da biblioteca de clones, os diferentes manguezais apresentam comunidades de *Pseudomonas* spp. bem distintas, corroborando com resultado da análise de RDA dos perfis de DGGE. Aproximadamente 60% dos clones de sedimentos de manguezais não puderam ser caracterizados pelo gene 16S rRNA. Entre as espécies caracterizadas, *P. nitroreducens* e *P. fluorescens* foram predominantes . *Pseudomonas* de sedimentos de manguezais halotolerantes produzem AIA, ACC deaminase, $NH_3$, solubilizam fosfato e fixam nitrogênio. *Pseudomonas* sp. selecionadas promoveram o crescimento de milho, estimulando também o desenvolvimento das plantas cultivadas sob estresse salino. Este trabalho enfatiza a importância de manguezais para obtenção de bactérias com potencial agrícola, industrial e biotecnológico.

***Palavras-chave*:** Manguezal, *Pseudomonas*, Regulador global de resposta *gacA*, DGGE, Biblioteca de clones, Biofertilizantes, Estresse salino.

**ABSTRACT**

**AVILA, L. A. Diversity and biotechnological potential of *Pseudomonas* spp. from mangrove sediments.** 2012. 129 p. Ph. D. thesis (Biotechnology). Instituto de Ciências Biomédicas, Universidade de São Paulo, São Paulo, 2012.

Mangroves possess unique environmental conditions, harboring particular species of plants, animals and microorganisms that interact in this environment that is characterized by the interface of continent and ocean in intertropical regions. The objective of this study was to evaluate the diversity and biotechnological potential of *Pseudomonas* spp. community in mangrove sediments of São Paulo state. Sediment samples from different mangroves were evaluated as follows; *i)* oil-contaminated mangrove in Bertioga, *ii)* uncontaminated mangrove in Bertioga, *iii)* preserved mangrove in Cananéia. Initially, the prospection of *gac*A gene was performed between the isolates of mangrove sediments and then the evaluation of antimicrobial activity and enzyme synthesis by the selected strains. *Pseudomonas* spp. diversity was analyzed through the detection of 16S rRNA gene and *gac*A gene of *Pseudomonas* isolates, as well as through unculturable methods (Denaturing Gradient Gel Electrophoresis - DGGE and clone library construction). Studies were conducted to analyze the potential of *Pseudomonas* for maize growth promotion and reduce the effects of salt stress on the plant. Of the 83 isolates, 55 (66,27%) were positive for *gac*A gene. Based on 16S rRNA and fatty acid profile of the cell membrane, only 29 isolates could be characterized at species level and 13 were characterized as *Pseudomonas* sp. Crude extracts of *Pseudomonas* sp. strains demonstrated broad spectrum antifungal and antibacterial activities. All selected strains produced the enzymes catalase, cellulase, laccase and lipase. In the study of community structure of *Pseudomonas* spp. by DGGE using 16S rRNA, it was possible to observe different band profiles in each of the mangroves and sample points, while for the *gac*A gene-based, the bands were ramdomly distributed within samples. According to clone library analysis, the different mangroves showed very distinct *Pseudomonas* spp. communities, corroborating with the results of RDA analysis of DGGE. Approximately 60% of the clones from mangroves sediments could not be characterized by 16S rRNA gene. Among the characterized species, *P. nitroreducens* and *P. fluorescens* were dominant. *Pseudomona*s mangrove halotolerant produce IAA, ACC deaminase, NH3, solubilize phosphate and fix nitrogen. Selected *Pseudomonas* sp. were able to promote maize growth, also stimulating the development of plants cultivated under salt stress. This work emphasizes the importance of mangroves for the search of bacteria with agriculture, industrial and biotechnological potential.

***Key words*:** Mangrove, *Pseudomonas*, Global response regulator *gacA*, DGGE, Clone library, Biofertilizers, Salt stress.

## 1.1 INTRODUÇÃO

O ecossistema de manguezal possui condições ambientais únicas, incluindo a interface de aerobiose e anaerobiose causada pelo regime de marés e a salinidade do solo que se situa entre 5 à 30%, podendo atingir até 90%. Os manguezais apresentam uma composição faunística e florística características, assim como uma microbiota adaptada as condições impostas pelo ambiente de transição de águas doces e salgadas.

Neste ambiente, os micro-organismos de sedimentos são abundantes e desempenham um importante papel na decomposição e mineralização da matéria orgânica, contribuindo para a produtividade do ecossistema de manguezal (NEDWELL et al., 1994; ALONGI, 1996; HOLGUIN et al., 2001) e ainda degradação de poluentes, em áreas impactadas. Além da importância ecológica e ambiental, os micro-organimos de manguezais podem ser importantes alvos biotecnológicos para a descoberta de produtos naturais.

Ambientes extremos, como os manguezais, são propícios para a bioprospecção de novos micro-organismos, suas atividades, produtos metabólicos ou genes. Os micro-organismos dos manguezais ainda são pouco estudados, apesar das particularidades desse ambiente. Muitos dos organismos de manguezais apresentam adaptações e especializações que lhes permitem sobreviver neste ambiente de águas salgadas. As comunidades bacterianas em ambientes salinos podem ser halofílicas ou halotolerantes (ZAHARAN et al., 1992), com diversa funcionalidade, como fixação de carbono, fixação de nitrogênio, degradação de celulose, metanogênese, produção de antibióticos e enzimas (HOLGUIN et al., 2001).

Bactérias do gênero *Pseudomonas* apresentam uma versatilidade metabólica e nutricional, com habilidade de se adaptar a diferentes ambientes, como os manguezais. As *Pseudomonas* são há muito tempo estudadas, no entanto, novas espécies e novos metabólitos produzidos por este grupo continuam sendo descritos. Na interação com espécies vegetais, *Pseudomonas* podem favorecer o desenvolvimento da planta conferindo maior resistência às condições de estresse (SGROY et al. 2009), fornecendo nutrientres como nitrogênio e fosfato solúvel e produzindo reguladores de crescimento vegetal. Dentre o potencial dessas bactérias está à capacidade de promoção de crescimento de plantas, o controle biológico de fitopatógenos, a degradação de xenobióticos, a produção de biossurfactantes, a produção de enzimas e a produção de antibióticos.

Muitos dos antibióticos e enzimas produzidas por *Pseudomonas* sp. são regulados pelo gene *gac*A, assim este gene pode ser utilizado para bioprospecção neste grupo de bactérias. O uso de técnicas de biologia molecular para estudo de diversidade e *screening* funcional de comunidades microbianas pode permitir o acesso a novos micro-organismos, possibilitar a descoberta de novos produtos naturais, além de possibilitar o conhecimento da ecologia desses micro-organismos em seu ambiente natural.

Dessa forma, no presente estudo foram usados métodos dependentes e independentes de cultivo para avaliar a diversidade de comunidades de *Pseudomonas* de sedimentos de manguezais do Estado de São Paulo, utilizando o gene *gac*A para selecionar linhagens produtoras de antibióticos e enzimas. Adicionalmente, também foi avaliado o potencial de linhagens de *Pseudomonas* para promoção de crescimento de planta e tolerância a estresse salino.

## CONCLUSÕES

Com base nos resultados obtidos pode-se concluir:

- A triagem com base no isolamento seletivo de *Pseudomonas* spp. de sedimentos de manguezais e detecção do gene *gacA* foi eficiente para seleção de linhagens produtoras de compostos de interesse biotecnológico;
- Os extratos brutos das linhagens de *Pseudomonas* sp. demonstraram atividade antimicrobiana de amplo espectro. Assim, podemos considerar o ambiente de manguezal uma importante fonte de bactérias produtoras de metabólitos antifúngicos e antibacterianos;
- As espécies de *Pseudomonas* estudadas apresentam grande potencial para produção das enzimas lacase, celulase e lipase;
- A produção de antimicrobianos e enzimas pelas *Pseudomonas gacA* positivas sugerem o envolvimento deste gene na síntese desses compostos;
- As técnicas independentes de cultivo demonstraram diferenças na composição das comunidades de *Pseudomonas* dos diferentes manguezais amostrados;
- Conforme análise de DGGE, a comunidade de *Pseudomonas* é modulada pelas condições ambientais (características físico-químicas e contaminação com óleo crú) e não pelo potencial competitivo dessas bactérias;
- As linhagens de *Pseudomonas* spp. avaliadas são halotolerantes, apresentam atividade de ACC deaminase, produzem altos níveis de AIA, são capazes de fixar nitrogênio, solubilizar fosfato e produzir amônia, demonstrando grande potencial dessas bactérias em promover o crescimento de plantas para uso em solos salinos;
- A linhagem 103, *P. putida*, se destacou entre as linhagens halotolerantes para promoção do crescimento de milho e para redução dos efeitos do estresse salino sobre planta.

## REFERÊNCIAS*


ABBAS, A.; MCGUIRE, J. E.; CROWLEY, D.; BAYSSE, C.; DOW, M.; O'GARA, F. The putative permease PhlE of *Pseudomonas fluorescens* F113 has a role in 2,4-diacetylphloroglucinol resistance and in general stress tolerance. **Microbiology**, v. 150, p.2443–2450, 2004.

ACHOUAK, W.; THIERY, J. M.; ROUBAUD, P.; HEULIN, T. Impact of crop management on intraspecific diversity of *Pseudomonas corrugata* in bulk soil. **FEMS Microbiology Ecology**, v. 31, p. 11–19, 2000.

ALFANO, J.; COLLMER, A. The type III (Hrp) secretion pathway of plant pathogenic bacteria: trafficking harpins, Avr proteins, and death. **Journal of Bacteriology**, v. 179, p. 5655–5662, 1997.

ALONGI, D. M. The dynamics of benthic nutrient pools and Xuxes in tropical mangrove forests. **Journal of Marine Research**, v. 54, p. 123–148, 1996.

ANDREOTE, F.D.; AZEVEDO, J.L.; ARAÚJO, W.L. Assessing the diversity of bacterial communities associated with plants. **Brazilian Journal of Microbiology**, v.40, p.417–432, 2009.

ANDREW, M.; DAVID, L. R.; O'DONNELL, A. G. Novel bacterial diversity recovered from the rhizosphere of oilseed rape (*Brassica napus*) determined by the analysis of 16S ribosomal DNA. **Antonie van Leeuwenhoek***,* v. 78, p. 13–21, 2000.

ARIMA, K.; IMANAKA, I.; KOUSAKA, M.; FUKUTA, A.; TAMURA, G. Pyrrolnitrin, a new antibiotic substance, produced by *Pseudomonas*. **Agricultural and Biological Chemistry**, v. 28, p. 575-576, 1969.

ARAÚJO, W. L.; MARCON, J.; MACCHERONI, J. W.; van ELSAS, J. D.; van VUURDE, J. W. L.; AZEVEDO, J. L. Diversity of endophytic bacterial populations and their interation with *Xylella fastidiosa* in citrus plants. **Applied and Environmental Microbiology,** v. 68, p. 4906-4914, 2002.

AYERS, R. S.; WESTCOT, D.W. Irrigation and Drainage. **Food and Agriculture Organization of the United Nations**, nº 24, 1976.


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*De acordo com:
ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS.
**NBR 6023:** informação e documetação: referências: elaboração. Rio de Janeiro, 2002.

BAKKER, A. W., SCHIPPERS, B. Microbial cyanide production in the rhizosphere in relation to potato yield reduction and *Pseudomonas* spp-mediated plant growth-stimulation. **Soil Biology and Biochemistry**, v. 19, p. 451–457, 1987.

BAKKER, P. A., PIETERSE, C. M., van LOON, L. C. Induced systemic resistance by fluorescent *Pseudomonas* spp. **Phytopathology**, v. 97, p. 239–243, 2007.

BARAN, E.; HAMBREY, J. "Mangrove Conservation and Coastal Management in Southeast Asia: What Impact on Fishery Resources?" **Marine Pollution Bulletin**, v. 37, p. 431-440, 1998.

BASHAN, Y.; HOLGUIN, G. Plant growth-promoting bacteria: a potential tool for arid mangrove reforestation. **Trees**, v. 16, p. 159-166, 2002.

BENIZRI, E.; COURTADE, A.; PICARD, C.; GUCKERT, A. Role of maize root exudates in the production of auxins by *Pseudomonas fluorescens* M.3.1. **Soil Biology and Biochemistry,** v. 30, p. 1481-1484, 1998.

BLOEMBERG, G. V., LUGTENBERG, B. J. Molecular basis of plant growth promotion and biocontrol by rhizobacteria. **Current Opinion in Plant Biology**, v. 4, p. 343–350, 2001.

BLUM, H.; BEIER, H.; GROSS, H. Improved Silver Stain of Plant Proteins, RNA and DNA in Polyacrilamyde Gels. **Electrophoresis**, v. 8, p. 93-99, 1987.

BLUMER, C.; HEEB, S.; PESSI, G.; HAAS, D. Global GacA-steered control of cyanide and exoprotease production in *Pseudomonas fluorescens* involves specific ribosome binding sites. **Proceedings of the National Academy of Science of the United States of America**, v. 96, p. 14073–14078, 1999.

BORNEMAN, J.; SKROCH, P. W.; O'SULLIVAN, K. M.; PALUS, J. A.; RUMJANEK, N. G.; JANSEN, J. L.; NIENHUIS, J.; TRIPLETT, E. W. Molecular microbial diversity of an agricultural soil in Wisconsin. **Applied and Enviromental Microbiology**, v. 62, p. 1935–1943, 1996.

BORNEMAN, J.; TRIPELTT, E. W. Molecular microbial diversity in soils from Eastern Amazonia: Evidence for unusual microorganisms and microbial population shifts associated with deforestation. **Applied and Enviromental Microbiology**, v. 63, p. 2647–2653, 1997.

BULL, C. T.; DUFFY, B.; VOISARD, C.; DÉFAGO, G.; KEEL, C.; HAAS, D. Characterization of spontaneous *gacS* and *gacA* regulatory mutants of *Pseudomonas fluorescens* biocontrol strain CHA0. **Antonie van Leeuwenhoek**, v. 79**,** p. 327–336, 2011.

CAMARA, B.; STROMPL, C.; VERBARG, S.; DIETMAR, S. C.; PIEPER, H.; BRIAN, J. *Pseudomonas reinekei* sp. nov., *Pseudomonas moorei* sp. nov. and *Pseudomonas mohnii* sp. nov., novel species capable of degrading chlorosalicylates or isopimaric acid. **International Journal of Systematic and Evolutionary Microbiology**, v. 57, p. 923–931, 2007.

CERIGIOLI, M.M. **Diversidade de bactérias endofíticas de raízes de milho (*Zea mays* L.) e potencial para promoção de crescimento.** 132 f. Tese Universidade Federal de São Carlos, Centro de Ciências Biológicas e da Saúde, Departamento de Genética e Evolução, São Carlos, 2005.

CHAN, Y. K.; BARRAQUIO, W. L.; KNOWLES, R. N2-fixing pseudomonads and related soil bacteria. **FEMS Microbiology Reviews**, v. 13, p. 95–118, 1994.

CHEN, H.; QUALLS, R. G.; MILLER, G. C. Adaptive responses of *Lepidium latifolium* to soil flooding: biomass allocation, adventitious rooting, aerenchyma formation and ethylene production. **Environmental and Experimental Botany**, v. 48, p. 119–128, 2002.

CHEN, Y. P.; REKHA, P. D.; ARUN, A. B.; SHEN, F. T.; LAI, W. A.; YOUNG, C. C. Phosphate solubilizing bacteria from subtropical soil and their tricalcium phosphate solubilizing abilities. **Applied Soil Ecology,** v. 34, p. 33–41, 2006.

CHENG , Z.; PARK, E.; GLICK, B. 1-Aminocyclopropane-1-carboxylate deaminase from *Pseudomonas putida* UW4 facilitates the growth of canola in the presence of salt. **Canadian Journal of Microbiology**, v. 53, p. 912-918, 2007.

CHOUDHARY, S.; SAR, P. Characterization of a metal resistant *Pseudomonas* sp. isolated from uranium mine for its potential in heavy metal (Ni(2+), Co(2+), Cu(2+), and Cd(2+) sequestration. **Bioresource Technology**, v. 100, p. 2482–2492, 2009.

CLAUS H.; FILIP, Z. Degradation and transformation of aquatic humic substances by laccase-producing fungi *Cladosporium cladosporioides* and *Polyporus versicolor*. **Acta Hydrochimica et Hydrobiologica**, v. 26, p. 180–185,1998.

CLAYS-JOSSERAND, A.; GHIGLIONE, J. F.; PHILIPPOT, L.; LEMANCEAU, P.; LENSI, R. Effect of soil type and plant species on the fluorescent pseudomonads nitrate dissimilating community. **Plant and Soil,** v. 209, p. 275–282, 1999.

COELHO-JR, C. **Ecologia de manguezais: zonação e dinâmica da cobertura vegetal em gradientes ambientais, Cananéia, São Paulo, Brasil.** 166 f. Tese de doutorado, Instituto Oceanográfico da Universidade de São Paulo, 2003.

COLE, J. R.; WANG. Q.; CARDENAS, E.; FISH, J.; CHAI, B.; FARRIS, R. J. et al. The Ribosomal Database Project: improved alignments and new tools for rRNA analysis. **Nucleic Acids Research**, v. 37**,** p. 141-145, 2009.

CONCEIÇÃO, D. M.; ANGELIS, D. A.; BIDOIA, E. D.; ANGELIS, D. F. Fungos filamentosos isolados do rio Atibaia, SP e refinaria de petróleo biodegradadores de compostos fenólicos. **Arquivos do Instituto Biológico***,* v. 72, p. 99-106, 2005.

CORRÊA, E. B. **Controle biológico da podridão radicular (*Pythium aphanidermatum*) em cultivos hidropônicos.** 133 f. Tese Universidade Estadual Paulista "Júlio de Mesquita Filho" Faculdade de Ciências Agronômicas, Botucatu, 2009.

CORRÊA, E. B.; GALVÃO, J. A. H; BETTIOL, W. Controle biológico da podridão radicular e promoção de crescimento em pepino hidropônico com microrganismos de manguezais. **Pesquisa Agropecuária Brasileira**, v. 46, p. 130-136, 2011.

COSTA, R.; GOMES, N. C. M.; KROGERRECKLENFORT, E.; OPELT, K.; BERG, G.; SMALLA, K. *Pseudomonas* communitie structure and antagonistic potential in the rhizosphere: insights gained by combining phylogenetic and functional gene-based analyses. **Environmental Microbiology**, v. 9, p. 2260-273, 2007.

CURY, J.C. **Atividade microbiana e diversidades metabólica e genética em solo de mangue contaminado por petróleo**. 84f. Dissertação (Mestrado em Agronomia: Solos e Nutrição de Plantas), Universidade de São Paulo, Piracicaba, 2002.

DANOVARO, R.; GAMBI, C.; MIRTO, S. Meiofaunal production and energy transfer efficiency in a seagrass *Posidonia oceanica* bed in the western Mediterranean. **Marine Ecology Progress Series**, v. 234, p. 95-104, 2002.

DEAN, J. F. D.; ERIKSSON, KEL. Laccase and the deposition of lignin in vascular plants. **Holzforschung**, v. 48, p. 21–33, 1994.

De LEIJ, F. A. A. M.; DIXON-HARDY, J. E.; LYNCH, J. M. Effect of 2,4-diacetylphloroglucinol-producing and non-producing strains of *Pseudomonas fluorescens* on root development of pea seedlings in three different soil types and its effect on nodulation by *Rhizobium*. **Biology and Fertility of Soils**, v. 35, p. 114–121, 2002.

DESNOUES, N.; LIN, M.; GUO, X.; MA, L.; O-LOPEZ, R. C.; ELMERICH, C. Nitrogen fixation genetics and regulation in a *Pseudomonas stutzeri* strain associated with rice. **Microbiology**, v. 149, p. 2251–2262, 2003.

De SOUZA, J. T. Antibiotic producing *Pseudomonas* spp. In: de SOUZA, J.T. **Distribuition, diversity, and activity of antibiotic producing *Pseudomonas* spp**. 161 f. Tese Universidade Wageningen, Holanda, 2002.

De SOUZA, J. T.; MAZZOLA, M.; RAAIJMAKERS, J. M. Conservation of the response regulator gene *gacA* in *Pseudomonas* species. **Environmental Microbiology**, v. 5, p.1328–1340, 2003.

De WEGER, L. A.; van der BIJ, A. J.; DEKKERS, L. C.; SIMONS, M.; WIJFFELMANN, C. A.; LUGTENBERG, B. J. J.Colonization of the rhizosphere of cropplants by plant-beneficial *pseudomonads*. **FEMS Microbiolology Ecology**, v. 17, p. 221–228, 1995.

DIAS, A. C. F. **Diversidade bacteriana em sedimento de manguezal na Ilha do Cardoso – Cananeia - São Paulo.** 61p. Dissertação (Mestrado em Biotecnologia), Universidade de São Paulo, 2008.

DIAS, A. C. F; ANDREOTE, F. D.; RIGONATO, J.; FIORE, M. F.; MELO, I. S.; ARAÚJO, W. L. The bacterial diversity in a Brazilian non-disturbed mangrove sediment. **Antonie van Leeuwenhoek,** v. 98, p. 541-551, 2010.

DIAS, A. C. F.; DINI-ANDREOTE, F.; TAKETANI, R. G.; TSAI, S. M.; AZEVEDO, J. L.; MELO, I. S.; ARCHAEAL, F. D. A. Communities in the sediments of three contrasting mangroves. **Journal of Soils and Sediments**, 2011 (In press).

DÖBEREINER, J.; BALDANI, V. L. D.; BALDANI, J. I. **Como isolar e identificar bactérias diazotróficas de plantas não-leguminosas**. Brasília: Embrapa-SPI, 1995. 60p.

DOWLING, D. N.; GARA, F. O. Metabolites of *Pseudomonas* involved in the biocontrol of plant disease. **Trends in Biotechnology**, v. 12, p. 133–141, 1994.

DRENKARD, E.; AUSUBEL, F. M. *Pseudomonas* biofilm formation and antibiotic resistance are linked to phenotypic variation. **Nature**, v. 416, p. 740–743, 2002.

DUA, M.; SING, A.; SETHUNATHAN, N.; JOHRI, A. K. Biotecnologia e biorremediação: Sucessos e limitações. **Applied Microbiol Biotechnology**, v. 59, p. 143-152, 2003.

DUFFY, B. D.; DEFAGO, G. Controlling Instability in *gacS-gacA* Regulatory Genes during Inoculant Production of *Pseudomonas fluorescens* Biocontrol Strains. **Applied and Environmental Microbiology**, v. 66, p. 3142–3150, 2000.

DUKE, N. C.; BALL, M. C.; ELLISON, J. C. Factors influencing biodiversity and distributional gradients in mangroves. **Global Ecology Biogeographic Letter**, v. 7, p. 27-47, 1998.

EHMANN, A. The van urk: salkowski reagent: a sensitive and specific chromogenic reagent for silica gel thin-layer chromatographic detection and identification of indole derivates. **Journal of Chromatography**, v. 132, p. 267-276, 1977.

ELLIS, R. J.; TIMMS-WILSON, T. M.; BERINGER, J. E.; RHODES, D.; RENWICK, A.; STEVENSON, L.; BAILEY, M. J. Ecological basis for biocontrol of damping-off disease by *Pseudomonas fluorescens* 54/96. **Journal of Applied Microbiology**, v. 87, p. 454–463, 1999.

ESPOSITO, E.; AZEVEDO, J.L. **Fungos: uma introdução à biologia, bioquímica e biotecnologia.** Caxias do Sul: Educs, 2004.

EUZÉBY, J. P. **List of Prokaryotic names with Standing in Nomenclature.** Disponível em: <http://www.bacterio.cict.fr/p/pseudomonas.html > Acesso em: 05 janeiro 2012.

FAUTH, J. E.; BERNARDO, J.; CAMARA, M.; RESETARITS, W. J.; VAN BUSKIRK, J.; McCOLLUM, S. A. Simplifying the jargon of community ecology: a conceptual approach. **The Americ Naturalist,** v. 147, p. 282-286, 1996.

FEDRIZZI, S.M.G. **Produção de metabólitos antimicrobianos e sideróforos de isolados provenientes da Terra Preta Antropogênica da Amozônia Ocidental.** 117 f. Tese (Doutorado, Centro de Energia Nuclear na Agricultura) Universidade de São Paulo, Piracicaba, 2006.

FELSENSTEIN, J. Confidence limits on phylogenies: An approach using the bootstrap. **Evolution**, v. 39, p. 783-791, 1985.

FELSKE, A.; RHEIMS, H.; WOLTERINK A.; STACKEBRANDT, E.; AKKERMANS, A. D. L. Ribosome analysis reveals prominent activity of an uncultured member of the class Actinobacteria in grassland soils. **Microbiology**, v. 143, p. 2983–2989, 1997.

FELSKE, A.; WOLTERINK, A.; van LIS, R.; AKKERMANS, A. D. L. Phylogeny of the main bacterial 16S rRNA sequences in a Drentse grassland soils (The Netherlands). **Applied and Enviromental Microbiology**, v. 54, p. 871–879, 1998.

FRIDLENDER, M.; INBAR, J.; CHET, I. Biological control of soil borne plant pathogens by a 1,3 glucanase-producing *Pseudomonas cepacia.* **Soil Biology and Biochemistry**, v. 25, p.1211–1221, 1993.

GEORGAKOPOULOS, D. G.; FIDDAMAN, P.; LEIFERT, C. et al. Biological control of cucumber and sugar beet damping-off caused by *Pythium ultimum* with bacterial and fungal antagonists. **Journal of Applied Microbiology**, v. 92, p. 1078-1086, 2002.

GHOSH, S.; PENTERMAN, J. N.; LITTLE, R. D.; CHAVEZ, R.; GLICK, B. R. Three newly isolated plant growth-promoting bacilli facilitate the seedling growth of canola, *Brassica campestris*. **Plant Physiology and Biochemistry**, v. 41, p. 277–281, 2003.

GIBELLO, A.; VELA, A. I.; MARTIN, M.; MENGS, G.; ALONSO, P. Z.; GARBI, C.; FERNANDEZ-GARAYZABAL, J. F. *Pseudomonas composti* sp. nov., isolated from compost samples. **International Journal Systematic and Evolutionary Microbiology**, v. 61, p. 2962-2966, 2011.

GINOLHAC, A.; JARRIN, C.; GILLET, B.; ROBE, P.; PUJIC, P.; TUPHILE, K.; BERTRAND, H.; VOGEL, T.M.; PERRIERE, G.; SIMONET, P.; NALIN, R. Phylogenetic analysis of polyketide synthase I domains from soil metagenomic libraries allows selection of promising clones. **Applied and Environmental Microbiology**, v. 70, p. 5522-5527, 2004.

GLICK, B. R. The enhancement of plant growth by free-living bacteria. **Canadian Journal of Microbiology,** v. 41, p. 109–117, 1995.

GLICK, B. R.; TODOROVIC, B.; CZARNY, J.; CHENG, Z.; DUAN, J.; McCONKEY, B. Promotion of plant growth by bacterial ACC deaminase. **Critical Reviews in Plant Sciences,** v. 26, p. 227–242, 2007.

GOMES, N. C. M; BORGES, L. R.; PARANHOS, R.; PINTO, F. N.; MENDONÇA-HAGLER, L. C. S; SMALLA, K. Exploring the diversity of bacterial communities in sediments of urban mangrove forests. **FEMS Microbiology Ecology**, v. 66, p. 96–109, 2008.

GOMES, N. C. M.; HEUER, H.; SCHONFELD, J.; COSTA, R.; MENDONCA-HAGLER, L.; SMALLA, K. Bacterial diversity of the rhizosphere of maize (*Zea mays*) grown in tropical soil studied by temperature gradient gel electrophoresis. **Plant and Soil**, v. 232, p. 167-180, 2001.

GONZÁLEZ, N.; HEEB, S.; VALVERDE, C.; KAY, E.; REIMMANN, C.; JUNIER, T.; HAAS, D. Genome-wide search reveals a novel GacA-regulated small RNA in *Pseudomonas* species. **BMC Genomics**, v. 9, p.167, 2008.

GOTTARDO, E. P. **Diversidade de bacterias diazotroficas endofiticas de mangue vermelho *(Rhizophora mangle)* e avaliação do potencial biotecnológico.** 85 f. Dissertação de Mestrado (Biotecnologia), Instituto de Ciências Biomédicas, Universidade de São Paulo, São Paulo, 2009.

GOULD, W. D.; HAGEDORN, C.; BARDINELLI, T. R.; ZABLOTOWICZ, R. M. New Selective Media for Enumeration and Recovery of Fluorescent Pseudomonads from Various Habitats. **Applied and Environmental Microbiology**, p. 28-32, 1985.

GRICHKO, V. P.; GLICK, B. R. Amelioration of flooding stress by ACC deaminase-containing plant growth-promoting bacteria. **Plant Physiology and Biochemistry**, v. 39, p. 11–17, 2001.

GROSS, H.; LOPER, J. E. Genomics of secondary metabolite production by *Pseudomonas* spp. **Natural Product Reports**, v. 26, p. 1408–1446, 2009.

GULATI, A.; RAHI, P; VYAS,P. Characterization of phosphate-solubilizing fluorescent pseudomonads from the rhizosphere of seabuckthorn growing in the cold deserts of Himalayas. **Current Microbiology**, v. 56, p. 73-79, 2008.

GUPTA, R.; MOHAPATRA, H.; GOSWANI, V. K.; CHAUHAN, B. Microbial α-Amylases: Biotechnological Perpective. **Process Biochemistry**, v. 38, p. 1599-1616, 2003.

GUSTI, W.; ALIT-SUSANTA, N.; TAKIKAWA, Y. Analysis of the *gacS-gacA* regulatory genes of spontaneous mutants of *Pseudomonas fluorescens* biocontrol strain PfG32R. **Journal of General Plant Pathology,** v. 72, p. 159–167, 2006.

HAAS, D.; DÉFAGO, G. Biological control of soil-borne pathogens by fluorescent pseudomonads. **Nature Reviews Microbiology***,* v*.* 3, p.307-319, 2005.

HAAS, D.; KEEL, C. Regulation of antibiotic production in root-colonizing *Pseudomonas* spp. and relevance for biological control of plant disease. **Annual Review Phytopathology**, v. 41, p. 117–153, 2003.

HAMMER, P. E.; EVENSEN, K. B. Post harvest control of *Botrytis cinerea* on cut flowers with pyrrolnitrin. **Plant Disease**, v. 77, p. 283-286, 1993.

HARDHAM, A.R. Cell biology of plant-oomycete interactions. **Cellular Microbiology**, v.9 p.31-39, 2007.

HEAD, I. M.; SAUNDERS, J. R.; PICKUP, R. W. Microbial evolution, diversity, and ecology: A decade of ribosomal RNA analysis of uncultivated microorganisms. **Microbial Ecology**, v. 35, p. 1-21, 1998.

HEEB, S.; HAAS, D. Regulatory roles of the GacS/ GacA two-component system in plant-associated and other Gram negative bacteria. **Molecular Plant Microbe Interact**, v. 14, p. 1351–1363, 2001.

HENRIQUES, I. S.; ALVES, A.; TACÃO, M.; ALMEIDA, A.; CUNHA, A.; CORREIA, A. Seasonal and spatial variability of free-living bacterial community composition along an estuarine gradient (Ria de Aveiro, Portugal). **Estuarine, Coastal and Shelf Science**, v. 68, p. 139-148, 2006.

HEUER, H.; SMALLA, K. Application of denaturing gradient gel electrophoresis (DGGE) and temperature gradient gel electrophoresis (TGGE) for studing soil microbial communities. In: VAN ELSAS, J. D.; TREVORS, J. T.; WELLINGTON, E. M. H (Ed.). **Modern Soil Microbiology**. New York: M. Dekker, 1997. p. 353-373.

HEUER, H.; KRSEK, M.; BAKER, P.; SMALLA, K.; WELLINGTON, E.M.H. Analysis of actinomycete communities by specific amplification of genes encoding 16S rRNA and gel-electrophoretic separation in denaturing gradients. **Applied and Environmental Microbiology**, v. 63, p. 3233-3241, 1997.

HEUER, H.; SMALLA, K. Bacterial phyllosphere communities of *Solanum tuberosum* L. and T4-lysozyme-producing transgenic variants. **FEMS Microbiology Ecology**, v. 28, p. 357-371, 1999.

HEYRMAN, J.; MERGAERT, J.; DENYS R. J. The use of fatty acid methyl ester analysis (FAME) for the identification of heterotrophic bacteria present on three mural paintings showing severe damage by microorganisms. **FEMS Microbiology Letters**, v. 181, p. 55–62, 1999.

HOLGUIN, G.; GUZMAN, M. A.; BASHAN, Y. Two new nitrogen-fixing bacteria from the rhizosphere of mangrove trees: their isolation, identification and in vitro interaction with rhizosphere *Staphylococcus* sp. **FEMS Microbiology Ecology**, v. 101, p. 207-216, 1992.

HOLGUIN, G.; BASHAN, Y.; MENDOZA-SALGADO, R.; AMADOR, E.; TOLEDO, G.; VÁZQUEZ, P.; AMADOR, A. La microbiología de los manglares. Bosques en la frontera entre el mar y la tierra. **Ciencia y Desarrollo,** p. 26-35, 1999.

HOLGUIN, G.; VAZQUEZ, P.; BASHAN, Y. The role of sediment microorganisms in the productivity, conservation, and rehabilitation of mangrove ecosystems: an overview. **Biology and Fertility of Soils**, v. 33, p. 265-278, 2001.

HOWELL, C. R.; STIPANOVIC, R. D. Suppression of *Pythium ultimum* induced damping-off of cotton seedlings by *Pseudomonas fluorescens* and its antibiotic pyoluteorin. **Phytopathology**, v. 70, p. 712-715, 1980.

HUMAIR, B.; WACKWITZ, B.; HAAS, D. GacA controlled activation of promoters for small RNA genes in *Pseudomonas fluorescens*. **Applied and Environmental Microbiology**, v. 76, p. 1497–1506, 2010.

HUNG, W.L.; WADE,W.G.; BODEN,R.; KELLY, D.P.; WOOD, A.P. Facultative methylotrophs from the human oral cavity and methylotrophy in strains of *Gordonia*, *Leifsonia*, and *Microbacterium.* **Archives Microbiology**, v. 193, p.407-417, 2011.

ISNANSETYO, A.; KAMEI, Y. MC21-A, a bactericidal antibiotic produced by a new marine bacterium, *Pseudoalteromonas phenolica* sp. nov.O-BC30T, against methicillin-resistant *Staphylococcus aureus*. **Antimicrobial Agents and Chemotherapy**, p. 480–488, 2003.

IWAKI, H.; WANG, S.; GROSSE, S.; BERGERON, H.; NAGAHASHI, A.; LERTVORACHON, J.; YANG, J.; KONISHI, Y.; HASEGAWA, Y.; LAU, P. C. Pseudomonad cyclopentadecanone monooxygenase displaying an uncommon spectrum of Baeyer-Villiger oxidations of cyclic ketones. **Applied and Environmental Microbiolology**, v. 72, p. 2707-2720, 2006.

JOHNSEN, K.; ANDERSON, S.; JACOBSEN, C. S. Phenotypic and genotypic characterisation of phenanthrene-degrading fluorescent *Pseudomonas* biovars. **Applied and Environmental Microbiology**, v. 62, p. 3818–3825, 1996.

JOUSSET, A.; SCHEU, S.; BONKOWSKI, M. Secondary metabolite production facilitates establishment of rhizobacteria by reducing both protozoan predation and the competitive effects of indigenous bacteria. **Functional Ecology**, v. 22, p. 714–719, 2008.

JUKES, T. H.; CANTOR, C. R. Evolution of protein molecules. In: MUNRO, H.N., ed. **Mammalian protein metabolism**. New York: Academic Press, 1969.

KANLAYAKRIT, W.; IKEDA, T.; TOJAI, S.; RODPRAPAKORN, M.; SIRISANSANEEYACUL, S. Isolation and characterization of extracellular halophilic ribonuclease from halotolerant *Pseudomonas* sp. **Kasetsart Jounal: Natural Science**, v. 35, p. 179-187, 2001.

KARIGAR, C.; MAHESH, A.; NAGENAHALLI, M.; YUN, D.J. Phenol degradation by immobilized cells of *Arthrobacter citreus*. **Biodegradation**, v.17, p. 47-55, 2006.

KAY, E.; DUBUIS, C.; HAAS, D. Three small RNAs jointly ensure secondary metabolism and biocontrol in *Pseudomonas fluorescens* CHA0. **Proceedings of the National Academy of Sciences of the United States of America,** p.17136–17141, 2005.

KAY, E.; HUMAIR, B.; DÉNERVAUD, V.; RIEDEL, K.; SPAHR, S.; EBERL, L.; VALVERDE, C.; HAAS, D. Two GacA-dependent small RNAs modulate the quorum sensing response in *Pseudomonas aeruginosa*. **Journal of Bacteriology**, v.188, p. 6026–6033, 2006.

KEEL, C.; SCHNIDER, U.; MAURHOFER, M.; VOISARD, C.; LAVILLE, J.; BURGER, U.; WITHNER, P.; HAAS, D.; DÉFAGO, G. Suppression of root diseases by *Pseudomonas fluorescens* CHA0: Importance of the bacterial secondary metabolite 2,4-diacetylphloroglucinol. **Molecular Plant-Microbe Interactions**, v. 5, p. 4–13, 1992.

KERSTERS, K.; LUDWING, W.; VANCANNEYT, M.; De VOS, P.; GILLIS, M.; SCHLEIFER, K. Recent changes in the classification of the pseudomonads: an overview. **Systematic and Applied Microbiology,** v. 19, p. 465–477, 1996.

KHANDEPARKER, R.; VERMA, P.; DEOBAGKAR, D. A novel halotolerant xylanase from marine isolate *Bacillus subtilis* cho40: gene cloning and sequencing. **New Biotechnology**, v.28, p.814-821, 2011.

KIM, T. K.; FUERST, J. A. Diversity of polyketide synthase genes from bacteria associated with the marine sponge *Pseudoceratina clavata*: culture-dependent and culture-independent approaches. **Environmental Microbiology**, v. 8, p.1460-1470, 2006.

KIMURA, M. A simple method for estimating evolutionary rates of bases substitutions through comparative studies of nucleotide sequences. **Journal of Molecular Evolution**, v. 16, p. 111-120, 1980.

KING, E. O.; WARD, M. K.; RANEY, D. E. Two simple media for the demonstration of pyocyanin and fluorescein. **Journal of Laboratory and Clinical Medicine**, v. 44, p. 301-307, 1954.

KITTEN, T.; KINSCHERF, T. G.; MCEVOY, J. L.; WILLIS, D. K. A newly identified regulator is required for virulence and toxin production in *Pseudomonas syringae*. **Molecular Microbiology**, v. 28, p. 917–929, 1998.

KLOEPPER, J. W.; LEONG, J; TEINTZE, M.; SCHROT, M. N. Enhancing plant growth by siderophores produced by plant growth-promoting rhizobacteria. **Nature**, v. 286, p. 885–86, 1980.

KORDEL, M.; HOFMANN, B.; SCHOMBURG, D.; SCHIMID, R. Extracellular lipase of *Pseudomonas* sp. Strain ATCC 21808: purification, characterization, crystallization and preliminary X-ray diffraction data. **Journal of Bacteriology**, v. 177, p. 4836-4841, 1991.

KUMAR, R. S.; AYYADURAI, N.; PANDIARAJA, P.; REDDY, A. V.; VENKATESWARLU, Y.; PRAKASH, O.; SAKTHIVEL, N. Characterization of antifungal metabolite produced by a new strain *Pseudomonas aeruginosa* PUPa3 that exhibits broad-spectrum antifungal activity and biofertilizing traits. **Journal of Applied Microbiology**, v. 98, p. 145–154, 2005.

KUMAR, S.; KUNDU, S.; PAKSHIRAJAN, K.; DASU, V. V. Cephalosporins determination with a novel microbial biosensor based on permeabilized *Pseudomonas aeruginosa* whole cells. **Applied Biochemistry Biotechnology,** v. 151, p. 653–664, 2008.

LACERDA, L. D. Updating global mercury emissions from small-scale gold mining and accessing its environmental impacts. **Enviromental Geology**, v. 43, p. 308-314, 2003.

LAMBAIS, M. R.; CROWLEY, D. E.; CURY, J. C.; BULL, R. C.; RODRIGUES, R.R. Bacterial diversity in tree canopies of the Atlantic forest. **Science**, v. 312, p. 1917-1917, 2006.

LAMONT, I. L.; MARTIN, L. W. Identification and characterization of novel pyoverdine synthesis genes in *Pseudomonas aeruginosa*. **Microbiology**, v. 149, p. 833–842, 2003.

LARKIN, M. A.; BLACKSHIELDS, G.; BROWN, N. P.; CHENNA, R.; MCGETTIGAN P. A.; MCWILLIAM, H.; VALENTIN, F.; WALLACE, I. M.; WILM, A.; LOPEZ, R.; THOMPSON, J. D.; GIBSON, T. J.; HIGGINS, D. G. ClustalW and ClustalX version 2. **Bioinformatics**, v. 23, p. 2947-2948, 2007.

LARSEN, H. Halophilic and halotolerant microorganisms - an overview and historical perspective. **FEMS Microbiology Letters**, v. 39, p. 3-7, 1986.

LATOUR, X.; LEMANCEAU, P. Carbon and energy metabolism of oxidase-positive saprophytic fluorescent *Pseudomonas* spp. **Agronomie,** v. 17, p. 427-443, 1997.

LATOUR, X.; CORBERAND, T. S.; LAGUERRE, G.; ALLARD, F.; LEMANCEAU, P. The composition of fluorescent pseudomonad populations associated with roots is influenced by plant and soil type. **Applied and Environmental Microbiology**, v. 62, p. 2449–2456, 1996.

LAURSEN, J. B.; NIELSEN, J. Phenazin natural products: biosynthesis, synthetic analogues and biological activity. **Chemical Reviews**, v. 104, p. 1663–1685, 2004.

LAVILLE, J.; VOISARD, C.; KEEL, C.; MAURHOFER, M.; DEFAGO, G.; HAAS, D. Global control in *Pseudomonas fluorescens* mediating antibiotic synthesis and suppression of black root rot of tobacco. **Proceedings of the National Academy of Science of the United States of America**, v. 89, p. 1562–1566, 1992.

LEMANCEAU, P.; ALABOUVETTE, C. Biological control of fusarium diseases by fluorescent *Pseudomonas* and nonpathogenic *Fusarium*. **Crop Protection**, v. 10, p. 279–286, 1991.

Le RUDULIER, D.; STROM, A. R. DANDEKAR, A. M.; SMITH, L. T.; VALENATINE, R.C. Molecular biology of osmoregulation. **Science**, v. 214, p. 1064-1068, 1984.

LI,D.; LI,Z.; YU,J.; CAO,N.; LIU,R.; YANG,M. Characterization of bacterial community structure in a drinking water distribution system during an occurrence of red Water. **Applied and Environmental Microbiolology**, v. 76, p. 7171-7180, 2010.

LIU, J.; ZHANG, Z.; ZHU, H.; DANG, H.; LU, J.; CUI, Z. Isolation and characterization of amylase from marine *Pseudomonas* sp. K6-28-040. **African Journal of Biotechnology**, v. 10, p. 2733-2740, 2011.

LOPER, J. E.; BUYER, J. S. Siderophores in microbial interactions on plant surfaces. **Molecular Plant-Microbe Interactions**, v. 4, p. 5–13, 1991.

LORCK, H. Production of hydrocynic acid from bacteria. **Physiologia Plantarum**, v. 1, p.142–146, 1948.

LOTTMANN, J.; BERG, G. Phenotypic and genotypic characterizationof antagonistic bacteria associated with roots of transgenic and non-transgenic potato plants. **Microbiological Research**, v. 156, p. 75–82, 2001.

LOUWS, F. J.; RADEMAKER, J. L. W.; De BRUIJN, F. J. The three Ds of PCR-based genomic analysis of phytobacteria: Diversity, detection, and disease diagnosis. **Annual Review of Phytopathology**, v. 37, p. 81-125, 1999.

LUDWIG, W.; STRUNK, O.; KLUGBAUER, N.; WEIZENEGGER, M.; NEUMAIER, J.; BACHLEITNER, M.; SCHELEIFER, K. H. Bacterial phylogeny based on comparative sequence analysis. **Electrophoresis**, v. 19, p. 554-568, 1998.

LUGOMELA, C.; BERGMAN, B. Biological N2-fixation on mangrove pneumatophores: preliminary observations and perspectives. **Ambio**, v. 31, p. 7–8, 2002.

LUGTENBERG, B. J. J.; CHIN-A-WOENG, T. F. C.; BLOEMBERG, G. V. Microbe-plant interactions: principles and mechanisms. **Antonie van Leeuwenhoek**, v. 81, p. 373–383, 2002.

MADIGAN, M.T.; MARTINKO, J.M.; PARKER, J. Antibiotics: isolation and characterization. In: **Brock Biology of microorganisms**, 8. ed., New Jersey: Prentice-Hall International Inc., 1997, p. 440-442.

MALAVOLTA, E.; VITTI, G. C.; OLIVEIRA, A. S. **Avaliação do estado nutricional das plantas:** princípios e aplicações. Piracicaba: Associação Brasileira para Pesquisa da Potassa e do Fosfato. 1989. 201p.

MARINHO, P. R.; MOREIRA, A. P. B.; PELLEGRINO, F. L. P. C.; MURICY, G.; BASTOS, M. C. F.; Dos SANTOS, K. R. N.; GIAMBIAGI-DEMARVAL, M.; LAPORT, M. S. Marine *Pseudomonas putida*: a potential source of antimicrobial substances against antibiotic-resistant bactéria. **Memórias do Instituto Oswaldo Cruz**, v. 104, p. 678-682, 2009.

MARUTANI, M.; TAGUCHI, F.; OGAWA, Y.; HOSSAIN, M. M. et al. Gac two-component system in *Pseudomonas syringae* pv. tabaci is required for virulence but not for hypersensitive reaction. **Molecular Genetics and Genomics,** v. 279, p. 313-322, 2008.

MAURHOFFER, M.; KEEL, C.; SCHNIDER, U.; VIOSARD, C.; HAAS, D.; DÉFAGO, G. Influenced of enhanced antibiotic production in *Pseudomonas fluorescens* strain CHA0 on its disease suppressive capacity. **Phythopathology**, v. 82, p. 190-195, 1992.

MAYAK, S.; TIROSH, T.; GLICK, B. R. Plant growth-promoting bacteria confer resistance in tomatoes plants to salt stress. **Plant Physiology and Biochemistry**, v. 42, p. 565–572, 2004.

MAZZOLA, M.; COOK, R. J.; THOMASHOW, L. S.; WELLER, D. M.; PIERSON, L. S. Contribution of phenazine antibiotic biosynthesis to the ecological competence of fluorescent pseudomonads in soil habitats. **Appllied and Environmental Microbiology**, v. 58, p. 2616–2624, 1992.

MELO, I. S.; AZEVEDO, J. L. **Controle Biológico**.  Jaguariúna, SP: Embrapa Meio Ambiente, 2000, v.2, 388p.

MELO, I. S.; SANHUEZA, R. M. V**. Métodos de seleção de micro-organismos antagônicos a fitopatógenos**: manual técnico. Jaguariúna: Embrapa Meio Ambiente, 1995, 72 p.

MENDES, R.; KRUIJT, M.; BRUIJN, I.; DEKKERS, E.; van der VOORT, M.; SCHNEIDER, J. H. M.; PICENO, Y. M.; DESANTIS, T. Z.; ANDERSEN, G. L.; BAKKER, P. A. H. M.; RAAIJMAKERS, J. M. Deciphering the rhizosphere microbiome for disease-suppressive bacteria. **Science**, v. 332, p. 1097-1100, 2011.

De MEYER G.; HÖFTE, M. Salicylic acid produced by the rhizobacterium *Pseudomonas aeruginosa* 7NSK2 induces resistance to leaf infection by *Botrytis cinerea* on bean. **Phytopathology**, v. 87, p. 588-593, 1997.

MILLING, A; SMALLA, K.; MAIDL, F. X.; SCHLOTER, M.; MUNCH, J. C. Effects of transgenic potatoes with an altered starch composition on the diversity of soil and rhizosphere bacteria and fungi. **Plant and Soil**, v. 226, p. 23-39, 2004.

MISKO, A. L.; GERMIDA, J. J. Taxonomic and functional diversity of pseudomonads isolated fromthe roots of grown canola. **FEMS Microbiology Ecology**, v. 42, p. 399-407, 2002.

MONTAÑEZ, A.; ABREU, C.; GILL, P. R.; HARDARSON, G.; SICARD M. Biological nitrogen fixation in maize (*Zea mays* L.) by 15N isotope-dilution and identification of associated culturable diazotrophs. **Biology and Fertility of Soils**, v. 45, p. 253–263, 2009.

MULET, M.; LALUCAT, J.; GARCÍA-VALDÉS, E. DNA sequence-based analysis of the *Pseudomonas* species. **Environmental Microbiology,** v. 12, p. 1513–1530, 2010.

MULYA, K.; WATANABE, M.; GOTO, M.; TAKIKAWA, Y.; TSUYUMU, S. Suppression of bacterial wilt disease of tomato by root-dipping with *Pseudomonas fluorescens* PfG32R: the role of antibiotic substances and siderophore production. **Annals of the Phytopathologicial Society of Japan**, v. 62, p.132–140, 1996.

MUNNS, R. Comparative physiology of salt and water stress. **Plant, Cell and Environment**, v. 25, p. 239–250, 2002.

MUYZER, G.; DEWAAL, E. C.; UITTERLINDEN, A. G. Profiling of complex microbial populations by Denaturing Gradient Gel Electrophoresis analysis of polymerase chain reaction-amplified genes coding for 16S Ribosomal RNA. **Applied and Environmental Microbiology**, v. 59, p. 695-700, 1993.

MUYZER, G.; SMALLA, K. Application of denaturing gradient gel electrophoresis (DGGE) and temperature gradient gel electrophoresis (TGGE) in microbial ecology. **Antonie van Leeuwenhoek**, v. 73, p. 127-141, 1998.

MYERS, D. F.; STROBEL, G. A. *Pseudomonas syringae* as a microbial antagonist against *C. ulmi* in the apoplast of American elms. **Transactions of the British Mycological Society**, v. 80, p. 389-394, 1983.

NAIK, P. R.; RAMAN, G.; NARAYANAN, K. B.; SAKTHIVEL, N. Assessment of genetic and functional diversity of phosphate solubilizing fluorescent pseudomonads isolated from rhizospheric soil. **BioMed Central Microbiology**, v. 8, 2008. doi:10.1186/1471-2180-8-230

NAIK, P. R.; SAKTHIVEL, N. Functional characterization of a novel hydrocarbonoclastic *Pseudomonas* sp. strain PUP6 with plant-growth-promoting traits and antifungal potential. **Research in Microbiology**, v. 157, p. 538–546, 2006.

NAIR, S. Distribution and significance of heterotrophic marine bacteria with antibacterial activity. **Applied and Environmental Microbiology**, v. 53, p. 2957-2962, 1987.

NAUTIYAL, C. S. An efficient microbiological growth medium for screening phosphate solubilizing microorganisms. **FEMS Microbiology Letters**, v. 170, p. 265-270, 1999.

NEDWELL, D. B.; BLACKBURN, T. H.; WIEBE, J. Dynamic nature of the turnover of organic carbon, nitrogen and sulphur in the sediments of a Jamaican mangrove forest. **Marine Ecology Progress Series**, v. 110, p. 223-231, 1994.

NIELSEN, T. H.; CHRISTOPHERSEN, C.; ANTHONI, U.; SORENSEN, J. Viscosinamide, a new cyclic depsipeptide with surfactant and antifungal properties produced by *Pseudomonas fluorescens* DR54. **Journal of Applied Microbiology**, v. 86, p. 80–90, 1999.

NISHIMORI, E.; KITA-TSUKAMOTO, K.; WAKABAYASHI, H. *Pseudomonas plecoglossicida* sp. nov., the causative agent of bacterial haemorrhagic ascites of ayu, *Plecoglossus altivelis.* **International Journal of Systematic and Evolutionary Microbiology**, v. 50, p. 83–89, 2000.

NITSCHKE, M.; SIDDHARTHA, G. V. A. O.; COSTA, J. C. Rhamnolipids and PHAs: Recent reports on *Pseudomonas*-derived molecules of increasing industrial interest. **Process Biochemistry**, v. 46, p. 621–630, 2011.

ODACI, D.; SEZGINTURK, M. K.; TIMUR, S.; PAZARLIOGLU, N.; PILLOTON, R.; DINCKAYA, E.; TELEFONCU, A. *Pseudomonas putida* based amperometric biosensors for 2,4-D detection. **Preparative Biochemistry Biotechnology,** v. 39, p. 11–19, 2009.

OLIVEIRA, V. M.; SETTE, L. D.; SIMIONI, K. C. M.; SANTOS NETO, E. V. Bacterial diversity characterization in petroleum samples from Brazilian reservoirs. **Brazilian Journal of Microbiology**, v.39, p. 445-452, 2008.

OLIVEIRA, Z. M. **Rizobactérias promotoras de crescimento vegetal isoladas de cana-de-açúcar sob biofertilização orgânica e/ou convencional.** 164p. Tese Universidade de São Paulo, Instituto de Ciências Biomédicas, Departamento de Microbiologia, São Paulo, 2009.

OLIVERA, S.; DUSICA, D.; DRAGANA, J.; DORDE, K.; NATASA, R.; JELENA, K. Improvement of common bean growth by co-inoculation with *Rhizobium* and plant growth-promoting bacteria. **Romanian Biotechnological Letters**, v. 16, p. 5919-5926, 2011.

OVREAS, L.; JENSEN, S.; DAAE, F. L.; TORSVIK, V. Microbial community changes in a perturbed agricultural soil investigated by molecular and physiological approaches. **Applied and Environmental Microbiology**. v. 64, p. 2739-2742. 1998.

PADILHA, G. S.; CASTIGLIONI, G. L.; ALEGRE, R. M.; TAMBOURGI, E. B. Avaliação de diferentes íons na atividade da lípase de *Pseudomonas cepacia.* **Exacta**, v. 7, p. 181-186, 2009.

PALLERONI, N. J. Introduction to the family pseudomonadaceae. In: BALOWS, H.G., TRUPER, M.; DWORKIN, W.; HARDER, A.; SCHLIEFER, K. (Eds.), 2a ed. **The Prokaryotes**, vol. 3. Springer-Verlag, New York, pp. 3071– 3085, 1992.

PAN, B.; BAI, Y. M.; LEIBOVITCH, S.; SMITH, D. L. Plant-growth promoting rhizobacteria and kinetin as ways to promote corn growth and yield in a short – growing –season area. **European Journal of Agronomy**, v. 11, p. 179-186, 1999.

PEIXOTO, A. R.; MARIANO, R. L. R.; MICHEREFF, S, J,; OLIVEIRA, S. M. A. Ação antagônica de *Pseudomonas aeruginosa* a *Pseudomonas solanacearum* e efeito no desenvolvimento de plântulas de tomate. **Summa Phytopathologica**, v. 21, p. 219-224, 1995.

PEIXOTO, R.; CHAER, G. M.; CARMO, F. L.; ARAÚJO, F. V.; PAES, J. E.; VOLPON, A.; SANTIAGO, G. A.; ROSADO, A.S. Bacterial communities reflect the spatial variation in pollutant levels in Brazilian mangrove sediment. **Antonie van Leeuwenhoek,** v. 99, p. 341-354, 2011.

PHAM, T. H.; BOON, N.; De MAEYER, K.; HOFTE, M.; RABAEY, K.; VERSTRAETE, W. Use of *Pseudomonas* species producing phenazine-based metabolites in the anodes of microbial fuel cells to improve electricity generation. **Applied Microbiology and Biotechnology**, v. 80, p. 985–993, 2008.

PIERSON, L. S.; PIERSON, E. A. Phenazine antibiotic production in *Pseudomonas aureofaciens*: role in rhizosphere ecology and pathogen suppression. **FEMS Microbiology Letters**, v. 136, p. 101–108, 1996.

PIETERSE, C. M. J.; van LOON, L. C. Salicylic acid independent plant defence pathways. **Trends Plant Science**, v.4, p.52–58, 1999.

PRADA-GAMERO, R. M. **Mineralogia, fisico-quimica e classificação dos solos de mangue do Rio Iriri no canal de Bertioga (Santos, SP)**. 76 f. Dissertação (M.S.) – Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo, Piracicaba, 2001.

PRESTON, G. M.; BERTRAND, N.; RAINEY, P. B. Type III secretion in plant growth promoting *Pseudomonas fluorescens* SBW25. **Molecular Microbiology**, v. 41, p. 999-1014, 2001.

PROSSER, J. I.; BOHANNAN, B. J. M.; CURTIS, T. P.; ELLIS, R. J.; FIRESTONE, M. K.; FRECKLETON, R. P.; GREEN, J. L.; GREEN, L. E.; KILLHAM, K.; LENNON, J. J.; OSBORN, A. M.; SOLAN, M.; Van DER GAST, C. J.; YOUNG, J. P. W. Essay - The role of ecological theory in microbial ecology. **Nature Reviews Microbiology**, v. 5, p. 384-392, 2007.

RAAIJMAKERS, J. M.; WELLER, D. M. Exploiting genotypic diversity of 2,4-diacetylphloroglucinol-producing *Pseudomonas* spp.: characterization of superior root-colonizing *P. fluorescens* strain Q8r1-96. **Applied Environmental Microbiology,** v. 67, p. 2545–2554, 2001.

RADWAN, T. E. E.; MOHAMED, Z. K.; REIS, V.M. Aeração e adição de sais na produção de ácido indol acético por bactérias diazotróficas. **Pesquisa Agropecuária Brasileira**, Brasília, v. 40, p. 997-1004, 2005.

RAMETTE, A.; FRAPOLLI, M.; SAUX, M.F.; GRUFFAZ, C.; MEYER, J.M.; DEFAGO, G.; SUTRA, L.; MOENNE-LOCCOZ, Y. *Pseudomonas protegens* sp. nov., widespread plant-protecting bacteria producing the biocontrol compounds 2,4-diacetylphloroglucinol and pyoluteorin. **Systematic and Applied Microbiolology**, v. 34, p.180-188, 2011.

RANGARAJAN, S.; LOGANATHAN, P.; SALEENA, L. M.; NAIR, S. Diversity of pseudomonads isolated from three different plant rhizospheres. **Journal of Applied Microbiolology**, v. 91, p. 742–749, 2001.

RAVIKUMAR, S.; RAMANATHAN, G.; SUBA, N.; JEYASEELI, L.; SUKUMARAN, M. Quantification of halophilic *Azospirillum* from mangroves. **Indian Journal of Marine Science**, v. 31, p. 157-160, 2002.

REIMMANN, C.; VALVERDE, C.; KAY, E.; HAAS, D. Posttranscriptional repression of GacS/GacA-controlled genes by the RNA-binding protein RsmE acting together with RsmA in the biocontrol strain *Pseudomonas fluorescens* CHA0. **Journal of Bacteriology**, v. 187, p.276–285, 2005.

REYES, L. F. **Diversidade de bactérias em manguezal e biodegradação de hidrocarbonetos poliaromáticos**. 123f. Tese (Biotecnologia), Instituto de Ciências Biomédicas, Universidade de São Paulo, São Paulo, 2009.

RIGONATO, J. **Diversidade de cianobactérias em manguezais do Estado de São Paulo.** 107 f. Tese (Doutorado em Microbiologia Agrícola), Escola Superior de Agricultura "Luiz de Queiroz", Piracicaba, 2010.

RIGONATO, J.; ALVARENGA, D. O.; ANDREOTE, F. D.; DIAS, A. C. F.; MELO, I. S. KENT, A.; FIORE, M. F. Cyanobacterial diversity in the phyllosphere of a mangrove forest. **FEMS Microbiology Ecology**, 2012. DOI: 10.1111/j.15746941.2012.01299.x

ROJAS, A.; HOLGUIN, G.; GLICK.; B. R.; BASHAN, Y. Synergism between *Phyllobacterium* sp. (N2 -fixer) and *Bacillus licheniformis* (P -solubilizer), both from a semiarid mangrove rhizosphere. **FEMS Microbiology Ecology**, v. 35, p. 181-187, 2001.

RONDON, M. R.; GOODMAN, R. M.; HANDELSMAN, J. The Earth's bounty: assessing and accessing soil microbial diversity. **Trends in Biotechnology,** v. 17, p. 403-409, 1999.

RONDON, M. R.; AUGUST, P. R.; BETTERMANN, A. D.; BRADY, S. F.; GROSSMAN, T. H.; LILES, M. R.; LOIACONO, K. A.; LYNCH, B. A.; MACNEIL, I. A.; MINOR, C.; TIONG, C. L.; GILMAN, M.; OSBURNE, M. S.; CLARDY, J.; HANDELSMAN, J.; GOODMAN, R.M. Cloning the soil metagenome: a strategy for accessing the genetic and functional diversity of uncultured microorganisms. **Applied and Environmental Microbiology,** v. 66, p. 2541-2547, 2000.

ROSENBERG, K.; BERTAUX, J.; KROME, K.; HARTMANN, A.; SCHEU, S.; BONKOWSKI, M. Soil amoebae rapidly change bacterial community composition in the rhizosphere of *Arabidopsis thaliana*. **The ISME Journal**, v. 3, p. 675–684, 2009.

ROVIRA, A. D.; SANDS, D.C. Fluorescent Pseudomonads-a Residual Component in the Soil Microflora? **Journal of Applied Microbiology,** v. 34, p. 253–259, 1971.

RUDRAPPA, T.; CZYMMEK, K. J.; PARE, P. W.; BAIS, H. P. Rootsecreted malic acid recruits beneficial soil bacteria. **Plant Physiology**, v. 148, p. 1547–1556, 2008.

RUSCH, D. B.; HALPERN, A. L.; SUTTON, G.; HEIDELBERG, K. B.; WILLIAMSON, S. et al. The Sorcerer II Global Ocean Sampling expedition: Northwest Atlantic through eastern tropical Pacific. **Public Library of Science Biology**, v. 5, p. 77, 2007.

RYCKEBOER, J.; MERGAERT, J.; COOSEMANS, J.; DEPRINS, K.; SWING, J. Microbiological aspects of biowaste during composting in monitored compost bin. **Journal of Applied Microbiology**, v. 94, p. 127-137, 2003.

SÁ, A. L. B. **Diversidade de bacterias endoglicoliticas isoladas de mangue vermelho (*Rhizophora mangle*)**. 60 f. Dissertação de mestrado (Biotecnologia), Instituto de Ciências Biomédicas, Universidade de São Paulo, São Paulo, 2008.

SACHERER, P.; DÉFAGO, G.; HAAS, D. Extracellular protease and phospholipase C are controlled by the global regulator gene *gacA* in the biocontrol strain *Pseudomonas fluorescens* CHA0. **FEMS Microbiology Letters**, v. 116, p. 155–160, 1994.

SAITOU, N.; NEI, M. The neighbor-joining method: a new method for reconstructing phylogenetic trees. **Molecular Biology and Evolution,** v. 4, p. 406-425, 1987.

SALLES, J. F.; DE SOUZA, F. A.; van ELSAS, J. D. Molecular method to assess the diversity of *Burkholderia* species in environmental samples. **Applied and Environmental Microbiology**, v. 68, p. 1595-1603, 2002.

SCHAEFFER-NOVELLI, Y.; JUNIOR, C. C.; TOGNELA-DE-ROSA, M. **Manguezais**. São Paulo: Ática, 2001, 48 p.

SCHIPPERS, B.; BAKKER, A.; BAKKER, P.; van PEER, R. Beneficial and deleterious effects of HCN-producing pseudomonads on rhizosphere interactions. **Plant and Soil**, v.129, p. 75-83, 1990.

SCHLOSS, P. D.; HANDELSMAN, J. Introducing DOTUR, a computer program for defining operational taxonomic units and estimating species richness. **Applied and Environmental Microbiology**, v. 71, p. 1501-1506, 2005.

SEBASTIANES, F. L. S. **Diversidade genética e potencial biotecnológico de fungos endofíticos de manguezais do estado de São Paulo**. 150 f. Tese (Doutorado em Ciências: Genética e Melhoramento de Plantas), Universidade de São Paulo, Piracicaba, 2010.

SGROY, V; CASSÁN, F; MASCIARELLI, O; PAPA, M. F.; LAGARES, A.; LUNA, V. Isolation and characterization of endophytic plant growth-promoting (PGPB) or stress homeostasis-regulating (PSHB) bacteria associated to the halophyte *Prosopis strombulifera.* **Applied Microbiology and Biotechnology,** v. 85, p. 371-381, 2009.

SHAHAROONA, B.; ARSHAD, M.; ZAHIR, Z.A.; KHALID, A. Performance of *Pseudomonas* spp. containing ACC-deaminase for improving growth and yield of maize (*Zea mays* L.) in the presence of nitrogenous fertilizer. **Soil Biology and Biochemistry,** v. 38, p. 2971-2975, 2006.

SHARMA, A.; JOHRI, B. N.; SHARMA, A. K.; GLICK, B. R. Plant growth promoting bacterium *Pseudomonas* sp. strain GRP(3) influences iron acquisition in mung bean (*Vigna radiata* L. Wilzeck). **Soil Biology and Biochemistry**, v. 35, p. 887–894, 2003.

SINDHU, S. S.; DADARWAL, K. R. Chitinolytic and cellulolytic *Pseudomonas* sp. antagonistic to fungal pathogens enhances nodulation by *Mesorhizobium* sp. in chickpea. **Microbiological Research,** v. 156, p. 353–358, 2001.

SINSUWAN, S.; RODTONG, S.; YONGSAWATDIGUL, J. Characterization of $Ca^{2+}$-activated cell-bound proteinase from *Virgibacillus* sp. SK37 isolated from fish sauce fermentation. **LWT-Food Science and Technology**, v. 41, p. 2166-2174, 2008.

SMITH, E. M.; KEMP, W. M. Planktonic and bacterial respiration along an estuarine gradient: responses to carbon and nutrient enrichment. **Aquatic Microbial Ecology**, v. 30, p. 251–261, 2003.

SOARES, A.; GUIEYSSE, B.; DELGADO, O.; MATTIASSON, B. Aerobic biodegradation of nonylphenol by cold-adapted bacteria. **Biotechnological Letters**, v.25, p. 731-738, 2003.

SOGIN, M. L.; MORRISON, H. G.; HUBER, J. A.; WELCH, D. M.; HUSE, S. M.; NEAL, P. R.; ARRIETA, J. M.; HERNDL, G. J. Microbial diversity in the deep sea and the underexplored "rare biosphere". **Proceedings of the National Academy of Sciences of the United States of America**, v. 103, p. 12115-12120, 2006.

SONNLEITNER, E.; HAAS, D. Small RNAs as regulators of primary and secundary of metabolism in *Pseudomonas* species. **Applied Microbiology and Biotechnology**, v. 91, p. 63-79, 2011.

STACKEBRANDT, P. H. A.; GOEBEL, B. M. Taxonomic note: a place for DNA-DNA reassociation and 16S rRNA sequence analysis in the present species definition in bacteriology. **International Journal of Systematic Bacteriology**, v. 28, p. 335-336, 1994.

STROBEL, G. A. Bacterial phytotoxins. **Annual Review of Microbiology**, v. 31, p. 205-224, 1977.

SUTRA, L.; RISÈDE, J.M.; GARDAN, L. Isolation os fluorescent pseudomonads from the rhizosphere of banana plants antagonistic towards root necrosing fungi. **Letters in Applied Microbiology**, v. 31, p. 289-293, 2000.

SZABOLCS, I. Soils and salinisation. In: **Handbook of plant and crop stress** PESSARAKALI, M. New York: Marcel Dekker,1994, p.3-11.

TAKEDA, R. *Pseudomonas* pigments. Pyoluterin, a new chorine containing pigment produced by *Pseudomonas aeruginosa*. **HakoKogakuZasshi**, v. 36, p. 281-290, 1958.

TAKETANI, R.G.; FRANCO, N. O.; ROSADO, A.S.; van ELSAS, J.D. Microbial community response to a simulated hydrocarbon spill in mangrove sediments. **Journal of Microbiology**, v. 48, p. 7–15, 2010.

TAMURA, K.; DUDLEY, J.; NEI, M.; KUMAR, S. MEGA4: Molecular Evolutionary Genetics Analysis (MEGA) software version 4.0. **Molecular Biology and Evolution,** v. 24, p. 1596-1599, 2007.

TAWARA, S.; MATSUMOTO, S.; HIROSE, T.; MATSUMOTO, Y; NAKAMOTO, S.; MITSUNO, M; KAMIMURA, T. *In vitro* antifungal synergism between pyrrolnitrin and clotrimazole. **Japanese Journal of Medical Mycology,** v. 30, p. 202-210, 1989.

TELKE, A. A.; KALYANIA, D. C.; JADHAVA, U. U; PARSHETTIB, G. K.; GOVINDWARA, S. P. Purification and characterization of an extracellular laccase from a *Pseudomonas* sp. LBC1 and its application for the removal of bisphenol A. **Journal of Molecular Catalysis B: Enzymatic,** v. 61, p. 252–260, 2009.

Ter BRAAK, C. J. F.; SMILAUER, P. **CANOCO Reference Manual and User's Guide to Canoco for Windows: Software for canonical community ordination (version 4)**. Ithaca, NY: Microcomputer Power, 1998, 352 p.

THOMASHOW, L. S.; WELLER, D. M. Role of a phenazine antibiotic from *Pseudomonasfluorescens*in biological control of *Gaeumannomycesgraminis*var. *tritici*. **Journal Bacteriology**, v. 170, p. 3499–508, 1988.

THOMPSON, J. D.; HIGGINS, D. G.; GIBSON, T. J.; CLUSTAL, W. Improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position specific gap penalties and weight matrix choice. **Nucleic Acids Research,** 1994.

THURSTON, C. F. The structure and function of fungal laccases. **Microbiology**, v. 140, p. 19–26, 1994.

TIAN, Y.; LIU, H. J.; ZHENG, T. L.; KWON, K. K.; KIM, S. J.; YAN, C. L. PAHs contamination and bacterial communities in mangrove surface sediments of the Jiulong River Estuary China. **Marine Pollution Bulletin**, v. 57, p. 707–715, 2008.

TORSVIK, V; DAAE, F. L.; SANDAA, R. A.; OVREAS, L. Novel techniques for analyzing microbial diversity in natural and perturbed environments. **Journal of Biotechnology**, v. 64, p. 53-62, 1998.

TUITE, J. **Plant pathological methods.** Minneapolis: Burguess, 1969. 239 p.

Van den BROEK, D.; CHIN-A-WOENG, T. F. C.; BLOEMBERG, G. V.; LUGTENBERG, B. J. J. Molecular nature of spontaneous modifications in *gacS* which cause colony phase variation in *Pseudomonas* sp. PCL1171. **Journal of Bacteriolology**, v. 187, p. 593–600, 2005.

Van den BROEK, D.; CHIN-A-WOENG, T. F. C.; EIJKEMANS, K.; MULDERS, I. H.; BLOEMBERG, G. V.; LUGTENBERG, B. J. J. Biocontrol traits of *Pseudomonas* spp. are regulated by phase variation. **Molecular Plant Microbe Interact**, v. 16, p. 1003–1012, 2003.

Van LOON, L. C.; BAKKER, P. A. H. M.; PIETERSE, C. M. J. Systemic resistance induced by rhizosphere bacteria. **Annual Review of Phytopathology**, v. 36, p. 453–483, 1998.

Van PEER, R.; SCHIPPERS, B. Plant growth responses to bacterization with selected *Pseudomonas* spp. strains and rhizosphere microbial development in hydroponic cultures. **Canadian Journal of Microbiology**, v. 35, p. 456-463, 1988.

Van RAIJ, B.; CANTARELLA, H.; ANDRADE, J. C.; QUAGGIO, J.A. **Análise química para avaliação da fertilidade de solos tropicais**. Campinas: Instituto Agronômico, 2001, 285 p.

VAZQUEZ, P.; HOLGUIN, G.; PUENTE, M. E.; LOPEZ-CORTES, A.; BASHAN, Y. Phosphate-solubilizing microorganisms associated with the rhizosphere of mangroves in a semiarid coastal lagoon. **Biology and Fertility of Soils**, v. 30, p. 460-468, 2000.

VENTOSA, A.; NIETO, J. J.; OREN, A. Biology of Moderately Halophilic Aerobic Bacteria. **Microbiology and Molecular Biology Reviews**, v. 62, p. 504–544, 1998.

VERMA, J. P.; YADAV, J.; TIWARI, K. N. Application of *Rhizobium* sp. BHURC01 and plant growth promoting rhizobacteria on nodulation, plant biomass and yields of Chickpea (*Cicer arietinum* L.). **International Journal of Agricultural Research**, v. 5, p.148-156, 2010.

VLASSAK, K.; Van HOLM, L.; DUCHATEAU, L.; VANDERLEYDEN, J.; De MOT, R. Isolation and characterization of fluorescent *Pseudomonas* associated with the roots of rice and banana grown in Sri Lanka. **Plant and Soil**, v. 145, p. 51-63, 1992.

VOISARD, C.; KEEL, C.; HAAS, D.; DEFAGO, G. Cyanide production by *Pseudomonas fluorescens* helps suppress black root rot of tobacco under gnotobiotic conditions. **The EMBO Journal***,* v. 8, p. 351-358, 1989.

Von GRAEVENITZ, A.; WEINSTEIN, J. Pathogenic significance of *Pseudomonas fluorescens* and *Pseudomonas putida*. **Yale Journal of Biology and Medicine**, v. 44, p. 265-273, 1971.

WHISTLER, C. A.; CORBELL, N. A.; SARNIGUET, A.; REAM, W.; LOPER, J. E. The two component regulators GacS and GacA influence accumulation of the stationary-phase sigma factors and the stress response in *Pseudomonas fluorescens* Pf-5. **Journal of Bacteriology**, v.180, p. 6635–6641, 1998.

WILLIS, D. K.; HOLMSTADT, J. J.; KINSCHERF, T. G. Genetic evidence that loss of virulence associated with *gacS* or *gacA* mutations in *Pseudomonas syringae* B728a does not result from effects on alginate production. **Applied and Environmental Microbiology**, v. 67, p. 1400–1403, 2001.

XU, F. Applications of oxidoreductases: Recent progress. **Industrial Biotechnolology**, v. 1, p. 38–50, 2005.

XU, X. R; LI, H. B.; GU, J. D. Metabolism and biochemical pathway of n-butyl benzyl phthalate by *Pseudomonas fluorescens* B-1 isolated from a mangrove sediment. **Ecotoxicology Environmental Safety**, v. 68, p. 379-85, 2007.

YOUNG, J. P. W. Phylogenetic classification of nitrogen-fixing organisms. In: **Biological Nitrogen Fixation**. STACEY, G.; BURRIS, R. H.; EVANS, H. J. (eds.) New York: Chapman and Hall, 1992, pp. 43–86.

ZAGO, V. C. P.; De-POLLI, H.; RUMJANEK, N.G. ***Pseudonomas*** **spp. Fluorescentes – Bactérias promotoras de crescimento de plantas e biocontroladoras de fitopatógenos em sistemas de produção agrícola.** Seropédica: Embrapa Agrobiologia, dez. 2000. 32p. (Embrapa-CNPAB. Documentos, 127).

ZAHARAN, H.H.; MOHARRAM, A.M.; MOHAMMAD, H.A. Some ecological and physiological studies on bacteria isolated from salt affected soils of Egypt. **Journal of Basic Microbiology**, v. 32, p. 405-413, 1992.

ZAHARAN, H. H. Diversity adaptation and activity of the bacterial flora in saline environments. **Biology and Fertility of Soils**, v. 25, p. 211-223, 1997.

ZEHR, J. P.; WARD, B. B. Nitrogen cycling in the ocean: new perspectives on processes and paradigms. **Applied and Environmental Microbiology**, v. 68, p. 1015–1024, 2002.

ZHANG, Y.; DONG, J.; YANG, Z.; ZHANG, S.; WANG, Y. Phylogenetic diversity of nitrogen-fixing bacteria in mangrove sediments assessed by PCR–denaturing gradient gel electrophoresis. **Archives Microbiology,** v. 190, p. 19–28, 2008.

ZHANG,Y.; DONG, J.; YANG, B.; LING, J.; WANG, Y.; ZHANG, S. Bacterial community structure of mangrove sediments in relation to environmental variables accessed by 16S rRNA gene-denaturing gradient gel electrophoresis fingerprinting**.** **Scientia Marina**, v. 73, p. 487-498, 2009.

ZHOU, H.W.; WONG; A.H.Y; YU, R.M.K.; PARK, Y.D.; WONG, Y.S.; TAM, N.F.Y. Polycyclic Aromatic Hydrocarbon-Induced Structural Shift of Bacterial Communities in Mangrove Sediment. **Microbial Ecology**, v.58, p.153–160, 2009.