

ENVIS CENTER

on

ENVIRONMENTAL BIOTECHNOLOGY

Abstract Vol. X



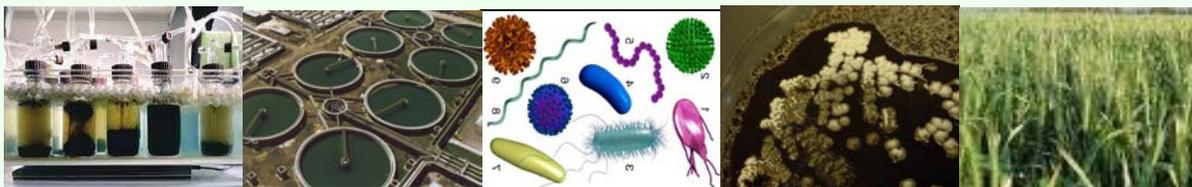
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Nadia, West Bengal**

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ENVIS CENTRE

on

ENVIRONMENTAL BIOTECHNOLOGY

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CONTENTS

| Sl. No. | Title | Page No. |
|----------------|----------------------------|-----------------|
| 1. | Background | 5 |
| 2. | Abstract format | 6 |
| 3. | General information | 7 |
| 4. | Abbreviation used | 10 |
| 5. | Abstracts | |
| | Bioaccumulation | 13 |
| | Bioremediation | 22 |
| | Biotransformation | 37 |
| | Biomarker | 42 |
| | Biofertilizer | 46 |
| | Biocomposting | 48 |
| | Biopesticide | 49 |
| | Biodegradation | 51 |
| | Biosensor | 77 |
| | Bioengineering | 89 |
| | Pollen Biotechnology | 93 |
| | Biotechnology Policy Issue | 97 |
| | Agricultural Biotechnology | 99 |
| | Bioenergy | 101 |
| 6. | Name of Journal | 109 |
| 7. | Author Index | 112 |
| 8. | Query Form | 119 |

BACKGROUND

Environmental Information System (ENVIS) is established in the year 1984 as a network of Information Centres. It is planned by the Ministry of Environment and Forest. Aim of this centre is to provide descriptive and environmental subject related numerical data. Now 78 centres are working under this network on various subject areas in the country. The focal point of this network is situated at the Ministry of Environment and Forest, Government of India, New Delhi.

This ENVIS Centre is established for studies on Environmental Biotechnology at the Department of Environmental Science, University of Kalyani, Nadia-741235, West Bengal.

The objective of this centre is to collect data related to the above mentioned subject, from different major libraries mainly in West Bengal and also from other states in India, through consultation with different journals, Annual Reviews, Internet and to generate a database and create a website uploaded with these information. Besides, we publish biannually Abstract Volume on our thematic area Environmental Biotechnology under fourteen subheads. The volume contains abstracts of scientific articles from relevant national and international journals. Viewpoint of this abstract volume is to help the interested research workers, scientists, administrators and the general people.

This is the 10th publication of Abstract Volume of this ENVIS Centre. This contains the abstracts of research papers collected in the area of Environmental Biotechnology from various journals published during December 2006 onwards. In this issue, various topics like Bioengineering, Bio-degradation, Bio-remediation, Bio-transformation etc. have been covered. We are grateful to the various libraries and their staff for their cooperation extended to us during the collection of the articles.

Abstract Format

The format of the abstract is as follows:

Abstract : The abstracts are arranged in different subheads.

Author: Name of the authors are given in the order in which they appear in the original document. These names are given in succession.

Address of Authors: Address of the author is given in parenthesis at the end of the authors name. When the address of any other author is found, it is written after wards delimited by stop(.).

Locus : The name of the journal is followed by the volume number, issue number, year of publication and the page no.

GENERAL INFORMATION

Abstract have been taken directly from source documents like research report, journals, internet, seminar proceedings, standards and patents. All the resources are published within last six months.

Abstract are broadly classified and arranged under the following 14 heads:

Bioaccumulation: Bioaccumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. Compounds accumulate in living things whenever they are taken up and stored at a rate faster than they are broken down (metabolized) or excreted. Understanding the dynamic process of bioaccumulation is very important in protecting human beings and other organisms from the adverse effects of chemical exposure, and it has become a critical consideration in the regulation of chemicals.

Bioremediation: It is a clean-up technology that uses naturally occurring microorganisms to degrade hazardous substances into less toxic or nontoxic compounds. The microorganisms may:

1. Ingest and degrade organic substances as their food and energy source,
2. Degrade organic substances, such as chlorinated solvents or petroleum products, that are hazardous to living organisms, including humans, and degrade the organic contaminants into inert products.

As the microorganisms occur naturally in the environment they are likely to pose little risks of contamination.

Bio-Transformation: This is a process of Biological changes of complex compounds to simpler one or toxic to non-toxic and vice-versa. Several microorganisms are capable of transforming a variety of compounds found in nature but generally in case of synthetic compounds they are unable to show any appropriate action. Biotransfer appears to be one of the major detoxication methods known so far.

Biomarker: It is a biological response to a chemical that gives a measurement of exposure and, sometimes, of toxic effect. It can be defined as any kind of molecule which indicate the existence (past or present) of living organisms. In particular, in the fields of geology and astrobiology biomarkers are also known as biosignatures. However, in environmental science a bio-markers can also be used to indicate exposure to various environmental substances in epidemiology and toxicology.

Biofertilizer: To reduce the impact of excess chemical fertilizers in the field of agriculture the biofertilizer is being considered as a potential tool; biologically fixed nitrogen is such a source which can supply an adequate amount of Nitrogen to plants and other nutrients to some extent. Many free living and symbiotic bacteria, which fix

atmospheric Nitrogen are used as biofertiliser material as a substitute for Nitrogen fertilizer. In general two types of biofertiliser are used

1. Bacterial Biofertilizer
2. Algal Biofertilizer

Biocomposting: It involves combining organic materials under conditions that enables them to decompose more quickly than they would in nature. Think about logs and leaves on the ground in a forest. The leaves will break down and disappear within a year. Logs of course will take much longer to crumble away. Composting is the process of converting all biodegradable wastes into organic manure. In composting process certain input should be made into waste to convert the process in a short time.

Biopesticide: Pest control by biological antagonism appears to be very useful tool in recent years. Bacterial pesticides are being developed. *Heliothis* complex, which lives in close association with plant roots, consists of two major crop pests budworm and ball worm. Biological insecticides against both these insects are being prepared by transfer of a gene from *Bacillus thuringiensis*

Biodegradation: It is nature's way of recycling wastes, breaking down organic matter into nutrients that can be used by other organisms. "Degradation" means decay, and the "bio-" prefix means that the decay is carried out by a huge assortment of bacteria, fungi, maggots, worms, and other organisms that eat dead material and recycle it into new forms.

In the nature, nothing is known as waste, because everything gets recycled. The waste products from one organism become the food for others, providing nutrients and energy while breaking down the waste organic matter. Some organic materials may break down much faster than others, but all will eventually decay.

By harnessing these natural forces of biodegradation, people can reduce wastes and clean up some types of environmental contaminants. Through **composting**, we accelerate natural biodegradation and convert organic wastes to a valuable resource.

Biosensor: Biosensor represents biophysical devices, which can detect the presence and measure the quantities of specific substances in a variety of environments. These specific substances may include sugars, proteins, or humas and variety of toxins in the industrial effluents. In designing a biosensor an enzyme or an antibody or even microbial cells are associated with microchip devices, which are used for quantitative estimate of a substance.

Bioengineering: It is a developing speciality featuring a multidisciplinary approach to the solution of problems in medicine and biology, based on the application of advances in science, engineering and technology. It generally engineers the biological processes through biotechnological or genetic engineering

interventions. It may also be a broad-based engineering discipline that involve product design, sustainability and analysis of biological systems.

Pollen-Biotechnology: This is a new field of science dealing with the pollen chemistry and allergenicity of aerospora. This subject also covers genetic manipulation of pollen development of haploid culture. Such haploid plants have immense values in genetic research.

Biotechnology Policy Issue: Biotechnology appears to be an emerging science in present decades. Genetic manipulation and development of genetically modified organism in human welfare is now showed a potential prospect and risk. Thus, researches and application of Biotechnology in diverse field is a major policy issue in the present decades.

Agricultural Biotechnology: Over the years, tremendous success has been made in diverse field of agriculture by applying Biotechnology. It includes development of genetically modified crops, genetic improvement in sericulture practices, improvement in Biofertilizer development and similar other aspects. Production of pest and disease resistant crop is also being considered to be an emerging area of Agricultural Biotechnology.

Bioenergy: In recent decades, efforts have been made for evolving were non-polluting bioenergy sources or energy generation from organic wastes and biomass. These are all ecofriendly solutions. Biomass energy supply-demand balances have become a component of energy sector analysis and planning and is propelled huge importance in the countries. Biomass, Biogas, Hydrogen are the example of Bioenergy.

ABBREVIATIONS USED IN ADDRESSES AND CITED JOURNALS

| | | | |
|------------|-------------------|---------------|-------------------|
| Acad | Academy | Chem | Chemistry |
| Adm | Administration | Cheml | Chemical |
| Admn | Administrative | Clinl | Clinical |
| Adv | Advance | Co | Company |
| Agri | Agriculture | Coll | College |
| Agricl | Agricultural | Comm | Committee |
| Amer | American | Commn | Commission |
| An | Annual | Comp | Comparative |
| Analyt | Analytical | Conf | Conference |
| Anat | Anatomy | Conv | Convention |
| Anim | Animal | Conserv | Conservation |
| Ann | Annals | Contl | Control |
| Appl | Applied | Contam | Contamination |
| Arch | Archives | Corpn | Corporation |
| Archaeo | Archaeology | Coun | Council |
| Archaeol | Archaeological | Cult | Culture |
| Architect | Architecture | Cultl | Cultural |
| Assoc | Association | Curr | Current |
| Asst | Assistant | Dept | Department |
| Atom | Atomic | Dev | Development |
| Bacterio | Bacteriology | Develop | Developmental |
| Bacteriol | Bacteriological | Dig | Digest |
| Bd | Board | Div | Division |
| Bio | Biology | Divl | Divisional |
| Biochem | Biochemistry | Dte | Directorate |
| Biocheml | Biochemical | Dy | Deputy |
| Bioengg | Bioengineering | Eco | Ecology |
| Biol | Biological | Ecol | Ecological |
| Biometeo | Biometeorology | Econ | Economics |
| Biophys | Biophysics | Ecosys | Ecosystem |
| Biometeol | Biometeorological | Ecotoxico | Ecotoxicology |
| Biotech | Biotechnology(s) | Endocrinol | Endocrinological |
| Biotechno | Biotechnology | Engg | Engineering |
| Biotechnol | Biotechnological | Engrs | Engineers |
| Bldg | Building | Env | Environment |
| Bot | Botany | Environ | Environmental |
| Botl | Botanical | Epidemic | Epidemiology |
| Br | Branch | Epidemiol | Epidemiological |
| Bull | Bulletin | Estd | Establishment |
| Cent | Centre | Ethnopharmaco | Ethnopharmacology |
| Centl | Central | Expt | Experiment |

| | | | |
|-----------|----------------|-------------|-------------------|
| Exptl | Experimental | Microbiol | Microbiological |
| Fac | Faculty | Min | Ministry |
| Fd | Food | Monit | Monitoring |
| Fedn | Federation | Myco | Mycology |
| Fert | Fertiliser | Mycol | Mycological |
| Fmg | Farming | Nat | Natural |
| Gaz | Gazette | Natl | National |
| Genet | Genetics | N-E | North Eastern |
| Geo | Geology | Nut | Nutrition |
| Geogr | Geography | No | Number |
| Geogrl | Geographical | Occ | Occasional |
| Geol | Geological | Occupl | Occupational |
| Geosci | Geoscience | Oceanogr | Oceanography |
| Govt | Government | Org | Original |
| Hist | History | Orgc | Organic |
| Hlth | Health | Orgn | Organisation |
| Hort | Horticulture | Pharmaco | Pharmacology |
| Hosp | Hospital | Pharmacol | Pharmacological |
| Hydro | Hydrology | Phyl | Physical |
| Hydrol | Hydrological | Patho | Pathology |
| Immuno | Immunology | Pathol | Pathological |
| Immunol | Immunological | Petrochem | Petrochemical |
| Ind | Industry | Petro | Petrology |
| Inf | Information | PG | Post Graduate |
| Inst | Institute | Phys | Physics |
| Instn | Institution | Physio | Physiology |
| Int | International | Phytopath | Phytopathology |
| Irrig | Irrigation | Phytopathol | Phytopathological |
| J | Journal | Plang | Planning |
| Lab | Laboratory | Polln | Pollution |
| Lett | Letter(s) | Proc | Proceedings |
| Ltd | Limited | Prot | Protection |
| Malario | Malariology | Pub | Publication |
| Malariol | Malariological | Pvt | Private |
| Manag | Management | Qlty | Quality |
| Med | Medicine | Qr | Quarter |
| Medl | Medical | Rad | Radiation |
| Metab | Metabolism | Radio | Radiology |
| Metall | Metallurgy | Radiol | Radiological |
| Metallurg | Metallurgical | Rd | Road |
| Meteo | Meteorology | Recd | Received |
| Meteol | Meteorological | Reg | Region |
| Microbio | Microbiology | Regl | Regional |

| | | | |
|--------|--------------|---------|----------------|
| Rep | Report | Surv | Survey |
| Reptr | Reporter | Syst | System |
| Res | Research | Tax | Taxonomy |
| Rev | Review | Techl | Technical |
| Sch | School(s) | Techno | Technology |
| Sci | Sciences(s) | Technol | Technological |
| Scient | Scientific | Toxico | Toxicology |
| S-E | South East | Toxicol | Toxicological |
| Sec | Section | Transec | Transcations |
| Sect | Sector | Transpt | Transportation |
| Semin | Seminar | Trng | Training |
| Ser | Services | Trop | Tropical |
| Soc | Society | Univ | University |
| Socl | Social | Util | Utilisation |
| Stat | Statistics | Vet | Veterinary |
| Statl | Statistical | Zoo | Zoology |
| Stnd | Standard(s) | Zool | Zoological |
| Stud | Study/ (eis) | | |

Bioaccumulation

S.K. Ghosh, J. Chaudhuri, R. Gachhui, A. Mandal, S. Ghosh. (Department of Biochemistry, University College of Science, Calcutta University, Kolkata, India, Sanjay Ghosh or Amalendu Mandal, Department of Biochemistry, Calcutta University, 35, Ballygunge Circular Road, Kolkata-700 019, India. E-mail: sgbioc@caluniv.ac.in, ghosh71@hotmail.com). Effect of mercury and organomercurials on cellular glucose utilization: a study using resting mercury-resistant yeast cells. Journal of Applied Microbiology 102 (2) (2007): 375–383.

Aims: Mercury compounds are highly toxic to all types of living cells. Isolated yeast strains of *Rhodotorula rubra* showed high and low resistance pattern towards mercury and organomercurial compounds. To investigate the basis of differential sensitivity of these two types of strains, glucose utilization was measured in the presence of mercury compounds.

Methods and Results: Glucose utilization process remained unaffected in resting cells of highly Hg²⁺-resistant strain in the presence of HgCl₂ but not in the presence of phenylmercuric acetate and thimerosal. However, HgCl₂ significantly affected glucose utilization in the case of low-resistant cells. The Hg-retaining ability of the cell wall of highly Hg²⁺-resistant yeast strain was greater than that of the weakly Hg²⁺-resistant strain. The spheroplast-bound Hg²⁺ was also significantly less in the highly Hg²⁺-resistant strain than in the weakly Hg²⁺-resistant strain.

Conclusions: Glucose uptake machinery was not affected in the presence of toxic metal ions in the case of high-resistant strains. But in the case of low Hg²⁺-resistant strain, glucose transport system may be affected either by inactivation of sensor proteins containing –SH group associated with glucose uptake.

Significance and Impact of the Study: Cell wall of mercury-resistant yeast cells may play an important role in heavy metal bioremediation process.

Douglas Hayward^a, Jon Wong^a and Alexander J. Krynitsky^a. (^aUS Food and Drug Administration, 5100 Paint Branch Parkway, College Park, MD 20740, USA) Polybrominated diphenyl ethers and polychlorinated biphenyls in commercially wild caught and farm-raised fish fillets in the United States. Environmental Research, Volume 103(1)(2007): 46-54

Wild caught and farm-raised fish fillets collected in fish markets and large-chain super markets located in the Maryland, Washington, DC, and North Carolina were measured for their polybrominated diphenyl ether (PBDE), polychlorinated biphenyl (PCB), and polychlorodibenzo-*p*-dioxins/dibenzofurans (PCDD/Fs) levels. PCB and PBDE concentrations were the highest in a wild bluefish fillet (800 and 38 ng/g wet weight, respectively) and the lowest in wild Coho salmon fillet (0.35 and 0.04 ng/g, respectively). Levels for both PCBs and PBDEs in ng/g wet weight decreased from bluefish with medians of 200 and 6.2, to rockfish 66 and 4.7, followed by farmed-raised salmon with 9.0 and 1.1, with the lowest in wild salmon, 4.0 and 0.3 ng/g for PCBs and PBDEs, respectively (PCBs are the sum of 25 congeners). The chlorinated biphenyl (CB)-153 and brominated diphenyl ether (BDE)-47 levels correlated in the 22 fish fillets with a Pearson correlation coefficient of 0.94. Bluefish, rockfish (striped bass), wild caught and farm-raised salmons all showed different linear regression slopes between CB-

153 and BDE-47 of 7.5, 2.7, 0.97, and 1.5, respectively. A Wilcoxon rank sum test showed no significant difference in the CB-153/BDE-47 ratios between farmed raised and all species of wild salmon combined, but was significant between bluefish and rockfish, farmed raised salmon or wild salmon.

Keywords: Polybrominated diphenyl ethers (PBDES); Polychlorinated biphenyls (PCBs); Polychlorodibenzo-*p*-dioxins/dibenzofurans (PCDD/Fs); Wild fish; Farmed fish; Bluefish; Striped bass; Salmon; Correlation

Denise Fernandes^{a, b}, Cinta Porte^b and Maria João Bebianno^a. (^aC.I.M.A., University of Algarve, F.C.M.A., Campus de Gambelas, 8005-139-Faro, Portugal, ^bDepartment of Environmental Chemistry, IIQAB-CSIC, Jordi Girona 18, 08034-Barcelona, Spain. **Corresponding author. Fax: +34 93 2045904**). **Chemical residues and biochemical responses in wild and cultured European sea bass (*Dicentrarchus labrax* L.). Environmental Research, Volume 103(2) (2007): 247-256**

Cultured and wild sea bass (*Dicentrarchus labrax*) from the Arade Estuary were sampled in summer and winter and the degree of exposure to metals and polycyclic aromatic hydrocarbons (PAHs) assessed, together with some biochemical responses against those and other pollutants. The highest levels of copper (up to 997 $\mu\text{g g}^{-1}$ dry weight) and cadmium (up to 4.22 $\mu\text{g g}^{-1}$ dry weight) were detected in the liver and kidney of cultured specimens, whereas the highest exposure to PAHs was observed in wild fish. Significant alterations in some biochemical markers were detected and associated to pollutant exposure. Thus, metallothionein concentrations were higher in the tissues of cultured fish and positively correlated with metal residues. The activity 7-ethoxyresorufin *O*-deethylase ranged from 28 pmol/min/mg protein in cultured fish to 83 pmol/min/mg protein in wild fish collected near a marina area. Cultured fish and wild fish from the marina area had depressed acetylcholinesterase in muscle tissue and a parasitic infection in the gonads. The obtained results support the usefulness of the combined use of chemical and biochemical markers to assess the impact of anthropogenic pollutants in both wild and cultured fish.

Keywords: Sea bass; Metallothionein; Catalase; 7-ethoxyresorufin *O*-deethylase; Acetylcholinesterase; Pollution; *Sphaerospora testicularis*

Charles J. Everett^a, Ivar L. Frithsen^a, Vanessa A. Diaz^a, Richelle J. Koopman^a, William M. Simpson, Jr.^a and Arch G. Mainous III^a. (^aDepartment of Family Medicine, Medical University of South Carolina, 295 Calhoun Street, PO Box 250192, Charleston, SC 29425, USA. **Corresponding author. Fax: +1 843 792 3598**). **Association of a polychlorinated dibenzo-*p*-dioxin, a polychlorinated biphenyl, and DDT with diabetes in the 1999–2002 National Health and Nutrition Examination Survey. Environmental Research, Volume 103(3) (2007): 413-418**

The association of a polychlorinated dibenzo-*p*-dioxin, a polychlorinated biphenyl, and *p,p'*-DDT with diabetes was evaluated using the 1999–2002 National Health and Nutrition Examination Survey. Persons 20 years old and older were included. Relationships with diagnosed diabetes, undiagnosed diabetes (glycohemoglobin (HbA1c) >6.1%), and total diabetes (diagnosed plus undiagnosed) were tested. When all three chemicals were evaluated together for total diabetes, the unweighted number of participants was 1830. All three compounds were significantly associated with diagnosed diabetes. PCB 126 and *p,p'*-DDT were significantly

associated with undiagnosed diabetes. 1,2,3,6,7,8-hexachlorodibenzo-*p*-dioxin (HxCDD) was not associated with undiagnosed diabetes. When the three chemicals were included in a combined model for total diabetes, PCB 126 > 83.8 pg/g lipid adjusted had an odds ratio of 2.57 (95% CI 1.33–4.95) compared to PCB 126 ≤ 31.2 pg/g lipid adjusted. Also significant in a combined model for total diabetes was *p,p'*-DDT 20.8–26.6 ng/g lipid adjusted with an odds ratio of 2.52 (95% CI 1.26–5.02) and *p,p'*-DDT > 26.6 ng/g lipid adjusted with an odds ratio of 2.74 (95% CI 1.44–5.23) both compared to *p,p'*-DDT ≤ 20.7 ng/g lipid adjusted. HxCDD was not associated with total diabetes in a combined model. When participants with poor liver function and poor kidney function were removed from the analysis, the combined model for total diabetes produced similar results with PCB 126 and *p,p'*-DDT having been significantly associated, and HxCDD not having been associated. These findings add to the list of chemicals found to be associated with diabetes in the 1999–2002 National Health and Nutrition Examination Survey.

Keywords: Dioxin; PCB; DDT; Diabetes

S. K. Mehta^a; J. P. Gaur^a. (^a **Laboratory of Algal Biology, Department of Botany, Banaras Hindu University, Varanasi, India**). **Use of Algae for Removing Heavy Metal Ions From Wastewater: Progress and Prospects Critical Reviews in Biotechnology, Volume 25(3) (2005): 113 - 152**

Many algae have immense capability to sorb metals, and there is considerable potential for using them to treat wastewaters. Metal sorption involves binding on the cell surface and to intracellular ligands. The adsorbed metal is several times greater than intracellular metal. Carboxyl group is most important for metal binding. Concentration of metal and biomass in solution, pH, temperature, cations, anions and metabolic stage of the organism affect metal sorption. Algae can effectively remove metals from multi-metal solutions. Dead cells sorb more metal than live cells. Various pretreatments enhance metal sorption capacity of algae. CaCl₂ pretreatment is the most suitable and economic method for activation of algal biomass. Algal periphyton has great potential for removing metals from wastewaters. An immobilized or granulated biomass-filled column can be used for several sorption/desorption cycles with unaltered or slightly decreased metal removal. Langmuir and Freundlich models, commonly used for fitting sorption data, cannot precisely describe metal sorption since they ignore the effect of pH, biomass concentration, etc. For commercial application of algal technology for metal removal from wastewaters, emphasis should be given to: (i) selection of strains with high metal sorption capacity, (ii) adequate understanding of sorption mechanisms, (iii) development of low-cost methods for cell immobilization, (iv) development of better models for predicting metal sorption, (v) genetic manipulation of algae for increased number of surface groups or over expression of metal binding proteins, and (vi) economic feasibility.

Keywords: algae; biosorption; heavy metal; immobilization; isotherm; ion exchange; seaweed; periphyton

Hiren Doshi¹, Arabinda Ray¹ and I. L. Kothari². (¹ **Department of Chemistry, Sardar Patel University, Vallabh Vidyanagar, 388 120, Gujarat, India,** ² **Department of Biosciences, Sardar Patel University, Vallabh Vidyanagar, 388 120, Gujarat, India.** **Hiren Doshi, Email: arabinda24@yahoo.co.in**). **Biosorption of Cadmium by Live and Dead *Spirulina*: IR Spectroscopic, Kinetics, and SEM Studies. Current Microbiology, Volume 54(3) (2007) : 213-218**

Cadmium is an important environmental pollutant and a potent toxicant to bacteria, algae, and fungi. Mechanisms of Cd^{+2} toxicity and resistance are variable, depending on the organism. The present work reports the use of live and dead *Spirulina* sp. for sorption of Cd^{+2} . This investigation shows that this biomass takes up substantial amount of Cd^{+2} ions. IR spectroscopic study, kinetics models, Langmuir & Freundlich adsorption isotherms, scanning electron microscopic analysis of *Spirulina* sp., and the *Spirulina* sp. treated with different metal ions have been employed to understand the sorption mechanism. Infrared spectra of live *Spirulina* treated with Cd^{+2} ions for different lengths of time have been taken to understand the time dependency of metal interaction.

Min Wang^a, Jinhua Zou^a, Xuchuan Duan^a, Wusheng Jiang^a and Donghua Liu^a. (Department of Biology, College of Chemistry and Life Sciences, Tianjin Normal University, Tianjin 300074, China). Cadmium accumulation and its effects on metal uptake in maize (*Zea mays* L.). Bioresource Technology, Volume 98(1) (2007): 82-88

The effects of different concentrations of Cd on growth of maize (*Zea mays* L.) and metal uptake were investigated. Cd accumulations in roots and shoots and the interactions among other metals (Mn, Fe, Cu and Zn) were analyzed using inductively coupled plasma atomic emission spectrometry (ICP-AES). The concentrations of cadmium chloride ($\text{CdCl}_2 \cdot 2.5\text{H}_2\text{O}$) used ranged from 10^{-4} M to 10^{-6} M. Cd had stimulatory effects during the first 5 days on root length of Nongda No. 108 at 10^{-6} M and 10^{-5} M Cd concentrations. Seedlings exposed to 10^{-4} M Cd solution exhibited substantial growth reduction, and root growth even stopped. Root growth of Liyu No. 6 was stimulated at concentrations of 10^{-5} M and 10^{-6} M Cd during the entire experiment (15 days). Cadmium inhibited root growth of Liyu No. 6 at 10^{-4} M Cd after 10 days of treatment. The Cd accumulation in roots and shoots of the two cultivars increased significantly ($P < 0.05$) with increasing Cd concentration and duration of treatment. Cadmium concentrated mainly in the roots, and small amounts were transferred to shoots. The proportion of Cd in the roots of Nongda No. 108 decreased with increases in Cd concentrations and duration of treatment, except for the group exposed to 10^{-4} M Cd. In Liyu No. 6, the proportion of Cd in the root decreased progressively with an increase in Cd concentrations. Liyu No. 6 has a greater ability to remove Cd from solution and accumulate it when compared with Nongda No. 108. Liyu No. 6 can be considered a Cd-hyperaccumulator, according to the current accepted shoot concentration that defines hyperaccumulation as 0.01% (w/w) for cadmium. This cultivar, producing many roots and a high biomass and with great ability to accumulate Cd can play an important role in the treatment of soils stressed by Cd.

Keywords: *Zea mays* L.; Accumulation; Cd; Mn; Fe; Cu; Zn

Parul Sharma^a, Pushpa Kumari^a, M.M. Srivastava^a and Shalini Srivastava^a. (Department of Chemistry, Faculty of Science, Dayalbagh Educational Institute, Dayalbagh, Agra 282 005, India. Corresponding author. Tel.: +91 0562 2801545; fax: +91 0562 2801226). Ternary biosorption studies of Cd(II), Cr(III) and Ni(II) on shelled *Moringa oleifera* seeds. Bioresource Technology, Volume 98(2) (2007): 474-477

Competitive biosorption of Cd(II), Cr(III) and Ni(II) on unmodified shelled *Moringa oleifera* seeds (SMOS) present in ternary mixture were compared with the single metal solution. The extent of adsorption capacity of the ternary metal ions tested on unmodified SMOS was low (10–20%) as compared to single metal ions. SMOS removed the target metal ions in the selectivity order of $\text{Cd(II)} > \text{Cr(III)} > \text{Ni(II)}$. Sorption equilibria, calculated from adsorption data, explained

favorable performance of biosorption system. Regeneration of exhausted biomass was also attempted for several cycles with a view to restore the sorbent to its original state.

Keywords: Competitive sorption; Metal removal; *Moringa oleifera*; Regeneration

S. Venkata Mohan^a, S.V. Ramanaiah^a, B. Rajkumar^b and P.N. Sarma^a. (^aBioengineering and Environmental Centre, Indian Institute of Chemical Technology, Hyderabad 500 007, India, ^bDepartment of Botany, Osmania University, Hyderabad 500 007, India). **Biosorption of fluoride from aqueous phase onto algal *Spirogyra* IO1 and evaluation of adsorption kinetics. *Bioresource Technology*, Volume 98(5)(2007): 1006-1011**

Non-viable algal *Spirogyra* IO1 was studied for its fluoride sorption potential in batch studies. The results demonstrated the ability of the biosorbent for fluoride removal. The sorption interaction of fluoride on to non-viable algal species obeyed the pseudo-first-order rate equation. The intraparticle diffusion of fluoride molecules within the *Spirogyra* was identified to be the rate-limiting step. It was also found that the adsorption isotherm followed the rearranged Langmuir isotherm adsorption model. Fluoride sorption was dependent on the aqueous phase pH and the fluoride uptake was greater at lower pH.

Keywords: Biosorption; Algal *Spirogyra* sp.; Adsorption kinetics; pH; Intraparticle diffusion model; Pseudo-first order; Pseudo-second order; Biosorbent; Isotherm

Yunus Pamukoglu^a and Fikret Kargi^a. (^aDepartment of Environmental Engineering, Dokuz Eylul University, Buca, 35160 Izmir, Turkey. Corresponding author. Tel.: +90 232 4127109; fax: +90 232 4531143). **Biosorption of copper(II) ions onto powdered waste sludge in a completely mixed fed-batch reactor: Estimation of design parameters. *Bioresource Technology*, Volume 98(6) (2007): 1155-1162**

Biosorption of Cu(II) ions onto pre-treated powdered waste sludge (PWS) was investigated using a fed-batch operated completely mixed reactor. Fed-batch adsorption experiments were performed by varying the feed flow rate (0.075–0.325 l h⁻¹), feed copper (II) ion concentrations (50–300 mg l⁻¹) and the amount of adsorbent (1–6 g PWS) using fed-batch operation. Breakthrough curves describing the variations of effluent copper ion concentrations with time were determined for different operating conditions. Percent copper ion removals from the aqueous phase decreased, but the biosorbed (solid phase) copper ion concentrations increased with increasing the feed flow rate and Cu(II) concentration. A modified Bohart–Adams equation was used to determine the biosorption capacity of PWS and the rate constant for Cu(II) ion biosorption. Adsorption rate constant in fed-batch operation was an order of magnitude larger than those obtained in adsorption columns because of elimination of mass transfer limitations encountered in the column operations while the biosorption capacity of PWS was comparable with powdered activated (PAC) in column operations. Therefore, a completely mixed reactor operated in fed-batch mode was proven to be more advantageous as compared to adsorption columns due to better contact between the phases yielding faster adsorption rates.

Keywords: Biosorption; Fed-batch reactor; Powdered waste sludge (PWS); Copper(II) ions

Aldre Jorge Morais Barros^a, Shiva Prasad^b, Valderi Duarte Leite^c and Antonio Gouveia Souza^a. (^aDepartment of Chemistry, Universidade Federal da Paraíba, Campus I, CEP: 58059-900, João Pessoa, PB, Brazil, Department of Chemical Engineering, Universidade

Federal da Campina Grande, CEP: 58109-970, Campina Grande, PB, Brazil, 'Department of Chemistry, Universidade Estadual da Paraíba, CEP: 58109-790, Campina Grande, PB, Brazil. Corresponding author. Tel.: +55 83 310 1115; fax: +55 83 310 1114). Biosorption of heavy metals in upflow sludge columns. Bioresource Technology, Volume 98(7) (2007): 1418-1425

The present study was carried out for evaluating the retention behavior of sanitary sewage and sand in relation to chromium and nickel ions in upflow reactors. It was found that the sludge presented a greater assimilation of the metals studied when compared to the inert material, probably due to the presence of anionic groups, which favors adsorption and complexation processes. Thermal analyses of the samples showed a shift in the decomposition peaks of the "in natura" sludge, when compared with those of the samples spiked with the metals, confirming the possibility of interactions between the heavy metals and the anionic groups present in the sludge.

Keywords: Heavy metals; Biosorption; Complexation; Sanitary sludge; Thermal analysis

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In this study, the recovery of nickel from a low-grade chromite overburden was attempted by employing two fungal strains, *Aspergillus niger* and *Aspergillus fumigatus*, and a mixed culture of mesophilic acidophiles (predominantly *Acidithiobacillus ferrooxidans*). Various factors were studied for bioleaching of chromite overburden such as, temperature, pH and pulp density. It was found that the *At. ferrooxidans* culture solubilized nickel effectively at temperatures ranging from 30 °C to 37 °C, whereas the organism was not able to solubilize nickel at higher temperatures, such as 45 °C. The use of higher pulp density resulted in a decrease of the percent nickel recovery whereas lower pulp density resulted in higher recovery values. Besides, increased supplemental ferrous iron increased the leaching efficiency of the *At. ferrooxidans* culture. The maximum nickel solubilization was 40%, at 2% pulp density, and 24%, at 10% pulp density, at 30 °C after 28 days leaching at 150 rpm.

In the case of fungal strains, a comparison of leach ability of chromite overburden and roasted overburden was made. The factors studied were pulp density and reaction time. The adapted fungal strain showed better leaching results as compared to the unadapted strains. The *in situ* nickel leaching efficiency of a laboratory stock culture of *A. niger* showed maximum recovery of 34% nickel with roasted chromite overburden, at 2% pulp density, while 32% nickel was solubilized by *A. fumigatus*, under the same conditions at 30 °C and 150 rpm, after 28 days incubation.

Keywords: Nickel; Chromite overburden; Bioleaching; *Aspergillus niger*; *Aspergillus fumigatus*; *Acidithiobacillus ferrooxidans*

Yasar Avsar^a, Hussein Tarabeah^b, Shlomo Kimchie^c and Izzet Ozturk^d. (^aTowns Association for Environmental Quality TAEQ, Agan Beit Natufa, P.O. Box 1093, Sakhnin 20173, Israel, ^bManager of Sakhnin Regional Center for Environmental Education and Research, Israel, ^cTechnion Institute for Research and Development, Faculty of Civil Engineering, Department of Environmental and Water Resources Engineering, Technion

City, Haifa, Israel, ^dIstanbul Technical University, Faculty of Civil Engineering, Department of Environmental, Istanbul, Turkey). **Rehabilitation by constructed wetlands of available wastewater treatment plant in Sakhnin. Ecological Engineering, Volume 29(1)(2007): 27-32**

In rural areas, insufficient wastewater treatment often causes serious environmental problems, especially for human health. Due to this problem, new wastewater treatment plants (WWTP) should be constructed or upgraded. When considering economic and maintenance factors, constructed wetlands (CWs) are more desirable processes. The available WWTP located in the Northern Israeli town of Sakhnin was redesigned and upgraded. To rehabilitate the WWTP, six new CWs having different operating conditions were constructed as a pilot project. The most appropriate place of construction of the CWs was thought to be at the end of the WWTP. From the beginning of the system, inlet and outlet pollution parameters such as chemical oxygen demand (COD), ammonia (NH₄-N⁺), total suspended solids (TSS), and phosphorus (PO₄-P³⁻) were monitored in the CWs from August 2005 to February 2006. As a result the most appropriate CWs were found having Phragmites as plant and volcanic tufa as media material. The maximum removal efficiencies were 71.8% on COD, 92.9% on TSS, 63.8% on ammonia for CW5 tank. Adversely, phosphorus removal was not so high in CW5. Phosphorus removal was negligible in the study.

Keywords: Constructed wetland; Rehabilitation; Rural area; COD; TSS; Nutrients

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Trace elements were analyzed in fish of commercial interest to determine their importance in marine systems of the Western Indian Ocean and their bioaccumulation patterns. The results are equivalent or lower than levels reported in ichthyofauna worldwide. Certain values of muscular Cd, Hg, Pb and Zn were, however, above thresholds for human consumption. Levels varied among tissues, species and fish length, but were seldom influenced by the nutritional condition of the fish, its gender and its reproductive status. Correlations between hepatic Hg and Se levels in Swordfish ($r^2 = 0.747$) and Yellowfin Tunas ($r^2 = 0.226$), and among metallothionein linking metals imply the existence of detoxification processes in these species. Level differences between fish from the Mozambique Channel and Reunion Island reflect differences of diets rather than differences of elemental availability in both environments.

Metal bioaccumulation was quantified in four species of pelagic fish.

Keywords: Metals; Fish; Contamination; Detoxification; Guidelines

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Universidade Católica (PUC-Rio), 22451-900, Rio de Janeiro, Rua Marquês de São Vicente, 225, Brazil). Accumulation of metals in macrophytes from water reservoirs of a power supply plant, Rio de Janeiro State, Brazil Water, Air, & Soil Pollution, Volume 178(1-4) (2007): 89-102

Aquatic macrophytes are well known accumulators for heavy metals, the reason why they are used as bioindicators for water quality and in phytoremediation strategies. This study reports on the elemental concentrations in four free-floating aquatic macrophytes (*S. auriculata*; *P. stratiotes*; *E. crassipes* and *E. azurea*) growing in two water reservoirs (Santana e Vigário, Rio de Janeiro State, Brazil) of an electric power plant that receive input from the polluted Paraíba do Sul River. Filtered water samples and water suspended solids from these environments were also analysed. Inductively coupled plasma mass spectrometry was used as the principal method, allowing the determination of up to 41 elements, including the rare-earth elements (REEs) and other trace metals not assayed before in these macrophytes. The results show that all elements studied are accumulated by the macrophytes with concentration ratios (CR = [plant]: [water]) varying from about 1,000 to 200,000, based on the dry weight of the plant species. With a few exceptions, highest accumulations were observed in *E. crassipes* in which CRs increase in the sequence: Cu < Mo < Cr < Pb < Tl < Fe < La < Zn < Ce < Mn. Surprisingly high CRs (e.g. Ce: 74,000) and corresponding mass concentrations were observed for the rare-earth elements (e.g. Σ REE: 112 mg kg⁻¹), also measured in the water suspended particle fraction. The results show that this fraction acts as an effective sink for trace metals in the aquatic system studied and seems to play also an important role in the transfer of metals from water to the plant species.

Keywords: Aquatic macrophytes - Bio-concentration factors - Metal uptake - Phytoremediation

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The objectives of this study are: (1) Evaluate the capacity of Indian mustard (*Brassica juncea*) for uptake and accumulation of Cs and Sr natural isotopes. (2) Identify foliar structural and other physiological changes (biomass, relative water content etc.) resulted from the accumulation of these two elements. (3) Monitor the Cs and Sr uptake and bioaccumulation process by spectral reflectance. Potted Indian mustard plants were exposed to different concentrations of Cs (50 and 600 ppm) and Sr (50 and 300 ppm) natural isotopes in solution form for 23 days. Bioaccumulation of Cs and Sr were found in the order of leaves > stems > roots for both Cs- and Sr-treated plants. The highest leaf and root Sr accumulations are observed to be 2,708, and 1,194 mg kg⁻¹, respectively; and the highest leaf and root Cs accumulations are 12,251, and 6,794 mg kg⁻¹, respectively. High translocation efficiency for both elements is documented by shoot/root concentration ratios greater than one. Biomass decreases were observed for plants treated with higher concentration of Cs or Sr. Cs accumulation affected the pigment concentration and internal structure of the leaf and the spectral characteristics of plants. Within the applied concentration range, Sr accumulation resulted in no significant changes in relative water content (RWC), leaf structural and spectral characteristics of mustard plants. Cs shoot

concentration showed significant negative correlation with relative water content (RWC; $r = -0.88^*$) and normalized difference vegetative index (NDVI) value ($r = -0.68^*$) of plant shoots. The canopy spectral reflectance and NDVI analysis clearly revealed ($p < 0.05$) the stress caused by Cs accumulation.

Keywords *Brassica juncea* - cesium - leaf anatomy - microscopy - phytoextraction - spectral reflectance - strontium

K. Parvathi¹, R. Naresh Kumar¹ and R. Nagendran¹. (¹Centre for Environmental Studies, Anna University, Chennai, 600025, Tamil Nadu, India. **Biosorption of manganese by *Aspergillus niger* and *Saccharomyces cerevisiae*. World Journal of Microbiology and Biotechnology, Volume 23(5) (2007): 671-676**

Biosorption of manganese from its aqueous solution using yeast biomass *Saccharomyces cerevisiae* and fungal biomass *Aspergillus niger* was carried out. Manganese biosorption equilibration time for *A. niger* and *S. cerevisiae* were found to be 60 and 20 min, with uptakes of 19.34 and 18.95 mg/g, respectively. Biosorption increased with rise in pH, biomass, and manganese concentration. The biosorption equilibrium data fitted with the Freundlich isotherm model revealed that *A. niger* was a better biosorbent of manganese than *S. cerevisiae*.

Keywords: *Aspergillus niger* - Biosorption - Freundlich isotherm - Manganese - *Saccharomyces cerevisiae*

B. D. Trivedi² and K. C. Patel¹. (¹Post Graduate Department of Biosciences, Sardar Patel University, Vallabh Vidyanagar, 388 120 Gujarat, India, ²M. B. Patel Science College, Anand-388 001, Gujarat, India). **Biosorption of hexavalent chromium from aqueous solution by a tropical basidiomycete BDT-14 (DSM 15396). World Journal of Microbiology and Biotechnology, Volume 23(5) (2007): 683-689**

A tropical white-rot basidiomycete, BDT-14 (DSM 15396) was investigated for its chromium (VI) biosorption potential from an aqueous solution. Pre-treatment of fungal biomass with acid resulted in 100% metal adsorption compared to only 26.64% adsorption without any pre-treatment. Chromium adsorption was a rapid process at early exposure resulting in 60% chromium removal within the first 2 h of exposure. An increase in biomass showed an increase in the total metal ions adsorption but a decrease in specific uptake of metal ions. The concentrations of chromium had a pronounced effect on the rate of adsorption. The adsorption efficiency was 100% when the initial Cr (VI) concentration was 100 mg l⁻¹ with 1,000 mg biomass. Only 47.5% adsorption was observed with 500 mg l⁻¹ Cr (VI) concentration. **The adsorption data fit well with the Langmuir and Freundlich isotherm models. Comprehensive characterization of parameters indicates BDT-14 biomass as a promising material for Cr (VI) adsorption.**

Keywords: Biomass - Biosorption - Chromium - Isotherms - White-rot fungi

Bioremediation

Okoronkwo, N. E.^{1*}, ¹Igwe, J. C.¹ and Okoronkwo, I. J.². (¹Industrial Chemistry Department, Abia State University, Uturu, Nigeria., ²Chemistry Department, Michael Okpara University of Agriculture Umudike, Abia State, Nigeria.. *Corresponding author. E-mail: nnennaetjeokoronkwo@ya-hoo.com). Environmental impacts of mercury and its detoxification from aqueous solutions. African Journal of Biotechnology Vol. 6 (4)(2007): 335-340

There has been an increased concern over the level of heavy metals in the environment because of the serious environmental hazards these metals pose. Mercury is one of these heavy metals present in the environment. Mercury undergoes complex chemical and physical transformation once released to the air, land or rivers. The main sources of mercury are the natural and anthropogenic sources. Mercury may be emitted to the atmosphere as a gas or particulate matter, which may return to the earth's surface either dry by gravitational settling or wet by precipitation. While it circulates and changes its form, it becomes persistent. It tends to accumulate in sediments of water bodies. Mercury constitutes a considerable hazard to vertebrates including man and it is bioaccumulating in biota. The detoxification of mercury from aqueous solutions has been achieved by conventional methods such as precipitation, coagulation, reverse osmosis, ion exchange and adsorption using activated carbon. Recent advances in mercury remediation include the use of agricultural by-products and microorganisms as adsorbent. The application of biosorbents has proved to be a very good process for mercury remediation from aqueous solutions. This paper reviews the toxicity of mercury and its remediation processes.

Key words: Mercury, detoxification, pollution, environment, heavy metals.

Okoh, A. I.^{1*} and Trejo-Hernandez, M. R.². (¹Department of Biochemistry and Microbiology, University of Fort Hare, Private Bag X1314, Alice 5700, South Africa, ²Centro de Investigacion en Biotecnologia, Autonoma Universidad del Estado de Morelos, Av. Universidad 1001, Col. Chamilpa, Cuernavaca, Mor. CP 62209, Mexico. *Corresponding Authors E-mail: aokoh@ufh.ac.za). Remediation of petroleum hydrocarbon polluted systems: Exploiting the bioremediation strategies. African Journal of Biotechnology Vol. 5 (25)(2006): 2520-2525

The irrepensible quest for a cheap source of energy to meet the extensive global industrialization demand has expanded the frontiers of petroleum hydrocarbon exploration. These exploration activities amongst others often result in pollution of the environment, thus creating serious imbalance in the biotic and abiotic regimes of the ecosystem. Several remediation alternatives have been in use for the restoration of petroleum hydrocarbon polluted systems. In this paper, we present an overview of bioremediation alternative vis-à-vis other cleanup methods and its adaptations in various polluted systems.

Key words: Crude oil, pollution, environment, bioremediation.

Yaomin Jin, Ling Guo, María C. Veiga, Christian Kennes* (Chemical Engineering Laboratory, Faculty of Sciences, University of La Coruña, Rúa Alejandro de la Sota, 1, 15008 La Coruña, Spain; telephone: +34-981-167000 ext. 2036; fax: +34-981-167065 email: Christian Kennes: Kennes@udc.es). Fungal biofiltration of α -pinene: Effects of temperature, relative humidity, and transient loads. **Biotechnology and Bioengineering**, Volume 96(3)(2007): 433 - 443

Over the past decade much effort has been made to develop new carrier materials, more performant biocatalysts, and new types of bioreactors for waste gas treatment. In biofilters fungal biocatalysts are more resistant to acid and dry conditions and take up hydrophobic compounds from the gas phase more easily than wet bacterial biofilms. In the present study, a biofilter packed with a mixture of perlite and Pall rings and fed α -pinene-polluted air was inoculated with a new fungal isolate identified as *Ophiostoma* species. α -Pinene is a volatile pollutant typically found in waste gases from wood-related industries. The temperature of waste gas streams from pulp and paper industries containing α -pinene is usually higher than ambient temperature. Studies were undertaken here on the effect on performance of temperature changes in the range of 15-40°C. The effect of temperature on biodegradation kinetics in continuous reactors was elucidated through equations derived from the Arrhenius formula. Moreover, the effects of the relative humidity (RH) of the inlet gas phase, transient loads (shock or starvation), and the nature of the nitrogen source on α -pinene removal were also studied in this research. The results suggest that the fungal biofilter appears to be an effective treatment process for the removal of α -pinene. The optimal conditions are: temperature around 30°C, RH of the inlet waste gas stream around 85%, and nitrate as nitrogen source. The fungal biofilter also showed a good potential to withstand shock loads and recovered rapidly its full performance after a 3-7 days starvation period.

Keywords: fungi • temperature • relative humidity • non-steady-state • biofilter • α -pinene

Hironori Taki^{1,2}, Kazuaki Syutsubo^{1,3}, Richard G. Mattison¹ and Shigeaki Harayama^{1,4}. (¹Marine Biotechnology Institute, 3-75-1 Heita, Kamaishi, Iwate 026-0001, Japan, ²Technology Center, Taisei Corporation, 344-1 Nase-cho, Totsuka-ku, Yokohama, Kanagawa 245-0051, Japan, ³Water and Soil Environment Division, National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, Ibaraki 305-8506, Japan, ⁴Department of Biotechnology, National Institute of Technology and Evaluation, 2-5-8 Kazusa-Kamatari, Kisarazu, Chiba 292-0818, Japan. Hironori Taki, Email: hironori.taki@sakura.taisei.co.jp). Identification and characterization of *o*-xylene-degrading *Rhodococcus* spp. which were dominant species in the remediation of *o*-xylene-contaminated soils. **Biodegradation**, Volume 18(1) (2007): 17-26

Soils contaminated with *o*-xylene were more difficult to bioremediate than those contaminated with other BTEX hydrocarbons (benzene, toluene, ethylbenzene, *m*-xylene and *p*-xylene). In order to identify microorganisms responsible for *o*-xylene degradation in soil, microbial community structure analyses were carried out with two soil samples in the presence of *o*-xylene and mineral nutrients. In two different soil samples, *Rhodococcus opacus* became abundant. We were also able to isolate *o*-xylene degrading *Rhodococcus* species from these soil samples. A primer set was developed to specifically detect a cluster of this *Rhodococcus* group including isolated *Rhodococcus* strains, *Rhodococcus opacus* and *Rhodococcus koreensis*. The growth of this bacterial group in an *o*-xylene-contaminated soil was followed by competitive PCR (cPCR). The decrease in *o*-xylene clearly paralleled the growth of the *Rhodococcus* group.

Keywords bioremediation - *o*-xylene - population analysis, *Rhodococcus* - soil

Xiaolin Wang¹ and Marc A. Deshusses¹. (¹ Department of Chemical and Environmental Engineering, University of California, Riverside, CA 92521, USA. Marc A. Deshusses, Email: mdeshuss@engr.ucr.edu). Biotreatment of groundwater contaminated with MTBE: interaction of common environmental co-contaminants. *Biodegradation*, Volume 18(1) (2007): 37-50

Contamination of groundwater with the gasoline additive methyl *tert*-butyl ether (MTBE) is often accompanied by many aromatic components such as benzene, toluene, ethylbenzene, *o*-xylene, *m*-xylene and *p*-xylene (BTEX). In this study, a laboratory-scale biotrickling filter for groundwater treatment inoculated with a microbial consortium degrading MTBE was studied. Individual or mixtures of BTEX compounds were transiently loaded in combination with MTBE. The results indicated that single BTEX compound or BTEX mixtures inhibited MTBE degradation to varying degrees, but none of them completely repressed the metabolic degradation in the biotrickling filter. *Tert*-butyl alcohol (TBA), a frequent co-contaminant of MTBE had no inhibitory effect on MTBE degradation. The bacterial consortium was stable and showed promising capabilities to remove TBA, ethylbenzene and toluene, and partially degraded benzene and xylenes without significant lag time. The study suggests that it is feasible to deploy a mixed bacterial consortia to degrade MTBE, BTEX and TBA at the same time.

Keywords aerobic - biodegradation - BTEX - co-contaminant - MTBE - TBA

Katarína Dercová^a, Zuzana Sejáková^a, Marianna Skokanová^a, Gabriela Barančíková^b and Jarmila Makovníková^c. (^aSlovak University of Technology, Faculty of Chemical and Food Technology, Department of Biochemical Technology, Radlinského 9, 812 37 Bratislava, Slovak Republic, ^bSoil Conservation and Research Institute Bratislava, Regional Station Prešov, Reimannova 1, 080 01 Prešov, Slovak Republic, ^cSoil Conservation and Research Institute Bratislava, Regional Station Banská Bystrica, Mládežnícka 36, 974 05 Banská Bystrica, Slovak Republic. Corresponding author. Tel.:+421 2 59325 710; fax:+421 2 52967085). Potential use of organomineral complex (OMC) for bioremediation of pentachlorophenol (PCP) in soil. *International Biodeterioration & Biodegradation*, Volume 58(3-4) (2006) : 248-253

Adsorption/desorption characteristics for the organic pollutant pentachlorophenol (PCP) were determined for the organomineral complex (OMC) prepared in the laboratory with clay mineral (zeolite-clinoptilolite) and organic matter (humic acids), both natural products with excellent sorption properties. Sorption experiments were carried out in three characterized soil samples, Calcaro-haplic Chernozem, Gleyic Fluvisol, and Arenic Regosol. The results of this study indicate that OMC has better retention abilities than the clay minerals alone. Higher amounts of humic acids (HAs), bound to zeolite, enhance its potential to adsorb and retain PCP. An OMC containing approx. 5 mg HA g⁻¹ of zeolite possessed the best retention ability for PCP and presented an optimal economic solution from the preparation point of view. Then biodegradation of PCP was studied in the same types of sterilized soils bioaugmented with the bacterial isolate *Comamonas testosteroni* CCM 7350, with and without the addition of OMC. The immobilization effect of OMC in relation to PCP depends on the concentration of PCP and the content of organic carbon in the soil. The activity of the microorganisms and the effect of acid rain led to the gradual release and biodegradation of the irreversibly bound PCP, without any initial toxic effect on indigenous or bioaugmented microorganisms. OMC appeared to be a good

adsorbant for PCP, with potential application in remediation technology. Fast and effective adsorption and low desorption may serve as a pretreatment step for bioremediation technology for reducing PCP content in soil and thus for reducing its potential toxicity, reducing bioavailability, and in this way facilitating biodegradation.

Keywords: Bioremediation; Humic acids; Organomineral complex; Pentachlorophenol; PCP; Sorption; Zeolite

Danielle M. Pala^a, Denize D. de Carvalho^b, José Carlos Pinto^a and Geraldo L. Sant'Anna, Jr.^a. (^aPrograma de Engenharia Química, COPPE/Universidade Federal do Rio de Janeiro, Brazil, ^bCentro de Tecnologia, Escola de Química, Bloco E, sala 203, 21949-900, Universidade Federal do Rio de Janeiro, Brazil. Corresponding author. Tel.: +55 21 2562 7564; fax: +55 21 2562 7567). A suitable model to describe bioremediation of a petroleum-contaminated soil. *International Biodeterioration & Biodegradation*, Volume 58(3-4) (2006): 254-260

A critical environmental impact of the petroleum industry is the spillage of oil and related products that causes severe soil contamination. Although biodegradation of petroleum hydrocarbons may be successfully conducted under controlled conditions, the bioremediation of large volumes of contaminated soils still presents some technical challenges, particularly when contamination occurs in soils of high clay content. The main objective of this work is to evaluate the bioremediation of petroleum-contaminated clay-soil by fixed bed experiments. They were conducted in agreement with the full factorial experimental design 2³. The processes employed were shown to be highly effective in decontaminating the soil, achieving removal rates of around 80%. The model chosen to represent the bioremediation process provided satisfactory results. The values calculated by the model were consistent with the experimental results.

Keywords: Soil; Bioremediation; Experimental design; Kinetic model; Petroleum

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The paper refers to utilization of biological elements within permeable reactive barriers. The concept of a biofiltration permeable barrier has been tested in the laboratory and in pilot-scale. Oxyhumolite (oxidized young lignite) was examined as an absorption material and a biofilm carrier. Laboratory tests performed before the pilot verification confirmed that oxyhumolite adsorbs organic pollutants at a minimum value, but that it can be used for biofilm attachment. An experimental barrier was built on premises of a chemical factory contaminated mainly by various organic pollutants [benzene, toluene, ethylbenzene, and xylenes (BTEX), chlorobenzenes, naphthalene, nitro-derivatives, phenols, trichloroethylene (TCE), and total petroleum hydrocarbon (TPH)]. Before the barrier was installed, a preliminary survey of the unsaturated zone, hydrogeological investigation, and a microbiological survey had been

performed. The barrier was designed as a trench-and-gate system with an in situ bioreactor. During the year 2004, measurements of groundwater flux and retention time under current hydrological conditions, together with chemical and microbiological monitoring, were carried out on the site. The results showed high effectiveness of organic contamination removal. Average elimination varied from 57.3% (naphthalene) to 99.9% (nitro-derivatives, BTEX); microbial density in the bioreactor was approx. 10^5 CFU mL⁻¹.

Keywords: Biobarrier; Biofiltration; Oxyhumolite; Bioreactor; Groundwater

G. Martinez-Garcia^a, Robert Th. Bachmann^a, Ceri J. Williams^a, Andrea Burgoyne^a and Robert G.J. Edyvean^a. (^aDepartment of Chemical and Process Engineering, The University of Sheffield, S1 3JD Sheffield, UK. Corresponding author. Tel.:+44 114 222 75 06; fax:+44 114 222 75 01). Olive oil waste as a biosorbent for heavy metals. *International Biodeterioration & Biodegradation*, Volume 58(3-4) (2006) 231-238

The sourcing of novel, inexpensive biowastes such as olive mill waste (OMW) from the two-decanter olive-oil-production system offers potential for the removal of metal ions by biosorption. OMW can be used in repeated regeneration cycles for the adsorption of heavy metals from aqueous solutions. The metal ions sequestered can be released in an acid solution until the concentration of these metal ions reaches a level where conventional methods can be used to provide economic metal recovery and potential revenue generation. The ability of this biomass to adsorb more than one metal ion from solution may increase its potential for application in the wastewater industry since the majority of industrial effluents contain more than one metallic species. Metal ion adsorption was found to increase with the speed of agitation and at an optimum pH value of between 4 and 7.

Keywords: Olive oil waste; Adsorption; Biosorption; Heavy metals

Van Brian Driessel^a; Lew Christopher^{ab}. (^a University of the Free State, Sappi Biotechnology Laboratory, Department of Microbial, Biochemical and Food Biotechnology. Bloemfontein. South Africa, ^b Sappi Management Services. Springs. South Africa). Mechanisms Prevalent during Bioremediation of Wastewaters from the Pulp and Paper Industry. *Critical Reviews in Biotechnology*, Volume 24(2 & 3) (2004): 85 - 95

Bioremediation of wastewaters represents an important treatment methodology, especially when examined against the backdrop of ever-stricter legislation that is evolving in order to regulate effluent release into the environment. It has been reported that bioremediation specifically holds promise in solving environmental problems. Crucial questions surrounding the treatment of effluents include: efficiency of the process, economic feasibility, legal requirements, and the mechanisms involved in the remediation process. Of all these issues mentioned, the last requires special attention. This paper investigates these matters and focuses on techniques that are currently employed to determine the efficiency of bioremediation and mechanisms involved therein. The physiological significance of biosorption is also examined, as this subject has not been fully addressed in previous publications.

Keywords: bioremediation mechanisms; biodegradation; bioadsorption; bleach plant effluents; white-rot fungi

B. Suresh^{ab}; G. A. Ravishankar^a. (^a Plant Cell Biotechnology Department, Central Food Technological Research Institute, Mysore, India, ^b Horticulture & Land Landscape Architecture Department, Colorado State University, Fort Collins, CO, USA). *Phytoremediation - A Novel and Promising Approach for Environmental Clean-up. Critical Reviews in Biotechnology, Volume 24(2 & 3)(2004): 97 - 124*

Phytoremediation is an eco friendly approach for remediation of contaminated soil and water using plants. Phytoremediation is comprised of two components, one by the root colonizing microbes and the other by plants themselves, which degrade the toxic compounds to further non-toxic metabolites. Various compounds, viz. organic compounds, xenobiotics, pesticides and heavy metals, are among the contaminants that can be effectively remediated by plants. Plant cell cultures, hairy roots and algae have been studied for their ability to degrade a number of contaminants. They exhibit various enzymatic activities for degradation of xenobiotics, viz. dehalogenation, denitrification leading to breakdown of complex compounds to simple and non-toxic products. Plants and algae also have the ability to hyper accumulate various heavy metals by the action of phytochelatins and metallothioneins forming complexes with heavy metals and translocate them into vacuoles. Molecular cloning and expression of heavy metal accumulator genes and xenobiotic degrading enzyme coding genes resulted in enhanced remediation rates, which will be helpful in making the process for large-scale application to remediate vast areas of contaminated soils. A few companies worldwide are also working on this aspect of bioremediation, mainly by transgenic plants to replace expensive physical or chemical remediation techniques. Selection and testing multiple hyperaccumulator plants, protein engineering of phytochelatin and membrane transporter genes and their expression would enhance the rate of phytoremediation, making this process a successful one for bioremediation of environmental contamination. Recent years have seen major investments in the R&D, which have also resulted in competition of filing patents by several companies for economic gains. The details of science & technology related to phytoremediation have been discussed with a focus on future trends and prospects of global relevance.

Keywords: phytoremediation; hyperaccumulation; phytochelatins; metallothioneins; xenobiotics; heavy metals

Teris A. van Beek^a, Bram Kuster^a, Frank W. Claassen^a, Taisto Tienvieri^b, Frédérique Bertaud^c, Gilles Lenon^c, Michel Petit-Conil^c and Reyes Sierra-Alvarez^d. (^aLaboratory of Organic Chemistry, Natural Products Chemistry Group, Wageningen University, Dreijenplein 8, 6703 HB Wageningen, The Netherlands, ^bUPM Kymmene Corporation, Teollisuustie 1, P.O. Box 51, FIN-37601 Valkeakoski, Finland, ^cCentre Technique du Papier, Domaine Universitaire, BP. 251, 38044 Grenoble Cedex 9, France, ^dDepartment of Chemical and Environmental Engineering, University of Arizona, P.O. Box 210011, Tucson, AZ 85721-0011, United States. Corresponding author. Tel.: +31 317 482376; fax: +31 317 484914). *Fungal bio-treatment of spruce wood with *Trametes versicolor* for pitch control: Influence on extractive contents, pulping process parameters, paper quality and effluent toxicity. Bioresource Technology, Volume 98(2) (2007): 302-311*

Lipophilic low molar-mass constituents in wood chips for the paper industry result in low quality pulp, pitch deposition, and effluent toxicity. New biotechnological solutions such as fungal pre-treatment of wood chips can reduce pitch problems. This laboratory-scale study focuses on the potential and limitations of a fungal bio-treatment of Norway spruce chips with the white-rot fungus *Trametes versicolor*. Different fungal treatment conditions were compared. A 4-week

fungal treatment reduced the concentration of resin acids and triglycerides by 40% and 100%, respectively, but neither lowered the energy requirements of the TMP process nor significantly affected the morphological fiber characteristics and the physical pulp properties. The pre-treatment led to slightly poorer optical properties. The *Trametes versicolor* fungal treatment contributed to a less toxic effluent and improved the biodegradability. A treatment of 2–3 weeks appears optimal.

Keywords: Lipophilic wood extractives; Biodegradation; Norway spruce; White-rot fungus; Effluent toxicity; Pitch

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A Cr(VI) resistant bacterial strain SDCr-5, identified as *Ochrobactrum intermedium* on the basis of 16S rRNA gene sequencing, was tolerant to high concentrations of Cr(VI) up to 15 mg ml⁻¹ in acetate minimal medium. *O. intermedium* SDCr-5 reduced Cr(VI) under a wide range of concentrations from 100 to 1500 µg ml⁻¹ and reduction was optimum at 37 °C and pH 7. It reduced 200 and 721 µg ml⁻¹ Cr(VI) within 72 and 96 h, respectively. The rate of Cr(VI) reduction increased with concentration from 100 to 1500 µg ml⁻¹. The presence of heavy metal cations such as Cu²⁺, Co²⁺, Mn²⁺ and Ni²⁺ stimulated Cr(VI) reduction. Strain SDCr-5 might be useful for Cr(VI) detoxification under a wide range of environmental conditions.

Keywords: Cr(VI) detoxification; Cr(VI) reduction; Cr(VI) resistance; Heavy metals; *Ochrobactrum intermedium*

A.K. Gupta^a and S. Sinha^a. (^aEcotoxicology and Bioremediation, National Botanical Research Institute, Lucknow 226 001, India. Corresponding author. Tel.: +91 522 205831 35x221; fax: +91 522 205839/836). Phytoextraction capacity of the *Chenopodium album* L. grown on soil amended with tannery sludge. *Bioresource Technology*, Volume 98(2)(2007): 442-446

The metal accumulation potential of *Chenopodium album* L. grown on various amendments of tannery sludge (TS) was studied after 60 days of sapling planted. The analysis of the results showed that the levels of pH, cation exchange capacity, organic carbon, organic matter and DTPA extractable metals (except Mn) of amendments increased by the addition of tannery sludge ratio. Shoot length of the plant increased by the addition of sludge, whereas, no marked change was observed in root length, fresh and dry weight of the plant. Accumulation of the metals in the plants was found in the order; Fe > Mn > Zn > Cr > Cu > Pb > Ni > Cd. Translocation of toxic metals (Cr, Pb, Cd) in different parts of the tested plant was found in the order; leaves > stems > roots. An increase in the photosynthetic pigments, carotenoid and leaf protein contents of the plants were found to increase with increase in sludge amendments. Correlation analysis between metal accumulation in the plants with DTPA extractable metals emphasized that Mn, Ni, Cr, Pb and Cd showed positive correlation ($p < 0.05$), whereas, Fe, Zn and Cu showed negative correlation. Transfer factor analysis emphasized that 10% TS amendments were suitable for phytoextraction of Cr. Overall analysis of the data exhibited that

the plants may be used for phytoextraction of Cr from tannery waste contaminated soil as most of the metal was accumulated in harvestable part which is a matter of serious concern, whenever used for edible purposes.

Keywords: Tannery sludge; *Chenopodium album*; Phytoextraction; DTPA; Bioavailability

V.K. Verma^a, Y.P. Singh^a and J.P.N. Rai^a. (^aEcotechnology Laboratory, Department of Environmental Science, G.B. Pant University of Agriculture and Technology, Pantnagar 263 145, India. Corresponding author. Tel.: +91 5944 233 904; fax: +91 5944 33473). Biogas production from plant biomass used for phytoremediation of industrial wastes. *Bioresource Technology*, Volume 98(8) (2007): 1664-1669

In present study, potentials of water hyacinth (*Eichhornia crassipes*) and water chestnut (*Trapa bispinnosa*) employed for phytoremediation of toxic metal rich brass and electroplating industry effluent, were examined in terms of biogas generation. Inability of the plants to grow in undiluted effluent directed to select 20%, 40% and 60% effluent concentrations (with deionized water) for phytoremediation experiments. Slurry of both the plants used for phytoremediation produced significantly more biogas than that by the control plants grown in unpolluted water; the effect being more pronounced with plants used for phytoremediation of 20% effluent. Maximum cumulative production of biogas (2430 c.c./100 g d m of water hyacinth and 1940 c.c./100 g d m of water chestnut) and per cent methane content (63.82% for water hyacinth and 57.04% for water chestnut) was observed at 5 mm particle size and 1:1 substrate/inoculum ratio, after twenty days incubation. Biogas production was quicker (maximum from 8–12 days) in water hyacinth than in water chestnut (maximum from 12–16 days). The qualitative and quantitative variations in biogas production were correlated with COD, C, N, C/N ratio and toxic metal contents of the slurry used.

Keywords: Phytoremediation; Methanogenesis; Anaerobic digestion; Brass industry effluent; Heavy metals; Slurry; Inoculum potential

G. Mohebal^a, A.S. Ball^b, B. Rasekh^a and A. Kaytash^a. (^aDepartment of Microbiology, Research Institute of Petroleum Industry, National Iranian Oil Company, Tehran, Iran, ^bSchool of Biological Sciences, Flinders University of South Australia, Adelaide, SA 5001, Australia. Corresponding author. Tel.: +98 21 55901021; fax: +98 21 55901094). Biodesulfurization potential of a newly isolated bacterium, *Gordonia alkanivorans* RIPI90A. *Enzyme and Microbial Technology*, Volume 40(4) (2007): 578-584

A number of bacteria have been recognized as being capable of desulfurizing dibenzothiophene (DBT) via a carbon–sulfur (C—S) bond targeted reaction. Herein we report the ability of a newly isolated bacterium, *Gordonia alkanivorans* RIPI90A (GenBank accession number DQ321498, 179. <http://www.ncbi.nlm.nih.gov>) to desulfurize both DBT and DBT-containing hexadecane during both the growth and resting stages, with conversion of DBT to 2-hydroxybiphenyl (2-HBP) via the 4S pathway. The highest specific activity, in terms of DBT-utilization occurred in cells harvested from the late exponential growth phase; the reaction rate and the specific activity were 182 $\mu\text{M h}^{-1}$ and $56.34 \mu\text{M 2-HBP g}_{\text{dry cell weight}}^{-1} \text{h}^{-1}$, respectively. Suitable cell surface hydrophobicity allowed the cells to obtain the sulfur compounds directly from the organic phase. The main goal of this effort was to study the desulfurizing resting cells function in biphasic organic media and to provide information to maximize biocatalyst activity in the media. The optimal conditions for the desulfurization of DBT-containing hexadecane in a

biphasic system including resting cell suspension (water/oil, 50:50) were determined as 20 and 7 for cell concentration (OD₆₆₀) and pH, respectively. The results suggest that this strain is of potential for the biodesulfurization of diesel oils.

Keywords: Biodesulfurization; Gordonia; Alkanivorans

Janjit Iamchaturapatr^{a, b}, Su Won Yi^a and Jae Seong Rhee^{a, b}. (^aWater Environment and Remediation Research Center, Division of Environment and Process Technology, Korea Institute of Science and Technology (KIST), Hawolgok-dong 39-1, Seongbuk-gu, Seoul 136-791, Republic of Korea, ^bDepartment of Green Chemistry and Environmental Biotechnology, University of Science and Technology (UST), Eoeun-dong 52, Yuseong-gu, Daejeon 305-333, Republic of Korea. *Corresponding author at:* Water Environment and Remediation Research Center, Division of Environment and Process Technology, Korea Institute of Science and Technology (KIST), Hawolgok-dong 39-1, Seongbuk-gu, Seoul 136-791, Republic of Korea. Tel.: +82 2 958 5954; fax: +82 2 958 5839). Nutrient removals by 21 aquatic plants for vertical free surface-flow (VFS) constructed wetland. *Ecological Engineering, Volume 29(3) (2007): 287-293*

An attempt was made to investigate the removal of high nutrient contents from polluted water. This study focused on the comparisons between nitrogen and phosphorus removal rates by area-based calculation and biomass-based calculation using various kinds of aquatic plants (18 emergent and 3 floating plants). Results showed that all floating plants performed maximum nutrient removal rates based on plant weight calculation while most emergent plants performed maximum nutrient removal rates based on planted area calculation. The reason is that the weights of rooted mass by emergent plants are heavier than their shoots, resulting to low nutrient removal efficiencies in terms of their total weight. The study suggests that the planted area and the plant's geometries (such as roots and shoots) should be considered for the effective design in aquatic plant treatment systems.

Keywords: Constructed wetlands; Nitrogen removal; Phosphorus removal; Plant selection; Planted area; Plant's geometry

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Growing short-rotation woody crops (SRWC) in rotation with conventional agriculture (phase farming with trees) is a prospective method for ameliorating degraded soils, particularly those at risk from salinisation. This work details changes in soil water storage and crop and pasture growth in the first 2 years after harvesting SRWCs at two sites in Western Australia between 2002 and 2004.

This trial has demonstrated that where the roots of SRWCs can penetrate deeply into the subsoil, it is possible to develop soil water deficits large enough to subsequently allow several decades of conventional agriculture before groundwater recharge is resumed. At one site, *Eucalyptus polybractea* dried the soil to 10 m, creating a soil water deficit of 1350 mm within 6 years of planting. It is estimated that annual crops and pasture could be grown at this site for 68 years

before the soil again reaches field capacity. Further work is required to determine where in the landscape SRWCs can develop these large soil water deficits.

Reduced soil fertility limited crop and pasture growth in the first year after the SRWC at one site, while reduced plant-available water limited crop and pasture growth for 2 years after the SRWC at the other. Monitoring is continuing to determine longer-term changes in soil water content and crop and pasture productivity.

Keywords: Phase farming with trees; Salinity; Agroforestry; Groundwater recharge

E. Kudjo Dzantor *. (Tennessee State University Nashville, Tennessee, USA. email: E. Kudjo Dzantor (edzantor@tnstate.edu). *Correspondence to E. Kudjo Dzantor, Institute of Agricultural and Environmental Research, Tennessee State University, 3500 John A. Merritt Blvd., Nashville, TN 3709-1561, USA). **Phytoremediation: the state of rhizosphere engineering for accelerated rhizodegradation of xenobiotic contaminants. Journal of Chemical Technology & Biotechnology, Volume 82(3) (2007): 228 – 232**

Phytoremediation has emerged as the method of choice for cleaning up a broad range of environmental contaminants. One process through which plants render some xenobiotic organic contaminants innocuous in soil involves plant-microbe interactions in which root exudates stimulate entire microbial communities, or induce specific enzymes in competent individuals to cause enhanced rhizodegradation. For some contaminants these inherent processes can be slow; however, potentials exist for their improvement through rhizosphere manipulations. Although this requires a greater understanding than currently exists with respect to plant and microbe components and interactions involved in the biodegradation of xenobiotic contaminants, improved understanding is being achieved by advances in biochemical and molecular characterization, and visualization of rhizosphere phenomena. In combination with earlier knowledge of naturally-occurring plant-microbe interactions such as the opine concept, this new knowledge considerably improves the opportunities for manipulating rhizosphere interactions to greatly accelerate rhizodegradation for routine practical implementation in the field.

Keywords: phytoremediation • xenobiotic organic contaminants • biodegradation • rhizodegradation • opine concept • rhizosphere engineering

F. Rigas^a, **K. Papadopoulou**^a, **V. Dritsa**^a and **D. Doulia**^a. (^aNational Technical University of Athens, School of Chemical Engineering, 15700 Athens, Greece). **Bioremediation of a soil contaminated by lindane utilizing the fungus *Ganoderma australe* via response surface methodology. Journal of Hazardous Materials, Volume 140(1-2) (2007): 325-332**

Mixtures of a sandy soil and wheat straw were doped with the organochlorine insecticide lindane in glass tubes and were inoculated with the polypore fungus, *Ganoderma australe*. An evaluation of bioremediation process effectiveness was searched and five parameters identified for the solid-state system. Fungi growth is a function of temperature and requires moisture for a proper colonization. These microorganisms need inorganic nutrients such nitrogen and phosphorus to support cell growth and it is also appropriate to know the range of concentration and toxicity of the used insecticide. Thus, an orthogonal central composite design (CCD) of experiments was used to construct second order response surfaces. Five design factors, namely temperature, moisture, straw, lindane content and nitrogen content and seven optimization parameters (responses), namely lag time, propagation velocity, biomass growth rate, biodegradation rate,

biodegradation/biomass, biomass/propagation and biomass content were analyzed. The optima of the responses of the adequate models were found to be the following: propagation velocity 4.25 mm/day, biomass growth rate 408 mg/day, biodegradation/biomass 56.9 µg/g, biomass/propagation 250 mg/mm and fungal biomass content in solid mixture 260 mg/cm³. The most important response for bioremediation purposes is biodegradation/biomass which is maximized at the factors levels: temperature 17.3 °C, moisture 58%, straw content 45%, lindane content 13 ppm and nitrogen content 8.2 ppm.

Keywords: Bioremediation; Contaminated soil; Ligninolytic fungi; *Ganoderma australe*; Central composite design

Quan-Ying Cai^{a, d}, Ce-Hui Mo^b, Qi-Tang Wu^a, Qiao-Yun Zeng^a, Athanasios Katsoyiannis^c and Jean-François Férard^d. (^aCollege of Resources and Environment, South China Agricultural University, Guangzhou 510642, China, ^bDepartment of Environmental Engineering, Jinan University, Guangzhou 510632, China, ^cEU-Joint Research Center, Institute for Health and Consumer Protection, Physical and Chemical Exposure Unit, Ispra (VA), TP-281, Via E. Fermi 1, I-21020, Italy, ^dLaboratoire d'Ecotoxicité, Santé Environnementale, CNRS UMR 7146, Université Paul Verlaine-Metz, Campus Bridoux, 57070 Metz, France). **Bioremediation of polycyclic aromatic hydrocarbons (PAHs)-contaminated sewage sludge by different composting processes. Journal of Hazardous Materials, Volume 142(1-2) (2007): 535-542**

The efficiency of four different composting processes to bioremediate polycyclic aromatic hydrocarbons (PAHs)-contaminated sewage sludge was investigated. Prior to composting, sewage sludge coming from the Datansha wastewater treatment plant, Guangzhou, China, was mixed with rice straw to obtain a C/N ratio of 13:1. After 56 days of composting, the total concentrations of 16 PAHs (Σ_{PAHs}) ranged from 1.8 to 10.2 mg kg⁻¹ dry weight, decreasing in order of inoculated-manual turned compost (IMTC) > manual turned compost (MTC) > continuous aerated compost (CAC) > intermittent aerated compost (IAC), exhibiting removal rates of 64%, 70%, 85% and 94%, respectively. Individual PAHs were generally removed in similar rates. IAC treatment showed a higher removal rate of high molecular weight PAHs and carcinogenic PAHs comparing to the other composting processes.

Keywords: Polycyclic aromatic hydrocarbons; Bioremediation; Composting; Sewage sludge; Rice straw

Praveena Bhatt^a, M. Suresh Kumar^a and Tapan Chakrabarti^a. (^aEnvironmental Biotechnology Division, National Environmental Engineering Research Institute (NEERI), Nehru Marg, Nagpur, India) **Assessment of bioremediation possibilities of technical grade hexachlorocyclohexane (tech-HCH) contaminated soils. Journal of Hazardous Materials, Volume 143(1-2): (2007): 349-353**

Hexachlorocyclohexane (HCH) is a broad spectrum insecticide still used in some of the developing countries, though developed countries have banned or curtailed its use. Even in those countries where the use of t-HCH has been discontinued for a number of years, the problem of residues of all isomers of t-HCH remains because of its high persistence. These insecticides in the soil disturb the delicate equilibrium between microorganisms and their environment. Few reports on the degradation of t-HCH isomers in soil are present in literature, and very little information is available on the effect of these t-HCH isomers on soil microflora. In the present

study, an attempt has been made to see the microbial diversity in the uncontaminated soils and the effect of application of t-HCH on the soil microflora. The soil was spiked with t-HCH and incubated, at regular time intervals the soil samples were analyzed for microbial diversity as well as t-HCH isomers residues. The results show that at higher concentrations of t-HCH, microbial populations were inhibited and the inhibited populations did not reappear even after prolonged incubation. Potential t-HCH degrading cultures were isolated and subjected to further acclimation in order to enhance their degradation capacity. The results are presented and discussed in this paper.

Keywords: t-Hexachlorocyclohexane; Lindane; HCH isomers; BHC; γ -Hexachlorocyclohexane

K. Suresh Kumar^a, K. Ganesan^a and P.V. Subba Rao^a. (^aMarine Algae and Marine Environment Discipline, Central Salt and Marine Chemicals Research Institute, Gijubhai Badheka Marg, Bhavangar 364 002, Gujarat, India). **Phycoremediation of heavy metals by the three-color forms of *Kappaphycus alvarezii*. Journal of Hazardous Materials, Volume 143(1-2) (2007): 590-592**

In the present investigation, three living color forms (brown, green and pale yellow) of *Kappaphycus alvarezii* were examined for their biosorption ability in the laboratory. The brown color form proved to be an excellent metal biosorbent, i.e. it could adsorb good amount of cadmium 3.064 mg/100 g f.wt. and cobalt 3.365 mg/100 g f.wt. It also removed 2.799 mg/100 g f.wt. of chromium. The green color form absorbed 2.684, 3.43 and 2.692 mg/100 g f.wt. of cadmium, cobalt and chromium, respectively. In contrast, the pale yellow form removed almost equal proportion of cadmium 0.961 mg/100 g f.wt. and chromium 0.942 mg/100 g f.wt. It also removed 1.403 mg/100 g f.wt. cobalt. Thus, the living color forms of this seaweed could form an effective biosorbent material for removal of heavy metals.

Keywords: Biosorption; Color forms; Heavy metals; *Kappaphycus alvarezii*; Marine

Scott Gifford¹, R. Hugh Dunstan¹, Wayne O'Connor², Claudia E. Koller¹ and Geoff R. MacFarlane¹. (¹School of Environmental and Life Sciences, University of Newcastle, Callaghan, NSW, 2308, Australia, ²NSW Department of Primary Industries, Port Stephens Fisheries Centre, Private Bag 1 Nelson Bay, NSW, 2315, Australia). **Aquatic zooremediation: deploying animals to remediate contaminated aquatic environments. Trends in Biotechnology, Volume 25(2) (2007): 60-65**

The ability of animals to act in a bioremediative capacity is not widely known. Animals are rarely considered for bioremediation initiatives owing to ethical or human health concerns. Nonetheless, specific examples in the literature reveal that some animal species are effective remediators of heavy metals, microbial contaminants, hydrocarbons, nutrients and persistent organic pollutants, particularly in an aquatic environment. Recent examples include deploying pearl oysters to remove metals and nutrients from aquatic ecosystems and the harvest of fish to remove polychlorinated biphenyls (PCBs) from the Baltic. It is probable that many animal taxa will possess attributes amenable to bioremediation. We introduce zoological equivalents of the definitions used in phytoremediation literature (zooextraction, zootransformation, zoostabilization and animal hyperaccumulation), to serve as useful benchmarks in the evaluation of candidate animal species for zooremediation initiatives, and propose that recognition of the concept of zooremediation would act to stimulate discussion and future research in this area.

Andrew C. Singer^a, Thomas Bell^b, Chloe A. Heywood^a, J.A.C. Smith^c and Ian P. Thompson^a. (^aCentre for Ecology & Hydrology-Oxford, Mansfield Road, Oxford OX1 3SR, UK, ^bDepartment of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK, ^cDepartment of Plant Sciences, University of Oxford, South Parks Road, Oxford OX1 3RB, UK). **Phytoremediation of mixed-contaminated soil using the hyperaccumulator plant *Alyssum lesbiacum*: Evidence of histidine as a measure of phytoextractable nickel. *Environmental Pollution*, Volume 147(1)(2007): 74-82**

In this study we examine the effects of polycyclic aromatic hydrocarbons (PAHs) on the ability of the hyperaccumulator plant *Alyssum lesbiacum* to phytoextract nickel from co-contaminated soil. Planted and unplanted mesocosms containing the contaminated soils were repeatedly amended with sorbitan trioleate, salicylic acid and histidine in various combinations to enhance the degradation of two PAHs (phenanthrene and chrysene) and increase nickel phytoextraction. Plant growth was negatively affected by PAHs; however, there was no significant effect on the phytoextraction of Ni per unit biomass of shoot. Exogenous histidine did not increase nickel phytoextraction, but the histidine-extractable fraction of soil nickel showed a high correlation with phytoextractable nickel. These results indicate that *Alyssum lesbiacum* might be effective in phytoextracting nickel from marginally PAH-contaminated soils. In addition, we provide evidence for the broader applicability of histidine for quantifying and predicting Ni phytoavailability in soils.

Alyssum lesbiacum was shown to phytoextract nickel from PAH-contaminated soils from which the pool of nickel accessed for phytoextraction is closely modelled by a histidine-soil extract.

Keywords: Phytoextraction; Phytoremediation; Bioremediation; Nickel; *Alyssum lesbiacum*; Metal hyperaccumulator; Histidine; Co-contaminated soil

Tomoyuki Makino^a, Takashi Kamiya^b, Hiroyuki Takano^b, Tadashi Itou^c, Naoki Sekiya^c, Kouta Sasaki^b, Yuji Maejima^a and Kazuo Sugahara^a. (^aNational Institute for Agro-Environmental Sciences, 3-1-3, Kannondai, Tsukuba, Ibaraki 305-8604, Japan, ^bTaiheiyo Cement Corp., 2-4-2 Osaku, Sakura, Chiba 285-8655, Japan, ^cNagano Agricultural Research Center, 429 Ogawara, Suzaka, Nagano, 382-0072, Japan). **Remediation of cadmium-contaminated paddy soils by washing with calcium chloride: Verification of on-site washing. *Environmental Pollution*, Volume 147(1) (2007): 112-119**

We developed a new, three-step soil-wash method to remediate Cd-contaminated paddy fields. The method comprises (1) chemically washing the field soil with a CaCl₂ solution; (2) washing the treated soil with water to eliminate residual Cd and CaCl₂; and (3) on-site treatment of wastewater using a portable wastewater treatment system. Cd concentrations in the treated water were below Japan's environmental quality standard (0.01 mg Cd L⁻¹), and the removal of Cd from the exchangeable fraction was 55% and from the acid-soluble fraction 15%. While soil fertility properties were affected by the soil washing, adverse effects were not crucial and could be corrected. The washing had no affect on rice growth, and reduced the average Cd concentration in rice grains by about two-thirds compared to a control plot. These results confirmed the effectiveness of the soil-wash method in remediating Cd-contaminated paddy fields. In situ soil washing in a paddy field using an on-site wastewater treatment system resulted in an effective decrease of Cd in soil and rice grains without affecting rice yield.

Keywords: Soil washing; On site; Paddy soil; Rice; Cadmium

Patrick Audet^a and Christiane Charest^a (^aOttawa-Carleton Institute of Biology, Department of Biology, University of Ottawa, 30 Marie-Curie St., Ottawa, Ont. K1N 6N5, Canada). Heavy metal phytoremediation from a meta-analytical perspective. *Environmental Pollution*, Volume 147(1) (2007): 231-237

We conducted a literature survey and correlated heavy metal (HM) uptake and plant growth factors from published data to estimate the effectiveness of phytoextraction. The indicators of the actual plant HM uptake showed positive correlations with soil-HM concentrations, while the relative plant HM uptake showed negative correlations. Plant growth was negatively correlated with both the plant and soil-HM concentrations. These significant relationships were found for the majority of HM tested (e.g. Zn, Cd, Pb, Cu, Cr, and Fe) with a few exceptions (e.g. Ni, Co, and Mn). After fitting the correlation coefficients, the highest proportion of variance among the studies was mainly due to the experimental parameters or the plant species. When the metabolic costs of HM uptake are taken into account, the phytoextraction appears to be less effective beyond critical HM concentrations. Despite these constraints, it is emphasized that HM phytoextraction can play an important role in bioremediation.

This meta-analytical approach has revealed a compromise between growth and HM uptake when plants are subjected to toxic soil-HM levels.

Keywords: Bioconcentration factor; Specific extraction yield; Tolerance index

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Selecting a phytoextraction plant with high Cd-accumulating ability based on the plant's compatibility with mechanized cultivation techniques may yield more immediately practical results than selection based on high tolerance to Cd. Rice (*Oryza sativa* L., cv. Nipponbare and Milyang 23), soybean (*Glycine max* [L.] Merr., cv. Enrei and Suzuyutaka), and maize (*Zea mays* L., cv. Gold Dent) were grown on one Andosol and two Fluvisols with low concentration of Cd contamination ranging from 0.83 to 4.29 mg Cd kg⁻¹, during 60 days in pots (550 mL) placed in a greenhouse. Shoot Cd uptake was as follows: Gold Dent < Enrei and Nipponbare < Suzuyutaka and Milyang 23. Several soil Cd fractions after Milyang 23 harvesting decreased most. Milyang 23 accumulated 10–15% of the total soil Cd in its shoot. The Milyang 23 rice is thus promising for phytoextraction of Cd from paddy soils with low contamination level.

Milyang 23 rice (*Oryza sativa* L.) accumulated 10–15% of the total soil Cd in its shoot.

Keywords: Soil Cd fraction; Cd uptake; Maize; Soybean; Rice

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gerwin.koopmans@wur.nl). Predicting the Phytoextraction Duration to Remediate Heavy Metal Contaminated Soils. Water, Air, & Soil Pollution, Volume 181(1-4) (2007): 355-371

The applicability of phytoextraction to remediate soils contaminated with heavy metals (HMs) depends on, amongst others, the duration before remediation is completed. The impact of changes in the HM content in soil occurring during remediation on plant uptake has to be considered in order to obtain a reliable estimate of the phytoextraction duration. To simulate the decrease in the HM content in soil and to assess the resulting decrease in the uptake of HMs by plants, contaminated soil was mixed with uncontaminated, but otherwise similar soil. Uptake of Cd, Pb, and Zn by the indicator plant *Lupinus hartwegii* and the Zn hyperaccumulator *Thlaspi caerulescens* (La Calamine ecotype) was a log-linear function of the in-situ measured HM soil solution concentrations. Over a wide range in dissolved Cd and Zn concentrations, uptake of these HMs by *T. caerulescens* was (much) greater than by *L. hartwegii*. Experimentally derived regression models describing the relationships between soil, soil solution, and plant were implemented in a HM mass balance model used to obtain estimates of the phytoextraction duration. For our target soils, estimates of the Cd phytoextraction duration using *L. hartwegii* or *T. caerulescens* increased significantly by more than 100 or 50 years when experimental soil—soil solution—plant relationships were used instead of the assumption of constant plant uptake of Cd. The two approaches gave similar results for phytoextraction of Zn by *T. caerulescens*.

Keywords: heavy metals - hyperaccumulator - leaching - phytoextraction - phytoextraction duration - plant uptake - *Thlaspi caerulescens*

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Salvinia minima combines several advantages for being used in aquatic phytoremediation. The objectives of this work were to compare the growth kinetics and productivity of *S. minima* and *Spirodela polyrrhiza* in high-strength synthetic organic wastewater (HSWW) and to evaluate the growth characteristics of *S. minima* in various culture media, including anaerobic effluents from pig wastewater (PWAE). It was found that the Relative Growth Rate (RGR) of *S. minima* was significantly higher ($p < 0.05$) compared to the RGR of *S. polyrrhiza* in Hutner Medium (HM) and in HSWW. Also, *S. minima* showed a 1.5 fold productivity and a 2.3 fold productivity, compared to *S. polyrrhiza* in HM and HSWW, respectively. Diauxic growth of *S. minima* was observed preferentially under pH control and there was a simultaneous consumption of two nitrogen sources. Productivity of *S. minima* was similar in pig waste anaerobic effluents (PWAE) and in HM without ammonium nitrate and amended with ammonium sulphate (MHM + AS), at an initial NH_4 concentration of 35 mg l^{-1} . Above this level, the productivity was found to decrease as the initial ammonium concentration increased, in both media. Growth was completely inhibited at 140 mg l^{-1} in the PWAE. In summary, *S. minima* is a better option than *S. polyrrhiza* for treating high-strength organic wastewater and lagoons should be operated at a maximum initial ammonium–nitrogen concentration of 70 mg l^{-1} and at a pH of 5.0 or 6.0. Likewise, the initial density should be maintained in the range of 7 to 15 g dw m^{-2} .

Keywords aquatic phytoremediation - aquatic floating plants - diauxic growth - anaerobic effluents - duckweed - lagoons - organic wastewater - pig wastewater - synthetic wastewater

Biotransformation

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Manufacture of nitroorganic explosives generates toxic wastes leading to contamination of soils and waters, especially groundwater. For that reason bacteria living in environments highly contaminated with 2,4,6-trinitrotoluene (TNT) and other nitroorganic compounds were investigated for their capacity for TNT degradation. One isolate, *Raoultella terrigena* strain HB, removed TNT at concentrations between 10 and 100 mg l⁻¹ completely from culture supernatants under optimum aerobic conditions within several hours. Only low concentrations of nutrient supplements were needed for the cometabolic transformation process. Radioactivity measurements with ring-labelled ¹⁴C-TNT detected about 10–20% of the initial radioactivity in the culture supernatant and the residual 80–90% as water-insoluble organic compounds in the cellular pellet. HPLC analysis identified aminodinitrotoluenes (2-ADNT, 4-ADNT) and diamionitrotoluenes (2,4-DANT) as the metabolites which remained soluble in the culture medium and azoxy-dimers as the main products in the cell extracts. Hence, the new isolate could be useful for the removal of TNT from contaminated waters.

Keywords: azoxy-dimers - bioremediation - *Raoultella terrigena* - TNT

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The potential of *Cosmarium* species, belonging to green algae, was investigated as a viable biomaterial for biological treatment of triphenylmethane dye, Malachite Green (MG). The results obtained from the batch experiments revealed the ability of algal species in removing dye. The effects of operational parameters (temperature, pH, dye concentration and algal concentration) on decolorization were examined. Optimal initial pH was determined 9. The stability and efficiency of the algae in long-term repetitive operations were also examined. Michaelis–Menten kinetics was used to describe the apparent correlation between the decolorization rate and the

dye concentration. The optimal kinetic parameters, v_{\max} and K_m are 7.63 mg dye g cell⁻¹ h⁻¹ and 164.57 ppm, respectively. All assays were conducted in triplicates.

Keywords: Biodegradation; Triphenylmethane; Malachite Green; Dyeing waste; Microalgae; *Cosmarium*

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Mannich base derivatives **1–3** were biotransformed through tandem enzymatic reactions by using several microorganisms isolated from Brazilian biomes. The hydrochlorides **1** and **3** produced propiophenone **1a**, α,β -unsaturated ketone **2c** and alcohol (*S*)-**1b** (yield 40%, e.e. 81%, *Aspergillus terreus*). The hydrochloride **2** underwent the Baeyer–Villiger oxidation producing exclusively *para*-methoxy-phenol by *A. terreus* and *A. niger*. The propiophenone **1a** was reduced to their corresponding enantiomerically enriched phenylpropanol (*S*)-**1b** (yield 65%, e.e. 81%, *A. terreus*). The *para*-methoxy-propiophenone **2a** afforded Baeyer–Villiger reaction hydrolyzed product, the *para*-methoxy-phenol (yield 80%, *A. terreus*). The racemic phenylpropanols **1b,2b** were resolved by lipase-catalyzed kinetic resolution (Novozym 435) affording (*S*)-alcohols **1b,2b** and (*R*)-acetates **1d,2d** in high enantiomeric excesses (up to 99%) and good yields (40–45%). We screened new microorganisms in biotransformation of Mannich bases, propiophenones and applied enzymatic resolution of phenylpropanols by *Candida antarctica* lipase.

Keywords: Mannich bases; Propiophenones; Phenylpropanols; Biotransformation; Bioreduction; Enzymatic resolution; Baeyer–Villiger reaction

Hui Ye^a, Sheng Yuan^a and Xiaodong Cong^b. (^aJiangsu Key Laboratory for Biodiversity and Biotechnology, Key Laboratory of Microbial Technology in College of Life Science, Nanjing Normal University, Nanjing 210097, PR China, ^bJiangsu Lianchuang Meditech Co., Ltd., Nanjing 210009, PR China. Corresponding author. Tel.: +86 25 83598790; fax: +86 25 83706565). **Biotransformation of puerarin into 3'-hydroxypuerarin by *Trichoderma harzianum* NJ01. *Enzyme and Microbial Technology*, Volume 40(4) (2007) :594-597**

Biotransformation of puerarin catalyzed by filamentous fungi has been studied. A primary screening was carried out using 138 filamentous fungi isolated from soil, that was able to grow in the presence of puerarin. Strain NJ01 was identified as *Trichoderma harzianum*. Under the optimum conditions, resting mycelium of *T. harzianum* NJ01 converted 41% of added 0.6 g/l puerarin to 3'-hydroxypuerarin that was characterized by MS, ¹³C NMR and ¹H NMR spectra. In the 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical-scavenging system, the activity of 3'-hydroxypuerarin (3'-OHP) was 20 times higher than that of puerarin. The solubility of 3'-OHP was 1.3 times greater than that of puerarin.

Keywords: *Trichoderma harzianum*; Biotransformation; Puerarin; 3'-Hydroxypuerarin; Antioxidant

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This paper analyses the purification efficiency and mass removal of organic material, suspended solids, nitrogen and phosphorus in a hybrid constructed wetland (CW) system treating wastewater from a basic school in Paistu, Estonia. The CW consists of two subsurface flow filter beds using lightweight aggregates (LWA): a two-chamber vertical subsurface flow (VSSF) filter bed followed by a horizontal subsurface flow (HSSF) filter bed, with a total area of 432 m². This CW was constructed in summer 2002 by the Centre for Ecological Engineering in Tartu (CEET). Eighteen series of water samples (from 30.10.2003 to 15.10.2005) were undertaken. The analyses show the outstanding purification effect of the system: for BOD₇ the average purification efficiency is 91%; for total suspended solids (TSS)—78%, for total P—89%, for total N—63%, and for NH₄—N—77%. The average outlet values for the above-listed parameters were 5.5, 7.0, 0.4, 19.2 and 9.1 mg L⁻¹, respectively. According to our results, the purification parameters meet the standards set by the Water Act of Estonia for wastewater treatment plants of 2000–9999 PE: 15, 25, and 1.5 mg L⁻¹ for BOD₇, TSS and total P, respectively. The results show that hybrid CW systems consisting of subsurface flow filter beds can work efficiently in conditions of changing hydraulic loading and relatively cold climate. We did not find significant differences between the removal efficiency, mass removal, and values of the first-order rate-constant k for most water quality indicators during the warm (May–October) and cold (November–April) periods. Locally produced LWA as a filter material in CWs has shown good hydraulic conductivity and phosphorus sorption capacity ($k = 17.1 \pm 12.4 \text{ m yr}^{-1}$). The Paistu CW, with its proper design and outstanding purification results, can be considered one of the best systems in Estonia.

Keywords: BOD; Hybrid constructed wetland; k - C^* model; LWA; Mass removal; Nitrogen; Phosphorus; Treatment efficiency

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The South Nation River Watershed, in eastern Ontario, Canada, is an agricultural watershed impacted by excess nutrient loading primarily from agricultural activities. A constructed wetland for the treatment of agricultural wastewater from a 150-cow dairy operation in this watershed was monitored in its eighth operating season to evaluate the proportion of total nitrogen (TN) (approximated by total Kjeldahl nitrogen (TKN) due to low NO₃⁻) and total phosphorus (TP) removal that could be attributed to storage in *Typha latifolia* L. and *Typha angustifolia* L., which

dominate this system. Nutrient loading rates were high, with $16.2 \text{ kg ha}^{-1} \text{ d}^{-1} \text{ N}$ and $3.4 \text{ kg ha}^{-1} \text{ d}^{-1} \text{ P}$ entering the wetland and loading the first wetland cell. Plant uptake accounted for 0.7% of TKN removal when the vegetated free water surface cells were considered together. However, separately, in the second wetland cell with lower N and P loading rates, plants accounted for 9% of TKN, 21% of NH_4^+ and 5% of TP removal. Plant uptake was significant to overall removal given wetland age and nutrient loading. Nutrient storage during the growing season at this constructed wetland helped reduce the nutrient load entering the watershed, already stressed by intensive local agriculture.

Keywords: Constructed wetland; Nitrogen; Phosphorus; *Typha* spp.; Nutrient uptake; Agriculture; Canada

Christos S. Akratos^a and Vassilios A. Tsihrintzis^a. (^aLaboratory of Ecological Engineering and Technology, Department of Environmental Engineering, School of Engineering, Democritus University of Thrace, 67100 Xanthi, Greece. *Corresponding author.* Tel.: +30 25410 78113; fax: +30 25410 78113). **Effect of temperature, HRT, vegetation and porous media on removal efficiency of pilot-scale horizontal subsurface flow constructed wetlands. Ecological Engineering, Volume 29(2) (2007): 173-191**

In order to investigate the effect of temperature, hydraulic residence time (HRT), vegetation type and porous media material and grain size on the performance of horizontal subsurface flow (HSF) constructed wetlands treating wastewater, five pilot-scale units of dimensions 3 m in length and 0.75 m in width were operated continuously from January 2004 until January 2006 in parallel experiments. Three units contained medium gravel obtained from a quarry. The other two contained one fine gravel and one cobbles, both obtained from a river bed. The three units with medium gravel were planted one with common reeds and one with cattails, and one was kept unplanted. The other two units were planted with common reeds. Planting and porous media combinations were appropriate for comparison of the effect of vegetation and media type on the function of the system. Synthetic wastewater was introduced in the units. During the operation period, four HRTs (i.e., 6, 8, 14 and 20 days) were used, while wastewater temperatures varied from about 2.0 to 26.0 °C. The removal performance of the constructed wetland units was very good, since it reached on an average 89, 65 and 60% for BOD, TKN and *ortho*-phosphate (P-PO_4^{3-}), respectively. All pollutant removal efficiencies showed dependence on temperature. It seems that the 8-day HRT was adequate for acceptable removal of organic matter, TKN and P-PO_4^{3-} for temperatures above 15 °C. Furthermore, based on statistical testing, cattails, finer media and media obtained from a river showed higher removal efficiencies of TKN and P-PO_4^{3-} .

Keywords: Constructed wetlands; Horizontal subsurface flow; Temperature; HRT; Vegetation; Porous media; Organic matter; Nitrogen; Phosphorus

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contributed equally to this study., ‡Present address: Unité de Génétique Microbienne, INRA, Domaine de Vilvert, 78352 Jouy en Josas, France). Conversion of Methionine to Cysteine in *Bacillus subtilis* and Its Regulation. ▽ J Bacteriol, 189(1)(2007): 187–197

Bacillus subtilis can use methionine as the sole sulfur source, indicating an efficient conversion of methionine to cysteine. To characterize this pathway, the enzymatic activities of CysK, YrhA and YrhB purified in *Escherichia coli* were tested. Both CysK and YrhA have an *O*-acetylserine-thiol-lyase activity, but YrhA was 75-fold less active than CysK. An atypical cystathionine β -synthase activity using *O*-acetylserine and homocysteine as substrates was observed for YrhA but not for CysK. The YrhB protein had both cystathionine lyase and homocysteine γ -lyase activities in vitro. Due to their activity, we propose that YrhA and YrhB should be renamed MccA and MccB for methionine-to-cysteine conversion. Mutants inactivated for *cysK* or *yrhB* grew similarly to the wild-type strain in the presence of methionine. In contrast, the growth of an Δ *yrhA* mutant or a *luxS* mutant, inactivated for the *S*-ribosyl-homocysteinase step of the *S*-adenosylmethionine recycling pathway, was strongly reduced with methionine, whereas a Δ *yrhA* Δ *cysK* or *cysE* mutant did not grow at all under the same conditions. The *yrhB* and *yrhA* genes form an operon together with *yrrT*, *mtnN*, and *yrhC*. The expression of the *yrrT* operon was repressed in the presence of sulfate or cysteine. Both purified CysK and CymR, the global repressor of cysteine metabolism, were required to observe the formation of a protein-DNA complex with the *yrrT* promoter region in gel-shift experiments. The addition of *O*-acetyl-serine prevented the formation of this protein-DNA complex.

S.M.*Dharmadhikari, S.B.Brahmane and M.S.Andhale. (Department of Microbiology, Govt. Institute of Science, Aurangabad, India). Biotransformation of benzonitrile by *Arthrobacter* Sp. BD – 1. Poll Res. Vol. 25 (2) (2006): 269-272.

The hydrolysis of the Nitrile groups is the limiting factor in the degradation of Nitrile herbicides and the persistence of such herbicides in the soil environment became toxic to rhizospheres. *Arthrobacter* sp. BD- 1 capable of utilizing Benzonitrile, one of the component of herbicides, as a sole source of carbon and energy, was isolated from rhizospheric soil. The presence of peptone and glucose at 0.1% (w/v) enhances hydrolysis. Maximum biodegradation was observed at 30°C for 48 hrs. *Arthrobacter* sp. BD – 1 rapidly metabolize Benzonitrile to benzoic acid and ammonia. Thin layer chromatography confirmed the absence of benzamide as an intermediate. Nitrilases were found to be responsible for this biotransformation. The ability of organism to degrade aromatic nitrile may be useful for the bioremediation of sites contaminated with synthetic nitriles.

Key words: Benzonitrile, Benzamide, *Arthrobacter*, Nitrilase

Biomarker

Mineshi Sakamoto^a, Tsuyoshi Kaneoka^b, Katsuyuki Murata^c, Kunihiko Nakai^d, Hiroshi Satoh^d and Hirokatsu Akagi^e. (^aDepartment of Epidemiology, National Institute for Minamata Disease, Kumamoto 867-0008, Japan, ^bDepartment of Obstetrics and Gynecology, Fukuoka University Graduate School of Medicine, Fukuoka 814-0180, Japan, ^cDepartment of Environmental Health Sciences, Akita University School of Medicine, Akita 010-8543, Japan, ^dDepartment of Environmental Health Sciences, Tohoku University Graduate School of Medicine, Miyagi 980-8575, Japan, ^eInternational Mercury Laboratory Inc., Kumamoto 867-0034, Japan). Correlations between mercury concentrations in umbilical cord tissue and other biomarkers of fetal exposure to methylmercury in the Japanese population. *Environmental Research*, Volume 103(1) (2007): 106-111

Methylmercury (MeHg) is one of the most risky substances to affect humans through fish consumption, and the fetus is known to be in the most susceptible group. Our objective in this study is to examine the relationships of total mercury (THg) and MeHg concentrations between umbilical cord tissue and other tissues as biomarkers of fetal exposure to MeHg in the Japanese population. In total, 116 paired samples were collected in three Japanese districts, the Tsushima Islands, Fukuoka City, and Katsushika ward of metropolitan Tokyo. THg was measured for hair and THg and MeHg were measured in cord tissues, maternal blood, and cord blood. The relationships among tissues in Hg concentrations were similar among districts. Therefore, we analyzed the relationships using all the samples. More than 90% of Hg in cord tissue, cord blood, and maternal blood was MeHg. THg and MeHg in cord blood was about two times higher than in maternal blood. A strong correlation was found between THg and MeHg in cord tissue. The cord tissue THg and MeHg showed a strong correlation with cord blood Hg, which is recognized as the best biomarker for fetal exposure to MeHg. The findings of this study indicate the significance of cord tissue THg and MeHg as biomarkers for fetal exposure to MeHg at parturition.

Keywords: Mercury; Methylmercury; Exposure; Umbilical cord tissue; Umbilical cord blood; Maternal blood; Hair; Parturition; Biomarkers; Fetus; Parturition

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Although a dose–effect relationship between water fluoride levels and damage to liver and kidney functions in animals has been reported, it was not demonstrated in humans. To evaluate the effects of drinking water fluoride levels on the liver and kidney functions in children with

and without dental fluorosis, we identified 210 children who were divided into seven groups with 30 each based on different drinking water fluoride levels in the same residential area. We found that the fluoride levels in serum and urine of these children increased as the levels of drinking water fluoride increased. There were no significant differences in the levels of total protein (TP), albumin (ALB), aspartate transamine (AST), and alanine transamine (ALT) in serum among these groups. However, the activities of serum lactic dehydrogenase (LDH), urine *N*-acetyl- β -glucosaminidase (NAG), and urine γ -glutamyl transpeptidase (γ -GT) in children with dental fluorosis and having water fluoride of 2.15–2.96 mg/L and in children having water fluoride of 3.15–5.69 mg/L regardless of dental fluorosis were significantly higher than children exposed to water fluoride of 0.61–0.87 mg/L in a dose–response manner. In contrast to children with dental fluorosis and having water fluoride of 2.15–2.96 and 3.10–5.69 mg/L, serum LDH activity of children without dental fluorosis but exposed to the same levels of water fluoride as those with dental fluorosis were also markedly lower, but the activities of NAG and γ -GT in their urine were not. Therefore, our results suggest that drinking water fluoride levels over 2.0 mg/L can cause damage to liver and kidney functions in children and that the dental fluorosis was independent of damage to the liver but not the kidney. Further studies on the mechanisms and significance underlying damage to the liver without dental fluorosis in the exposed children are warranted.

Keywords: Dental fluorosis; Dose–effect relationship; Drinking water fluoride; Serum and urine fluoride; Liver and kidney functions

Ernesto Alfaro-Moreno^{a, 1}, Rebeca López-Marure^b, Angélica Montiel-Dávalos^b, Peter Symonds^c, Alvaro R. Osornio-Vargas^a, Irma Rosas^d and J. Clifford Murray^c. (^aDivision of Basic Investigation, Instituto Nacional de Cancerología, Mexico City, Mexico, ^bCell Biology Department, Instituto Nacional de Cardiología, Mexico City, Mexico, ^cCancer Research—UK Tumour Cytokine Biology Group, Wolfson Digestive Diseases Centre, University Hospital, Nottingham, NG7 2UH, UK, ^dCentro de Ciencias de la Atmósfera, Universidad Nacional Autónoma de México, Mexico City, Mexico. Corresponding author: ¹ Provisional address during a postdoctoral position: Afd. Pneumologie, O.& N., Herestraat 49-bus 706, BE-3000 Leuven, Belgium). **E-Selectin expression in human endothelial cells exposed to PM₁₀: The role of endotoxin and insoluble fraction. Environmental Research, Volume 103(2) (2007): 221-228**

Exposure to PM₁₀ is associated with cardiovascular effects. We evaluated the effects of PM₁₀ on E-Selectin expression and monocytic cell adhesion in human umbilical vein endothelial cells (HUVECs). HUVEC were exposed to PM₁₀ (5–40 $\mu\text{g}/\text{cm}^2$) for 6 h, following which surface E-Selectin expression was detected by fluorescence microscopy and flow cytometry. The effects of total particles, particles treated with polymixin-B to block the effects of endotoxin, and both soluble and insoluble fractions of particles, were assessed. Incubation with PM₁₀ lead to a concentration-related increase of E-Selectin expression (>seven-fold increase at 40 $\mu\text{g}/\text{cm}^2$). Particles pre-treated with polymixin-B inhibited E-Selectin expression to a level slightly higher than untreated particles. An increase in fluorescence was also observed with the insoluble fraction, while the soluble fraction had no significant effect. HUVEC exposed to PM₁₀ were also evaluated for adhesivity of monocytic cells (U937). PM₁₀ strongly increased the adhesion of U937 cells to HUVEC. In conclusion, PM₁₀ induces endothelial cell activation, evidenced by enhanced E-Selectin expression. This activation is manifested functionally as an increase in monocytic cell adhesion. Insoluble components as well as endotoxins appear to be responsible for this activity.

Keywords: PM₁₀; HUVEC; Endothelial cells; E-Selectin; Endotoxin; LPS

Chung-Yen Lu^a, Yee-Chung Ma^a, Jia-Min Lin^{a, b}, Chun-Yu Chuang^c and Fung-Chang Sung^{a, b, d}. (^aInstitute of Environmental Health, National Taiwan University College of Public Health, 17 Xu-Zhou Road, Taipei 100, Taiwan, ^bPreventive Medicine, National Taiwan University College of Public Health, 17 Xu-Zhou Road, Taipei 100, Taiwan, ^cInstitute of Nuclear Science, National Tsing Hua University College of Nuclear Science, 101 Kuang Fu Road Sec. 2, Hsinchu 300, Taiwan, ^dInstitute of Environmental Health, China Medical University College of Public Health, 91 Hsueh-Shih Road, Taichung 404, Taiwan. Corresponding author. Institute of Environmental Health, China Medical University College of Public Health, 91 Hsueh-Shih Road, Taichung 404, Taiwan. Fax: +886 4 2201 9001). **Oxidative DNA damage estimated by urinary 8-hydroxydeoxyguanosine and indoor air pollution among non-smoking office employees. Environmental Research, Volume 103(3) (2007): 331-337**

This study investigated whether urinary 8-hydroxydeoxyguanosine (8-OHdG), a biomarker of oxidative stress, was associated with indoor air quality for non-smokers in high-rise building offices. With informed consents, urine samples from 344 non-smoking employees in 86 offices were collected to determine 8-OHdG concentrations. The concentrations of carbon dioxide (CO₂) and total volatile organic compounds (TVOCs) in each office and outside of the building were simultaneously measured for eight office hours. The average workday difference between indoor and outdoor CO₂ concentrations (dCO₂) was used as a surrogate measure of the ventilation efficiency for each office unit. The CO₂ levels in the offices ranged 467–2810 ppm with a mean of 1170 ppm, or 2.7 times higher than that in the outside air. The average urinary 8-OHdG levels among employees increased from 3.10 µg/g creatinine, for those at the lowest tertile levels of both dCO₂ and TVOCs, to 6.27 µg/g creatinine, for those at the highest tertile levels. Multivariate logistic regression analysis showed that the risk of having the urinary 8-OHdG level of greater than the median, 4.53 µg/g creatinine, for participants was increased significantly at the highest tertile dCO₂ level of >680 ppm (odds ratio (OR)=3.37, 95% confidence interval (CI)=1.20–9.46). The effect was significant at the middle tertile TVOCs level of 114–360 ppb (OR=2.62, 95% CI=1.43–4.79), but not at the highest tertile. Inadequate ventilation in office increases the risk of building-related oxidative stress in non-smoking employees.

Keywords: Oxidative stress; 8-hydroxydeoxyguanosine; Carbon dioxide; Volatile organic compounds; Ventilation rate; High-rise building office

Nazish Bostan¹, Muhammad Ashraf¹, Abdul S. Mumtaz¹ and Iftikhar Ahmad². (¹Department of Plant Sciences, Quaid-i-Azam University, Islamabad, Pakistan, ²National Agricultural Research Council, Islamabad, Pakistan. Muhammad Ashraf, Email: ashrafjahanian@yahoo.com). **Diagnosis of heavy metal contamination in agro-ecology of Gujranwala, Pakistan using cattle egret (*Bubulcus Ibis*) as bioindicator. Ecotoxicology, Volume 16(2) (2007): 247-251**

The present study investigated the status of heavy metals: Lead (Pb), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Silver (Ag) and Nickle (Ni) residues in egg, regurgitate and sediment samples collected from two colonies of cattle egret (*Bubulcus ibis*) during the breeding seasons between April and August in 2004 and 2005. The mean concentration of heavy metals in eggs and regurgitates was found higher compared to the maximum residue limit (mrl) standards

prescribed by Environmental Protection Agency (EPA). A further comparison was made with a similar study conducted in China. High concentrations of heavy metals have contributed to the altered breeding behaviour of the bird species studied. Based on these findings we suggested a regular monitoring of the spread of these pollutants as these have not yet reached to the sediments.

Keywords: Cattle Egret - Heavy metals - Industrial Pollutants - Regurgitate - Sediments

Wilfried Sanchez¹, Sélim Aït-Aïssa¹, Olivier Palluel¹, Jean-Maxence Ditché² and Jean-Marc Porcher¹. (¹Unité d'Évaluation des Risques Ecotoxicologiques, Institut National de l'Environnement Industriel et des Risques (INERIS), BP 2, 60550 Verneuil-en-Halatte, France, ²Conseil Supérieur de la Pêche, DR N°1,3 rue Sainte-Marie, 60200 Compiègne, France. Wilfried Sanchez, Email: Wilfried.Sanchez@ineris.fr). **Preliminary investigation of multi-biomarker responses in three-spined stickleback (*Gasterosteus aculeatus* L.) sampled in contaminated streams. *Ecotoxicology*, Volume 16(2)(2007): 279-287**

Recently, the three-spined stickleback (*Gasterosteus aculeatus* L.) has been proposed as a suitable fish species for detecting both androgen- and estrogen-induced endocrine disruption by environmental pollutants. This relatively pollution-tolerant fish is present in most European streams and small rivers but also coastal and estuarine areas. The purpose of the present field study was to determine the extent to which multiple biomarkers in this fish species could distinguish between streams with different pollution levels. Sticklebacks were sampled in French rivers characterised by various urban, industrial or agricultural contaminations and in outdoor lotic mesocosms as reference site. Physiological parameters including condition factor and liver somatic index, biotransformation enzymes such as 7-ethoxyresorufin-*O*-deethylase (EROD) and glutathione-*S*-transferase, antioxidant enzymes including glutathione peroxidase and total glutathione (GSH) content and lipoperoxidation (as TBARS) showed several differences between sites. For example, fish from an heavily contaminated stream exhibited a 9-fold EROD induction associated to a decrease of GSH and a 3-fold increase of TBARS content in comparison to fish from uncontaminated sites. When fish were transferred from polluted river to clean water, some of these biomarkers rapidly returned to basal levels found in fish in the reference site while others, like TBARS levels were still high after 2 weeks of depuration. Based on multivariate analyses, the battery of biomarkers proved to differentiate all sites, with a very good classification rate for highly contaminated streams. Influence of fish gender and sampling period on biomarker responses was also observed and is discussed. The results of this field study provide additional support for the use of stickleback for in situ multi-biomarker assessment.

Keywords: Three-spined stickleback - Biomarkers - Oxidative stress - Field study - Depuration experiment

Abdelaal Shamseldin¹. (¹Environmental Biotechnology Department, Genetic Engineering and Biotechnology Research Institute, Mubarak City for Scientific Research and Technological Applications, P.O. Box 21934, New Borg El-Arab City, Alexandria, Egypt. Abdelaal Shamseldin, Email: yabdelall@yahoo.com). **Use of DNA marker to select well-adapted *Phaseolus*-symbionts strains under acid conditions and high temperature. *Biotechnology Letters*, Volume 29(1) (2007): 37-44**

Soil acidity and high temperature contribute to the failure of nodulation in the common bean. It is therefore urgent to select strains with a high competitive ability under these stress conditions.

Two Egyptian *Rhizobium etli* strains, EBRI 2 and EBRI 26, were examined against *Rhizobium tropici* CIAT 899G labeled with the *gus* (β -glucuronidase) reporter gene. EBRI 2 and EBRI 26 were less competitive than CIAT 899G under acid conditions with both the Egyptian cultivar Giza 3 and the Colombian cultivar Rab 39. However, EBRI 2 and EBRI 26 gave higher nodule occupancy (78% and 62.5, respectively) than the nodule occupancy (18.5% and 35%) obtained by CIAT 899G at 35°C with cultivar Giza 3. Soil acidity (pH 5.8) was less detrimental to the nodule occupancy of EBRI 2 than EBRI 26 when they tested in competition with CIAT 899G.

Keywords: DNA marker - Phaseolus - *Rhizobium* competition - Soil acidity

Biofertilizer

D. Bera, D. Lahiri, Antonella De Leonardis, K.B. De and A. Nag. Biotechnological applications in agriculture: A new source of edible oil and production of biofertilizer and antioxidant from its by-products. Journal of Food Engineering, Volume 81(4) (2007): 688 – 692.

Terminalia bellerica Roxb (Combretaceae) known as bahera, found abundant in tropical Asia, is a source of new edible oil (37% by dry weight of kernel), biofertilizer, tannin and antioxidant. The oilcake contains high amount of nitrogen (8.34%). On biochemical evaluation from the oil cake it is evident that about 60% NaCl extractable protein is digestible which can be converted into biofertilizer or some useful fodder. The extractable high quality of tannin present in fruit pulp can be used in the leather industry and herbal medicines. The different processes for the extraction of tannin have been discussed. The maximum tannin was extracted at 135 °C over 12 h with shaking. The seed coat contains high amount of gallic acid (3.2 mg/ml) which showed good antioxidant properties on different vegetable oils.

Shu-Hsien Tsai, Ching-Piao Liu and Shang-Shyng Yang. Microbial conversion of food wastes for biofertilizer production with thermophilic lipolytic microbes. Renewable Energy, Volume 32(6) (2007): 904-915

Food waste is approximately one quarter of the total garbage in Taiwan. To investigate the feasibility of microbial conversion of food waste to multiple functional biofertilizer, food waste was mixed with bulking materials, inoculated with thermophilic and lipolytic microbes and incubated at 50 °C in a mechanical composter. Microbial inoculation enhanced the degradation of food wastes, increased the total nitrogen and the germination rate of alfalfa seed, shortened the maturity period and improved the quality of biofertilizer. In food waste inoculated with thermophilic and lipolytic *Brevibacillus borstelensis* SH168 for 28 days, total nitrogen increased from 2.01% to 2.10%, ash increased from 24.94% to 29.21%, crude fat decreased from 4.88% to 1.34% and the C/N ratio decreased from 18.02 to 17.65. Each gram of final product had a higher population of thermophilic microbes than mesophilic microbes. Microbial conversion of food waste to biofertilizer is a feasible and potential technology in the future to maintain the natural resources and to reduce the impact on environmental quality.

R. Nisha, A. Kaushik and C.P. Kaushik. Effect of indigenous cyanobacterial application on structural stability and productivity of an organically poor semi-arid soil. Geoderma, Volume 138(1-2) (2007): 49-56

Multi-strain biofertilizer consisting of three indigenous cyanobacterial isolates was applied to an organically poor semi-arid clay-loam soil (pH 7; electrical conductivity, EC, 0.8 dSm⁻¹; total organic carbon, TOC, 0.34%; total Kjeldahl Nitrogen, TKN, 0.06%) in pot-house experiment. During the 240 d experiment under conditions of limited water regime (6–12% soil moisture), there was a significant ($p < 0.05$) increase in TOC, TKN and PO₄³⁻P during the middle, which, however, diminished at later stages of the experiment. The biofertilizer (BF) improved carbon and nitrogen mineralization by promoting soil microbial activities and narrowed down C:N ratio. Effect of BF on cation exchange capacity of the soil became evident with time. Physical structure of the soil was influenced due to BF as indicated by significant ($p < 0.01$) decline in bulk density and increase in water holding capacity, hydraulic conductivity and mean weight diameter at the end of both pearl millet and wheat crop. Plant growth and yield of pearl millet-wheat sequence in the soil increased in response to cyanobacterial biofertilizer. Response of pearl millet to BF was more pronounced for certain parameters at the lower water level, W₂ (6% moisture). The native strains showed remarkable potential for improving structural stability, nutrient status and productivity of the soil under limited water regime.

P.G. Silva and H.J. Silva. Effect of mineral nutrients on cell growth and self-flocculation of *Tolypothrix tenuis* for the production of a biofertilizer. *Bioresource Technology*, Volume 98(3) (2007): 607-611

The influence of mineral nutrients on the growth and self-flocculation of *Tolypothrix tenuis* was studied. The identification of possible limiting nutrients in the culture medium was performed by the biomass elemental composition approach. A factorial experimental design was used in order to estimate the contribution of macronutrients and micronutrients, as well as their interactions. Iron was identified to be limiting in the culture medium. The micronutrients influenced mainly cellular growth without effects on self-flocculation. Conversely, the self-flocculation capacity of the biomass increased at higher concentrations of macronutrients. The optimization of mineral nutrition of *T. tenuis* allowed a 73% increase in the final biomass level and 3.5 times higher flocculation rates.

E. Aranda, I. García-Romera, J.A. Ocampo, V. Carbone, A. Malorni, F. Sannino, A. De Martino and R. Capasso. Reusing ethyl acetate and aqueous exhausted fractions of dry olive mill residue by saprobe fungi. *Chemosphere*, Volume 66(1) (2007): 67-74

Some saprobe fungi (*Phlebia radiata*, *Trametes versicolor*, *Coriolopsis rigida*, *Pycnoporus cinnabarinus*, *Fomes sclerodermus* or *Pleurotus pulmonarius*) were able to bioconvert the ethyl acetate fraction (DEAF) and the corresponding aqueous exhausted fraction (EAF) of dry olive mill residue (DOR), reducing their phytotoxicity on *Lepidium sativum* seeds. Large amount of hydroxytyrosol together with other eight monomeric phenols were found in the native DEAF fraction, which represents a good source of antioxidants. *P. radiata*, *T. versicolor* and *F. sclerodermus* caused an effective phytotoxicity reduction of EAF in the concentration range of 25–3 g l⁻¹. In particular, in the range between 12.5 and 3 g l⁻¹, the EAF samples inoculated with *P. radiata* and *F. sclerodermus* surprisingly stimulated the germinability of *L. sativum*, suggesting their use as a potential biofertilizer. This is the first report which showed the bioconversion of the above fractions in shorter time with respect to the previous findings concerning DOR. The possible implications of laccase in the decrease of DEAF and EAF phytotoxicity was also discussed.

Biocomposting

Ajay Singh^a; Kate Billingsley^b; Owen Ward^a. (^a Department of Biology, University of Waterloo. Waterloo, Ontario. Canada, ^b Canadian Food Inspection Agency, Fertilizer Section. Ottawa, Ontario. Canada). *Composting: A Potentially Safe Process for Disposal of Genetically Modified Organisms. Critical Reviews in Biotechnology, Volume 26(1) (2006): 1 - 16*

The widespread use of genetically modified organisms (GMOs) may result in the release of GMOs into the environment. The potential risks regarding their use and implementation of disposal methods, especially the possibility of novel genes from GMOs being transferred to natural organisms, need to be evaluated and better understood. There is an increasingly accepted public view that GMO products introduced into the environment should be degradable and should disappear after a limited period of time. Due to the risk of possible horizontal gene transfer, disposal methods for GMOs need to address destruction of both the organism and the genetic material. During the last two decades, we have developed a greater understanding of the biochemical, microbiological and molecular concepts of the composting process, such that maximum decomposition may be achieved in the shortest time with minimal negative impacts to the environment. The conditions created in a properly managed composting process environment may help in destroying GMOs and their genes, thereby reducing the risk of the spread of genetic material. When considering composting as a potential method for the disposal of GMOs, the establishment of controlled conditions providing an essentially homogenous environment appears to be an important requirement. An evaluation of composting as a safe option for disposal of GMOs is provided in this review.

Keywords: genetically modified organisms; composting disposal; microbial cell death; fate of DNA; gene transfer

Hefa Cheng^a, Weipu Xu^b, Junliang Liu^c, Qingjian Zhao^d, Yanqing He^b and Gang Chen^e. (^aDepartment of Civil and Environmental Engineering, Stanford University, Stanford, CA 94305, USA, ^bDepartment of Urban Construction, Hebei Institute of Architecture and Civil Engineering, Zhangjiakou, Hebei 075024, PR China, ^cCollege of Urban Construction, Hebei Agricultural University, Baoding, Hebei 071001, PR China, ^dCollege of Municipal and Environmental Engineering, Harbin Institute of Technology, Harbin, Heilongjiang 150090, PR China, ^eDepartment of Civil and Environmental Engineering, FAMU-FSU College of Engineering, Tallahassee, FL 32310, USA). *Application of composted sewage sludge (CSS) as a soil amendment for turfgrass growth. Ecological Engineering, Volume 29(1) (2007): 96-104*

We studied the growth of perennial ryegrass in soils amended with 5–100% composted sewage sludge (CSS), and the impacts of CSS amendment on soil physical and chemical properties. Soils amended with $\leq 20\%$ CSS did not significantly affect the seedling emergence, while the contents of chlorophyll, nitrogen, phosphorous, and potassium of perennial ryegrass grown in such soils were greatly improved. Bulk density, water retention, and nutrient contents of the soil were also improved with the amendment of CSS, but high CSS contents introduced excessive amounts of heavy metals and soluble salts. Results show that Cu, Zn, and Pb accumulated slightly (up to ≈ 2.3 times) in clippings of perennial ryegrass grown in CSS-amended soils compared to those grown in the base and reference soils, while no significant Cd absorption in

shoots of perennial ryegrass occurred. The detrimental effects on seedling emergence and turfgrass growth observed on substrates with high ($\geq 40\%$) CSS contents were mainly attributed to the presence of high soluble salt concentrations. The findings suggest that addition of CSS at 10–20% levels can greatly improve the soil nutrient supply for turfgrass growth without significantly affecting heavy metal and soluble salt contents of the soil.

Keywords: Perennial ryegrass; Composted sewage sludge (CSS); Soil nutrients; Heavy metals; Soluble salts; Waste disposal

Biopesticides

C. O. Nweke*, C. Ntinugwa, I. F. Obah, S. C. Ike, G. E. Eme, E. C. Opara, J. C. Okolo and C. E. Nwanyanwu. (Department of Microbiology, Federal University of Technology, P.M.B. 1526, Owerri, Nigeria. *Corresponding author. E-mail: xrisokey@yahoo.com). . *In vitro* effects of metals and pesticides on dehydrogenase activity in microbial community of cowpea (*Vigna unguiculata*) rhizoplane. African Journal of Biotechnology Vol. 6 (3) (2007): 290-295.

Effects of heavy metals and pesticides on cowpea (*Vigna unguiculata*) rhizoplane microbial community were assessed *in vitro* via dehydrogenase activity. The microbial community was exposed to various concentrations of heavy metals and pesticides in a nutrient broth-glucose-2,3,5-triphenyl chloride (TTC) medium. At 0.2 mM, iron and cadmium stimulated the dehydrogenase activity of the microbial community. For all the metal ions, there was progressive inhibition with each successive increase in the concentration of metal ion, reaching near 100% at 0.6, 0.8, 1.2, 0.12 and 12 mM for cobalt, cadmium, iron, mercury and nickel, respectively. Between 0.2 and 0.4 mM, zinc sharply inhibited dehydrogenase activity and at concentration above 0.4 mM, inhibition of dehydrogenase activity became less pronounced. The order of toxicity is $\text{Hg}^{2+} > \text{Co}^{2+} > \text{Cd}^{2+} > \text{Zn}^{2+} > \text{Fe}^{2+} > \text{Ni}^{2+}$. The herbicides Cotrazine (Atrazine 80W) and Northrin[®]10EC stimulated dehydrogenase activity of the microbial community at 0.2% and inhibited it at higher concentrations. The median inhibitory concentrations ($\text{IC}_{50\text{s}}$) of Cotrazine (Atrazine 80W) and Northrin[®]10EC were 0.552 ± 0.028 and $0.593 \pm 0.051\%$, respectively. The dehydrogenase activity varied significantly ($p < 0.05$) with the type and concentrations of metals or pesticides. The result indicates that the heavy metals and pesticides are potentially toxic to *V. unguiculata* root surface microorganisms. In soil, this toxicity may affect nitrogen fixation processes and by extrapolation affect crop yield.

Key words: Dehydrogenase activity, rhizoplane bacteria, atrazine, cypermethrin, heavy metals, cowpea.

Sunil C. Dubey^a, M. Suresh^a and Birendra Singh^a. (^aDivision of Plant Pathology, Indian Agricultural Research Institute, New Delhi 110 012, India). Evaluation of *Trichoderma* species against *Fusarium oxysporum* f. sp. *ciceris* for integrated management of chickpea wilt. Biological Control, Volume 40(1) (2007): 118-127

Fusarium wilt (*Fusarium oxysporum* f. sp. *ciceris* (Padwick) Matuo and K. Sato) is one of the major yield limiting factors of chickpea (*Cicer arietinum* L.). For eco-friendly and sustainable management of the disease, 10 isolates belonging to three species of *Trichoderma* (*Trichoderma viride*, *Trichoderma harzianum*, and *Trichoderma virens*) were evaluated against four isolates of

the pathogen representing four different races commonly prevalent in India. Dharwad (race 1), Kanpur (race 2), Ludhiana (race 3), and Delhi (race 4) isolates of *F. oxysporum* f. sp. *ciceris* were included in the study. The isolates of *Trichoderma* species were evaluated against the pathogen in dual culture and through production of volatile and non-volatile inhibitors. *T. viride* isolated from Ranchi followed by *T. harzianum* (Ranchi) and *T. viride* isolated from Delhi inhibited maximum mycelial growth of the pathogen. They also enhanced seed germination, root and shoot length, and decreased wilt incidence under green house condition. The isolates proved potential *in vitro* tests were evaluated along with other bioagents individually and in combination with carboxin under wilt sick field during 2002/03, 2003/04, and 2004/05 cropping season in randomized block design in three replications. Species of *Trichoderma* were found superior to *Bacillus subtilis* and Kalisena™ a commercial formulation of *Aspergillus niger*. The efficacy of *Trichoderma* species was enhanced in combination with carboxin. The integration of *T. harzianum* (10^6 spores/ml/10 g seed) and carboxin (2 g kg⁻¹ seed) for seed treatment was the best which enhanced seed germination by 12.0–14.0% and grain yields by 42.6–72.9% and reduced wilt incidence (44.1–60.3%) during experimentations.

Keywords: Chickpea; Fungal antagonist; Biological; Integrated control; *Trichoderma* spp.; *Fusarium oxysporum* f. sp. *ciceris*

Gaye Öngen¹, Gaye Güngör¹ and Bahar Kanberoglu¹. (¹Bioengineering Department, Ege University, Faculty of Engineering, 35100, Bornova, Izmir, Turkey). Decolourisation and dephenolisation potential of selected *Aspergillus* section *Nigri* strains – *Aspergillus tubingensis* in olive mill wastewater. *World Journal of Microbiology and Biotechnology*, Volume 23(4) (2007) 519-524

Aspergillus section *Nigri* strains *Aspergillus aculeatus* Ege-K 258, *A. foeditus* var. *pallidus* Ege-K156, *A. niger* Ege-K 4 and *A. tubingensis* Ege-K 265 were used to treat olive mill wastewater (OMW) in an investigation aimed at exploring their dephenolisation and decolourisation ability and, consequently, the economic feasibility of using any or all of these strains in a pre-treatment step in the processing of OMW. Of these strains *A. tubingensis* Ege-K 265 resulted in an 80% decolourisation of twofold-diluted OMW and a 30% decolourisation of undiluted OMW; in addition, it was able to remove approximately 30% of all phenolic compounds in both twofold-diluted and undiluted OMW. We conclude that *A. tubingensis* Ege-K 265 could be effectively used in the pre-treatment step of a combined aerobic-anaerobic process to solve the environmental problems caused by OMW in Mediterranean countries.

Keywords: *Aspergillus* section *Nigri* - *Aspergillus tubingensis* - Decolourisation - Dephenolisation - Olive mill wastewater

Zaki A. Siddiqui¹, G. Baghel¹ and M. S. Akhtar¹. (¹Department of Botany, Aligarh Muslim University, Aligarh, U.P, 202002, India). *World Journal of Microbiology and Biotechnology*, Volume 23(3) (2007): 435-441

Biocontrol of the root-knot nematode *Meloidogyne javanica* was studied on lentil using plant growth-promoting rhizobacteria (PGPR) namely *Pseudomonas putida*, *P. alcaligenes*, *Paenibacillus polymyxa* and *Bacillus pumilus* and root nodule bacterium *Rhizobium* sp. *Pseudomonas putida* caused greater inhibitory effect on the hatching and penetration of *M. javanica* followed by *P. alcaligenes*, *P. polymyxa* and *B. pumilus*. Inoculation of any PGPR species alone or together with *Rhizobium* increased plant growth both in *M. javanica*-inoculated

and -uninoculated plants. Inoculation of *Rhizobium* caused greater increase in plant growth than caused by any species of plant growth-promoting rhizobacteria in nematode-inoculated plants. Among PGPR, *P. putida* caused greater increase in plant growth and higher reduction in galling and nematode multiplication followed by *P. alcaligenes*, *P. polymyxa* and *B. pumilus*. Combined use of *Rhizobium* with any species of PGPR caused higher reduction in galling and nematode multiplication than their individual inoculation. Use of *Rhizobium* plus *P. putida* caused maximum reduction in galling and nematode multiplication followed by *Rhizobium* plus *P. alcaligenes*. *Pseudomonas putida* caused greater root colonization and siderophore production followed by *P. alcaligenes*, *P. polymyxa* and *B. pumilus*. Analysis of the protein bands of these four species by SDS-PAGE revealed that *P. putida* had a different protein band profile compared to the protein profiles of *P. alcaligenes*, *P. polymyxa* and *B. pumilus*. However, the protein profiles of *P. alcaligenes*, *P. polymyxa* and *B. pumilus* were similar.

Keywords: Bacillus - Biocontrol - Meloidogyne - Paenibacillus - Pseudomonas - Rhizobium

G.B.Raje and D.V.Muley*. (Departemnt of Zoology, D.B.J. College, Chiplun – 415 605. *Department of Zoology, Shivaji University, Kolhapur – 416 004). **Effect of pesticides on the enzyme activity in the fish, *Sarotherodon Mossambicus*. Poll Res. Vol. 25(2) (2006): 285-288.**

The fresh water fish, *Sarotherodon mossambicus* were exposed to 1/10th and 1/20th of predetermined LC₅₀ concentrations of Endosulfan 35 EC and Chlorpyriphos 20 EC for 30 days. The selected sublethal concentrations of Endosulfan were 0.00042 (1/10th of LC₅₀) and 0.00021 ppm (1/20th of LC₅₀) and of Chlorpyriphos were 0.014 and 0.007 ppm, respectively. After chronic exposure, amylase, protease and lipase activities in the intestine of control of experimental fishes were measured. Exposure of fishes to the pesticides showed significant decrease in the enzyme activities in the target organ of fish, *Sarotherodon mossambicus*.

Key words: Pesticides, Enzyme activity, *Sarotherodon Mossambicus*.

Biodegradation

A.A. Abia* and O.B. Didi. (Department of Pure and Industrial Chemistry, University of Port Harcourt, Port Harcourt, Nigeria. *Corresponding author. E-mail: abiauniport2005@yahoo.com . Tel: (+234) 080366125, (+234)08035509165). **Transfer zone behaviour of As(III), Co(II) and Mn(II) ions on sulphur-hydryl infused cellulose surface. African Journal of Biotechnology Vol. 6 (3)(2007): 285-289**

Penetrant transport phenomenon was applied to determine the strive of As(III), Co(II) and Mn(II) ions across the adsorbate/cellulose interface. Penetrant-n and K values calculated for the metals on differentially thiolated (mercaptoacetic acid treated) cellulose surfaces were highest for As(III) at UCF-n, K (3.1278, 0.3064), 0.5MF-n, K (2.4248, 0.4716) and 1.0MF-n, K (1.9136, 0.4885). For Co(II), n and K values were UCF (2.8608, 0.3220), 0.5MF (1.6791, 0.5351), 1.0MF (0.9348, 0.6952). For Mn(II), n and K values were UCF (1.2717, 0.6268), 0.5MF (1.1114, 0.6639), 1.0MF (0.5833, 0.7707). As(III) strive depicts 30% adsorption against the non-cationic moieties it generates in a partially electrical double layered adsorption system.

Key words: Adsorption, heavy metals, cassava fiber, penetrant transport, strive

Gurusamy Annadurai, Lai Yi Ling and Jiunn-Fwu Lee* (Graduate Institute of Environmental Engineering, National Central University Chung-Li, 320, Taiwan, ROC. *Corresponding author. E-mail: gannadurai@gmail.com, jflee@ncuen.ncu.edu.tw, Tel: +886-3-4227151-34658. Fax: +886-3-4226742). **Biodegradation of phenol by *Pseudomonas pictorum* on immobilized with chitin.** *African Journal of Biotechnology* Vol. 6 (3)(2007): 296-303

Biodegradation of phenol using *Pseudomonas pictorum* (ATCC 23328) a potential biodegradant of phenol was investigated under different operating conditions. Chitin was chosen as a support material and then partially characterized physically and chemically. The pH of the solution was varied over a range of 7 – 9. The maximum adsorption and degradation capacity of bacteria immobilized with chitin at 30°C when the phenol concentration was 0.200 mg/L is at pH 7.0. The results showed that the equilibrium data for all phenol-degradation sorbent systems fitted the Langmuir, Freundlich and Redlich-Peterson model best. Kinetic modeling of phenol degradation was done using the pseudo-first order and pseudo-second order rate expression. The biodegradation data generally fit the intraparticle diffusion rate equation from which biodegradation rate constant, diffusion rate constant were determined.

Key words: Adsorption, biodegradation, phenol, *Pseudomonas pictorum*, isotherm and kinetic studies.

B. K. Taşeli. (The Authority for the Protection of Special Areas (Özel Çevre Koruma Kurumu Başkanlığı), Alparslan Türkeş Cad., 31. Sok., 10 Nolu Hizmet Binası, Beştepe, Ankara, Turkey. E-mail: basaktaseli@hotmail.com). **Dehalogenation and decolorization of wheat straw-based bleachery effluents by *Penicillium camemberti*.** *African Journal of Biotechnology* Vol. 6 (3)(2007): 304-306

This paper examined the capability of *Penicillium camemberti* to dechlorinate and decolorize wheat straw-based pulping and bleaching effluents. In batch tests, the highest removals for CEH (Chlorination-Extraction-Hypochlorite) bleaching sequence [65% organic halides (AOX) 84% color] were obtained with 2 g/l acetate concentration in 10 days under non-shaking conditions. Experiments in shaking flasks containing Tween 80 produced 60% AOX, 79% color removals in 10 days. This removal efficiency was also in accord with gas chromatography analysis indicating drastic reductions at low molecular weight adsorbable organic halogen compounds.

Key words: Straw, bleaching, adsorbable organic halogens, pulping, *Penicillium camemberti*.

Owabor, C. N.* and Ogunbor, O. F. (Department of Chemical Engineering, University of Benin, Benin City, Nigeria. *Corresponding author. E-mail: owabor4you@yahoo.com). **Naphthalene and pyrene degradation in contaminated soil as a function of the variation of particle size and percent organic matter.** *African Journal of Biotechnology* Vol. 6 (4)(2007): 436-440

The effect of soil particle size distribution and percent organic matter on the degradation rate of naphthalene and pyrene in a water medium of 7.05 ml/min at 27 °C in a soil reactor was studied. Analysis of the pattern of disappearance of these polycyclic aromatic hydrocarbons (PAHs) using various particle sizes showed a rapid decline of concentration of the chemicals

during initial stages of bioremediation treatment, followed by a slow reduction rate. The extent of naphthalene and pyrene removal and final concentrations for the period under study differed among the different soil particle sizes. Results show that from an initial 100 mg/l, the concentration of both naphthalene and pyrene decreased in the following sequence clay \square silt \square fine sand \square coarse sand. The degradation of the two PAHs was significantly enhanced by the addition of organic matter to the bulk composite soil. The specific reaction rate constant k was found to increase with decreasing particle size and increase with increasing % organic matter. For both PAHs, coarse sand had the lowest rate constant while clay had the highest. This implies that degradation was faster in the clay fraction than in the other soil fractions. The correlation coefficients obtained using linear regression method was between 0.734 and 0.996 indicating the reliability of the experimental data.

Key words: Naphthalene, pyrene, biodegradation, particle size, organic matter, contaminated soil.

Sathiya moorthi, P.^{1*}, Periyar selvam, S.², Sasikalaveni, A.³ Murugesan, K.², and Kalaichelvan, P. T.². (¹ Dept. of Ind. Biotechnology, Dr. M.G.R. Educational and Research Institute, Dr.M.G.R.University, Chennai - 600 05, India, ²CAS in Botany, University of Madras, Chennai, – 600 025, India, ³Department of Microbiology Shrimathi Indira Gandhi College, Trichy, – 620 002, India. *Corresponding author. E-mail: sathiya.india@gmail.com. Decolorization of textile dyes and their effluents using white rot fungi. *African Journal of Biotechnology* Vol. 6 (4)(2007): 424-429

Reactive dyes are important chemical pollutants from textile industries. The two species of white rot fungi were evaluated for their ability to decolorize Blue CA, Black B133, Corazol Violet SR. *Trametes hirsuta* and *Pleurotus florida* displayed the greatest extent of decolorization. Laccase is the lignolytic enzyme from these fungi. The laccase activity was measured using both solid and aqueous state assays. The dye absorption ability of the mycelium was studied using appropriate medium containing dyes at the concentration of 75 mg/l. The effective decolorization of Blue CA and Corazol Violet SR dyes by both microorganisms were observed in the fifth day of incubation. Further decolorization activity was verified using various concentrations of dyes such as 25, 50 and 75 mg/l. Maximum decolorization was observed in Blue CA and Corazol Violet SR dyes. The effluent from the dye house was treated using both organisms with different concentration of glucose (1 and 2%). Effective decolorization was found to be more by the *Pleurotus florida* in 2% glucose.

Key words: Reactive dyes, dye house effluent, *Pleurotus florida*, *Trametes hirsuta*, laccase.

Slaoui M^{1*}, Ouhssine M¹, Berny E² and Elyachioui M¹. (¹Laboratory of Environmental Sciences, Department of Environmental engineering, Sale Medina, BP 227, Morocco, ²Laboratory of Microbial Biotechnology, Department of Biology, Science Faculty, Kénitra. B.P 133. Morocco, ³Laboratory of Biochemistry, Department of Biology, Science Faculty, Kénitra. B.P 133. Morocco. *Corresponding author, E-mail: smslaoui@yahoo.fr). Biodegradation of the carbofuran by a fungus isolated from treated soil. *African Journal of Biotechnology* Vol. 6 (4)(2007): 419-423

A total of 50 bacteriocin-producing *Lactobacillus* strains isolated from some Nigerian indigenous fermented foods and beverages (*ogi*, *fufu*, *garri* and *nono*) and characterized as *L. acidophilus*, *L. casei*, *L. fermentum*, *L. lactis* and *L. plantarum* were screened for their inhibitory

potentials against food-borne pathogenic indicator bacterial isolates; *Acinetobacter* sp., *Alkaligenes* sp., *Enterobacter aerogenes*, *Escherichia coli*, *Proteus mirabilis*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Shigella flexneri*, from the same or similar fermented food sources, and against clinical indicator bacterial isolates and type cultures-*Bacillus subtilis* NCTC8236, K12 *Escherichia coli* V157, NCTC11560, *Vibrio* INABA *B. cereus* CIS25, CIS32, *B. licheniformis* CIS26, *Pseudomonas aeruginosa* CIS23, *Klebsiella aerogenes* CIS24, *Kleb. pneumoniae* CIS29V and *Kleb. aerogenes* CIS55. It was observed that each fermented food had its own microbial interaction with minimal *in vitro* inhibitory activity (1.5 – 10.0%) by the bacteriocin-producing *Lactobacillus* strains against the indicator bacterial isolates from the fermented foods and beverages, indicating narrow to moderate antimicrobial spectrum; while the inhibitory profiles against the clinical bacterial isolates and the type cultures by the putative strains were between 75.0 – 100.0%. The effect of different pH on the antimicrobial potentials of the *Lactobacillus* strains indicates highest inhibitory activities between 5.5 and 7.5. The survival rates of the pathogenic indicator bacteria in the fermented food sources were between 8 and 14 days while the clinical isolates survived in simulated fermented food samples between 5 and 9 days.

Key words: Bacteriocin, fermented foods, food-borne pathogens, indicator isolates, *Lactobacillus*.

Zhang Chaojie¹, Zhou Qi¹, Chen Ling¹, Yuan Yuan¹ and Yu Hui¹. (¹State Key Laboratory of Pollution Control and Resource Reuse, College of Environmental Science and Engineering, Tongji University, Siping Road 1239, Shanghai, 200092, China. Zhang Chaojie, Email: myrazh@mail.tongji.edu.cn). **Degradation of Mono-Fluorophenols by an Acclimated Activated Sludge Biodegradation, Volume 18(1)(2007): 51-61**

Acclimated activated sludge was examined for its ability to degrade mono-fluorophenols as the sole carbon source in aerobic batch cultures. The acclimated activated sludge degraded fluorophenol efficiently. It degraded 100 mg/l 3-fluoropheno and 4-fluorophenol in 16 h with, respectively, 99.85% and 99.91% fluoride anion release and it degraded 50 mg/l 2-fluorophenol in 15 h with 99.26% fluoride anion release. The aerobic biodegradability of the mono-fluorophenols decreased in the order: 4-fluorophenol > 3-fluorophenol > 2-fluorophenol, resulting mainly from a different octanol/water partition coefficient and different steric parameter of the fluorophenols. The mechanism study revealed that the initial step in the aerobic biodegradation of mono-fluorophenols by the activated sludge was their transformation to fluorocatechol. Following transformation of the fluorophenol to fluorocatechol, ring cleavage by catechol 1, 2-dioxygenases proceeded via an *ortho*-cleavage pathway, then defluorination occurred.

Keywords: aerobic biodegradation - defluorination - *ortho*-cleavage pathway

Jose A. Perales¹, Manuel A. Manzano¹, M. Carmen Garrido¹, Diego Sales¹ and Jose M. Quiroga¹. (¹Area of Environmental Technologies, Faculty of Marine and Environmental Sciences, Campus of Puerto Real. Polígono Río San Pedro s/n, 11500 Puerto Real, Cádiz, Spain. Jose A. Perales, Email: joseantonio.perales@uca.es). **Biodegradation kinetics of linear alkylbenzene sulphonates in sea water. Biodegradation, Volume 18(1) (2007): 2007**

This article reports the primary biodegradation kinetics of linear alkylbenzene sulphonates (LAS) in sea water from the Bay of Cadiz (South West of the Iberian Peninsula). The authors used the biodegradation test guideline proposed by the Office of Prevention, Pesticides, and Toxic Substances of the United States Environmental Protection Agency; 835.3160 "Biodegradability in sea water" in its shake flask variant. High performance liquid chromatography (HPLC) has been employed for the analysis of the surfactant material. The surfactant shows a primary biodegradation kinetic in accordance with a logistic model, the kinetic parameters t_{50} and lag time were calculated by means of a easy quantitative procedure introduced. Mean values of 6.15 ± 0.45 and 6.67 ± 0.6 days were obtained for t_{50} and lag time, respectively. These results indicate that although LAS has a high primary biodegradation rate in sea water, it biodegrades slower than in similar tests conducted in river water.

Keywords: biodegradation - kinetic - linear alkylbenzene - sea water - surfactants - xenobiotics

Bilge Alpaslan Kocamemi¹ and Ferhan Çeçen². (¹Department of Environmental Engineering, University of Marmara, Kuyubasi, Istanbul, Turkey, ²Institute of Environmental Sciences, University of Bogazici, Bebek, Istanbul, Turkey). **Kinetic analysis of the inhibitory effect of trichloroethylene (TCE) on nitrification in cometabolic degradation. Biodegradation, Volume 18(1) (2007): 71-81**

In this study, the inhibitory effect of TCE on nitrification process was investigated with an enriched nitrifier culture. TCE was found to be a competitive inhibitor of ammonia oxidation and the inhibition constant (K_I) was determined as 666–802 $\mu\text{g/l}$. The TCE affinity for the AMO enzyme was significantly higher than ammonium. The effect of TCE on ammonium utilization was evaluated with linearized plots of Monod equation (e.g., Lineweaver–Burk, Hanes–Woelf and Eadie–Hofstee plots) and non-linear least square regression (NLSR). No significant differences were found among these data evaluation methods in terms of kinetic parameters obtained.

Keywords cometabolism - kinetics - modelling - nitrification - trichloroethylene

Ivana Ribeiro de Nardi¹, Marcelo Zaiat² and Eugenio Foresti². (¹Centro Universitário Central Paulista (UNICEP), Rua Miguel Petroni, 5111, Jardim Centenário, 13563-470 São Carlos, SP, Brazil, ²Laboratório de Processos Biológicos, Escola de Engenharia de São Carlos (EESC), Universidade de São Paulo (USP), Av. Trabalhador São-carlense, 400, 13566-590 São Carlos, SP, Brazil. Eugenio Foresti, Email: eforesti@sc.usp.br). **Kinetics of BTEX degradation in a packed-bed anaerobic reactor. Biodegradation, Volume 18(1) (2007): 83-90**

The ever-increasing diversity of industrial activity is responsible for the discharge of compounds that are toxic or difficult to degrade into the environment. Some of the compounds found in surface and ground waters, usually deriving from the contamination of oil-based products, are benzene, toluene, ethylbenzene and xylenes (BTEX). To remove these compounds from contaminated water, a bench-scale horizontal-flow anaerobic immobilized biomass reactor, containing anaerobic biomass from various sources immobilized in polyurethane foam matrices, was employed to treat a synthetic substrate composed of protein, carbohydrates and BTEX solution in ethanol, as well as a BTEX solution in ethanol as the sole carbon source. The reactor removed up to 15.0 mg/l of each BTEX compound over a hydraulic detention time of 11.4 h. A first-order kinetic model fitted the experimental data well, showing correlation coefficients

higher than 0.994. The apparent first-order coefficient values, k_1^{app} , ranged from $8.4 \pm 1.5 \text{ day}^{-1}$ for benzene to $10.7 \pm 1.4 \text{ day}^{-1}$ for *o*-xylene in the presence of ethanol, protein and carbohydrates, and from $10.0 \pm 2.0 \text{ day}^{-1}$ for benzene to $13.0 \pm 1.7 \text{ day}^{-1}$ for *o*-xylene in the presence of ethanol. The BTEX degradation rates estimated here were 10- to 94-fold higher than those found in reports on microcosm studies.

Keywords: anaerobic process - BTEX - fixed-bed reactor - immobilized biomass - kinetic parameters - polyurethane foam

Jae Woong Hwang¹, Young Bum Choi², Sunghoon Park², Cha Yong Choi¹ and Eun Yeol Lee³. (¹School of Chemical and Biological Engineering, Seoul National University, Seoul, 151-742, Korea, ²Department of Chemical and Biochemical Engineering, Pusan National University, Busan, 609-735, Korea, ³Department of Food Science and Technology, Kyungsoong University, Busan, 608-736, Korea. Eun Yeol Lee, Email: eylee@ks.ac.kr). **Development and mathematical modeling of a two-stage reactor system for trichloroethylene degradation using *Methylosinus trichosporium* OB3b. *Biodegradation*, Volume 18(1) (2007): 91-101**

A two-stage reactor system was developed for the continuous degradation of gas-phase trichloroethylene (TCE). *Methylosinus trichosporium* OB3b was immobilized on activated carbon in a TCE degradation reactor, trickling biofilter (TBF). The TBF was coupled with a continuous stirred tank reactor (CSTR) to allow recirculation of microbial cells from/to the TBF for the reactivation of inactivated cells during TCE degradation. The mass transfer aspect of the TBF was analyzed, and mass transfer coefficient of 3.9 h^{-1} was estimated. The loss of soluble methane monooxygenase (sMMO) activity was modeled based on a material balance on the CSTR and TBF, and transformation capacity (T_c) was determined to be 20.2 mol mg^{-1} . Maximum TCE degradation rate of $525 \text{ mg l}^{-1} \text{ d}^{-1}$ was obtained and reactor has been stably operated for more than 270 days.

Keywords: biofilters - biofilms - modeling - mass transfer - trichloroethylene - transformation capacity

Krista D. Vandermeer¹ and Andrew J. Daugulis¹. (¹Department of Chemical Engineering, Queen's University, K7L 3N6 Kingston, Ontario, Canada). **Enhanced Degradation of a Mixture of Polycyclic Aromatic Hydrocarbons by a Defined Microbial Consortium in a Two-Phase Partitioning Bioreactor. *Biodegradation*, Volume 18(2)(2007): 211-221**

Biological treatment methods are effective at destroying polycyclic aromatic hydrocarbons (PAHs), and some of the highest rates of PAH degradation have been achieved using two-phase-partitioning bioreactors (TPPBs). TPPBs consist of a cell-containing aqueous phase and a biocompatible and immiscible organic phase that partitions toxic and/or recalcitrant substrates to the cells based on their metabolic demand and on maintaining the thermodynamic equilibrium of the system. In this study, the degradation of a 5-component mixture of high and low molecular weight PAHs by a defined microbial consortium of *Sphingomonas aromaticivorans* B0695 and *Sphingomonas paucimobilis* EPA505 in a TPPB was examined. The extremely low aqueous solubilities of the high molecular weight (HMW) PAHs significantly reduce their bioavailability to cells, not only in the environment, but in TPPBs as well. That is, in the two-phase system, the

originally selected solvent, dodecane, was found to sequester the HMW PAHs from the cells in the aqueous phase due to the inherent high solubility of the hydrophobic compounds in this solvent. To circumvent this limitation, the initial PAH concentrations in dodecane were increased to sufficient levels in the aqueous phase to support degradation: LMW PAHs (naphthalene, phenanthrene) and fluoranthene were degraded completely in 8 h, while the HMW PAHs, pyrene and benzo[*a*]pyrene, were degraded by 64% and 11%, at rates of $42.9 \text{ mg l}^{-1} \text{ d}^{-1}$ and $7.5 \text{ mg l}^{-1} \text{ d}^{-1}$, respectively. Silicone oil has superior PAH partitioning abilities compared to dodecane for the HMW PAHs, and was used to improve the extent of degradation for the PAH mixture. Although silicone oil increased the bioavailability of the HMW PAHs and greater extents of biodegradation were observed, the rates of degradation were lower than that obtained in the TPPB employing dodecane.

Key words: Biodegradation - Consortium - Polycyclic Aromatic Hydrocarbons (PAHs) - *Sphingomonas* - Two-Phase Partitioning Bioreactor (TPPB)

Magdalena Klimek-Ochab¹, Agnieszka Obojska¹, Anna M. Picco² and Barbara Lejczak¹. (¹Department of Bioorganic Chemistry, Wrocław University of Technology, Wybrzeże Wyspińskiego 27, PL-50370 Wrocław, Poland, ²Department of Land Ecology, Section of Mycology, University of Pavia, I-27100 Pavia, Italy. Agnieszka Obojska, Email: agnieszka.obojska@pwr.wroc.pl). **Isolation and Characterization of two New Microbial Strains Capable of Degradation of the Naturally Occurring Organophosphonate—Ciliatine. Biodegradation, Volume 18(2) (2007): 223-231**

Air-born mixed fungal and bacterial culture capable of complete degradation of ciliatine was isolated. The utilization of the natural organophosphonate proceeded in the phosphate independent manner. Enzymatic activity involved in ciliatine degradation studied in the fungal cell-free extract proved to be distinct from bacterial pathway described before.

Keywords: 2-AEP:pyruvate transaminase - 2-Aminoethylphosphonic acid (2-AEP · ciliatine) - Biodegradation - Carbon–phosphorus bond cleavage - Organophosphonates

P. F. X. Corvini¹, R. Meesters², M. Mundt⁴, A. Schäffer¹, B. Schmidt¹, H. -Fr. Schröder², W. Verstraete³, R. Vinken¹ and J. Hollender⁴. (¹Institute of Environmental Research (Biology V), RWTH Aachen University, Worringerweg 1, D-52056 Aachen, Germany, ²Department of Environmental Engineering (ISA), RWTH Aachen University, Mies-van-der-Rohe-Strasse 1, D-52074 Aachen, Germany, ³Laboratory of Microbial Ecology and Technology (LabMET), Coupure Links 653, 9000 Ghent, Belgium, ⁴Institute of Hygiene and Environmental Health, University Hospital-RWTH Aachen, Pauwelsstraße 30, D-52074 Aachen, Germany. P. F. X. Corvini, Email: Philippe.Corvini@bio5.rwth-aachen.de). **Contribution to the Detection and Identification of Oxidation Metabolites of Nonylphenol in *Sphingomonas* sp. strain TTNP3. Biodegradation, Volume 18(2) (2007): 233-245**

Sphingomonas sp. strain TTNP3 has been previously described as a bacterium that is capable of degrading the technical mixture of nonylphenol (NP) isomers and also the 4(3',5'-dimethyl-3'-heptyl)-phenol single isomer of NP. Until recently, 3,5-dimethyl-3-heptanol was the only reported metabolite of 4(3',5'-dimethyl-3'-heptyl)-phenol. A short time ago, the detection of an intracellular metabolite resulting from the oxidation of 4(3',5'-dimethyl-3'-heptyl)-phenol which was identified as 2(3,5-dimethyl-3-heptyl)-benzenediol has been reported. A decisive element for this identification was the occurrence of some slight differences with the two most probable

metabolites i.e. 4(3',5'-dimethyl-3'-heptyl)-resorcinol and 4(3',5'-dimethyl-3'-heptyl)-catechol. These facts led us to hypothesise some NIH shift mechanisms explaining the formation of 2(3',5'-dimethyl-3'-heptyl)-benzenediol. In the present work, we describe the steps that led to the detection of these metabolites in the intracellular fraction of *Sphingomonas* sp. strain TTNP3. The formation of analogous intracellular metabolites resulting from the degradation of the technical mixture of NP is reported. To further elucidate these degradation products, studies were carried out with cells grown with 4(3',5'-dimethyl-3'-heptyl)-phenol as sole carbon source. The description of the syntheses of reference compounds, i.e. 4(3',5'-dimethyl-3'-heptyl)-resorcinol and 4(3',5'-dimethyl-3'-heptyl)-catechol and their comparative analyses with the intermediates of the degradation of 4(3',5'-dimethyl-3'-heptyl)-phenol are presented.

Keywords: 4(3',5'-Dimethyl-3'-heptyl)-phenol - Branched isomer - Metabolites - Nonylphenol - Oxidation - *Sphingomonas*

Joong Kyun Kim^a, Jeong Bo Kim^a, Kyoung Sook Cho^a and Yong-Ki Hong^a. (^aDepartment of Biotechnology and Bioengineering, Pukyong National University, Busan 608-737, Republic of Korea, Received 13 June 2006; revised 19 August 2006; accepted 3 September 2006. Available online 17 October 2006. Corresponding author. Tel.: +82 51 620 6186; fax: +82 51 620 6180). **Isolation and identification of microorganisms and their aerobic biodegradation of fish-meal wastewater for liquid-fertilization. International Biodeterioration & Biodegradation, Volume 59(2) (2007): 156-165**

To reuse the wastewater generated during the process of fish-meal production (FMW), seven thermophilic microorganisms were newly isolated and their characteristics of aerobic biodegradation of FMW were examined in a 5 l-bioreactor. It clearly showed that the amino-acid composition (12.54 g 100 g sample⁻¹) in the final broth of the biodegradation using 8-folds diluted FMW was almost twice that of non-biodegraded FMW. The levels of amino acids in the final broth were also comparable to those in a commercial fertilizer. When more (32-folds) diluted FMW was used as a substrate, phytotoxicity of biodegraded final broth was further reduced with disappearance of a strong unpleasant smell in the end. The final broth of biodegradation using 32-folds diluted FMW required only 2-folds dilution to meet the minimum GI criterion of a phytotoxin-free fertilizer. All the results suggest the promising potential of biodegraded FMW for the production of fertilizer, which is expected to yield high economic value.

Keywords: Thermophilic microorganisms; Aerobic biodegradation; Fish-meal wastewater treatment; Fertilizer

C.S. Benimeli^a, G.R. Castro^a, A.P. Chaile^c and M.J. Amoroso^{a, b}. (^aPROIMI-CONICET, Av. Belgrano y Caseros, 4000 Tucumán, Argentina, ^bInstituto de Microbiología, Facultad de Bioquímica, Química y Farmacia, Universidad Nacional de Tucumán, Ayacucho 491, 4000 Tucumán, Argentina, ^cSAT, Av. Sarmiento 991, 4000 Tucumán, Argentina. Corresponding author. PROIMI-CONICET, Av. Belgrano y Caseros, 4000 Tucumán, Argentina. Tel.: +54 381 4344888; fax: +54 381 4344887). **Lindane uptake and degradation by aquatic *Streptomyces* sp. strain M7. International Biodeterioration & Biodegradation, Volume 59(2) (2007): 148-155**

Five actinomycete strains isolated from pesticide-contaminated sediments were able to grow in the presence of 10 µg l⁻¹ lindane, an organochlorine pesticide. The strain growing best in the

presence of lindane as the only carbon source was identified as *Streptomyces* sp. M7. After 96 h of incubation in synthetic medium containing lindane and glucose, both substrates were simultaneously consumed; glucose 6.0 g l⁻¹ improved lindane degradation and obtained biomass. When *Streptomyces* sp. M7 was cultured in presence of lindane plus glucose, the disappearance of the pesticide from the medium and the lindane degradation was observed after 72 h of incubation. This is the first report of lindane degradation without intracellular accumulation or biotransformation products of lindane using *Streptomyces* sp. under aerobic conditions.

Keywords: *Streptomyces*; Lindane; γ -hexachlorocyclohexane; Degradation; Bioremediation

Anjali Pandey^a, Poonam Singh^a and Leela Iyengar^a . (^aDepartment of Chemistry, Biotechnology Laboratory, I.I.T., Kanpur 208016, India. Corresponding author. Tel.: +91 512 2597160; fax: +91 512 2597437). **Bacterial decolorization and degradation of azo dyes. International Biodeterioration & Biodegradation, Volume 59(2) (2007): 73-84**

Azo compounds constitute the largest and the most diverse group of synthetic dyes and are widely used in a number of industries such as textile, food, cosmetics and paper printing. They are generally recalcitrant to biodegradation due to their xenobiotic nature. However microorganisms, being highly versatile, have developed enzyme systems for the decolorization and mineralization of azo dyes under certain environmental conditions. Several genera of *Basidomycetes* have been shown to mineralize azo dyes. Reductive cleavage of azo bond, leading to the formation of aromatic amines, is the initial reaction during the bacterial metabolism of azo dyes. Anaerobic/anoxic azo dye decolorization by several mixed and pure bacterial cultures have been reported. Under these conditions, this reaction is non-specific with respect to organisms as well as dyes. Various mechanisms, which include enzymatic as well as low molecular weight redox mediators, have been proposed for this non-specific reductive cleavage. Only few aerobic bacterial strains that can utilize azo dyes as growth substrates have been isolated. These organisms generally have a narrow substrate range. Degradation of aromatic amines depends on their chemical structure and the conditions. It is now known that simple aromatic amines can be mineralized under methanogenic conditions. Sulfonated aromatic amines, on the other hand, are resistant and require specialized aerobic microbial consortia for their mineralization. This review is focused on the bacterial decolorization of azo dyes and mineralization of aromatic amines, as well as the application of these processes for the treatment of azo-dye-containing wastewaters.

Keywords: Azo dyes; Decolorization; Biodegradation; Aromatic amines; Anaerobic/aerobic treatment

Niansheng Wan^a, Ji-Dong Gu^{a, b}, and Yan Yan^a . (^aSouth China Sea Institute of Oceanography, Chinese Academy of Sciences, 164 Xingang Road West, Guangzhou 510301, PR China, ^bLaboratory of Environmental Microbiology and Toxicology, Department of Ecology & Biodiversity, The University of Hong Kong, Pokfulam Road, Hong Kong, PR China. Corresponding author. Laboratory of Environmental Microbiology and Toxicology, Department of Ecology & Biodiversity, The University of Hong Kong, Pokfulam Road, Hong Kong, PR China. Tel.: +852 2299 0605; fax: +852 2517 6082). **Degradation of *p*-nitrophenol by *Achromobacter xylosoxidans* Ns isolated from wetland sediment. International Biodeterioration & Biodegradation, Volume 59(2) (2007): 90-96**

Achromobacter xylosoxidans Ns strain, capable of utilizing *p*-nitrophenol (PNP) as the sole source of carbon, energy, and nitrogen, was isolated from wetland sediment and confirmed based on 16S rRNA gene sequence. The strain Ns could tolerate concentrations of PNP up to 1.8 mM, and degradation of PNP was achieved in 7 d at 30 °C in the dark under aerobic conditions. Biodegradation of PNP occurred quickly at an optimal pH of 7.0 and higher, and at ≤0.5% salt (NaCl) contents. During bacterial growth on PNP, 4-nitrocatechol was observed as a key degradation intermediate using a combination of techniques, including HPLC, UV-visible spectra, and comparison with the authentic standard. In a similar way, a second degradation intermediate was identified to be 1,2,4-benzenetriol. Moreover, *A. xylosoxidans* Ns could also degrade 3-nitrophenol as the sole source of carbon, nitrogen, and energy, but 2-nitrophenol could not. The experimental results showed that bacteria indigenous to the wetland sediment are capable of degrading PNP and chemicals with similar structures.

Keywords: Biodegradation; *p*-nitrophenol; 3-nitrophenol; *Achromobacter xylosoxidans*; Wetland

Chi-Wen Lin^a, Hung-Chun Lin^a and Chi-Yung Lai^b. (^aDepartment of Environmental Engineering, Da-Yeh University, 112 Shan-Jiau Rd., Da-Tsuen, Changhua 515, Taiwan, ROC, ^bDepartment of Biology, National Changhua University of Education, Changhua 515, Taiwan, ROC. Corresponding author. Tel.: +886 4 8511339; fax: +886 4 8511347). **MTBE biodegradation and degrader microbial community dynamics in MTBE, BTEX, and heavy metal-contaminated water. International Biodeterioration & Biodegradation, Volume 59(2) (2007): 97-102**

The aim of this investigation was to explore microbial community changes under various environmental groundwater conditions (single substrate, mixed substrates, and the presence of heavy metals) and link the changes with simultaneously diminishing substrate concentration in the microcosms. Most microorganisms from environmental microcosms or wastewater treatment plants cannot be cultivated artificially. Capturing microbial community fingerprints, therefore, requires applying a molecular biological technique. By using SSCP profiles of PCR-amplified 16S rDNA genes, it was demonstrated that with the repeated addition of substrates during long-term acclimation, substrate-utilizing populations in a microcosm gradually increased to become the dominant constituent. Conversely, the presence of metals inhibited community development and differentiation. It was also shown that substrate degradation rates increased under co-substrate conditions, with substrate-degraders easily adapting to the environment and becoming the dominant bacteria, a phenomenon attributed to the propensity of the fittest species to outgrow their competitors when presented with suitable substrates.

Keywords: 16S rDNA; Metal ions; Microbial community structure; Molecular profiling; Methyl *tert*-butyl ether

Leticia Pizzul^a, María del Pilar Castillo^a and John Stenström^a. (^aDepartment of Microbiology, Swedish University of Agricultural Sciences, Box 7025, SE-750 07, Uppsala, Sweden. Corresponding author. Tel.: +46 18 673284; fax: +46 18 673392). **Effect of rapeseed oil on the degradation of polycyclic aromatic hydrocarbons in soil by *Rhodococcus wratislaviensis*. International Biodeterioration & Biodegradation, Volume 59(2) (2007): 111-118**

The effect of rapeseed oil (0, 0.1 and 1% w/w) on the degradation of polycyclic aromatic hydrocarbons (PAH) by *Rhodococcus wratislaviensis* was studied in soils artificially contaminated with phenanthrene, anthracene, pyrene and benzo(a)pyrene (50 mg kg⁻¹ each), during 49 days at 30 °C. Without or with 0.1% of rapeseed oil, *R. wratislaviensis* degraded >90% of phenanthrene and anthracene in 14 days and mineralised approx. 23% of ¹⁴C-phenanthrene. The native microflora degraded pyrene (90% degradation; 75% mineralisation) and benzo(a)pyrene (30% degradation, no mineralisation). With 1% rapeseed oil, *R. wratislaviensis* degraded only 66% of the phenanthrene and mineralised 12.4%, and had no effect on other PAH, while degradation by the native microflora was inhibited. On the other hand, the addition of 1% oil promoted degradation of benzo(a)pyrene (75%) and anthracene (90%) and anthraquinone was produced at high concentrations and accumulated. Two distinct processes gave degradation of PAH, one biological and one abiotic. Biological processes mainly degraded phenanthrene and pyrene, either by *R. wratislaviensis* or by the indigenous microflora. Benzo(a)pyrene was degraded mainly by an abiotic process in the presence of 1% rapeseed oil. Anthracene was degraded by a combination of both processes.

PAH are often found in contaminated soils and there is the need of developing techniques that can be applied in the remediation of these sites, where PAH, specially those with high molecular weight, pose health and environmental risks. There is a continuous search for efficient microorganisms able to degrade these pollutants and for methods to enhance their degradation and bioavailability, e.g. by the use of vegetable oils. This paper presents a novel process for the degradation of PAH by a combined biological/abiotic system.

Keywords: Polycyclic aromatic hydrocarbons; Rapeseed oil; *Rhodococcus wratislaviensis*; Soil bioremediation

Krzysztof Ulfig^a, Grażyna Plaza^a, Maciej Terakowski^a and Tadeusz Mańko^a. (^aInstitute for Ecology of Industrial Areas, 40-832 Katowice, Kossutha St. 6, Poland. Corresponding author. Polymer Institute, Technical University of Szczecin, Pulaskiego St. 10, 70-322 Szczecin, Poland. Tel.: +48 91 449 44 48; fax: +48 91 449 42 47). Investigation of keratinolytic and non-keratinolytic fungi grown above or below a 1-cm sewage sludge blanket. *International Biodeterioration & Biodegradation*, Volume 59(2) (2007): 119-124

This study investigated the incidence of keratinolytic and non-keratinolytic fungi grown above or below a 1-cm sewage sludge blanket. The hair baiting method was used. Incubation was carried out at 23 and 37 °C. The number of keratinolytic fungi occurrences below a sludge blanket (anoxic conditions) was almost two times smaller than the number of fungal occurrences above this blanket (oxic conditions). The anoxic conditions did not significantly affect the number of non-keratinolytic fungi. Qualitative differences were also observed. *Trichophyton ajelloi* with its teleomorph *Arthroderma uncinatum* and some other fungi were found to prefer oxic conditions. In the case of non-keratinolytic fungi, the most evident differences were observed at 37 °C. *Aspergillus fumigatus* prevailed above a sludge blanket, while *Pseudallescheria boydii* was the predominating species below this blanket. The incidence of keratinolytic fungi was dependent on sludge physico-chemical characteristics: mainly on sludge organic matter stabilization (total nitrogen and ammonium nitrogen contents, proteolytic activity and C:N ratio) and hygienization (total and fecal coliforms) factors.

Keywords: Keratinolytic and non-keratinolytic fungi; Sewage sludge; Oxic or anoxic conditions

Sára Révész^a, Rita Sipos^a, Anikó Kende^b, Tamás Rikker^b, Csaba Romsics^a, Éva Mészáros^a, Anita Mohr^a, András Táncsics^a and Károly Márialigeti^a. (^aDepartment of Microbiology, Eötvös Loránd University, Pázmány P. sétány I/C., H-1117 Budapest, Hungary, ^bDr. E. Wessling Chemical Laboratory Ltd., Budapest, Hungary). **Bacterial community changes in TCE biodegradation detected in microcosm experiments. International Biodeterioration & Biodegradation, Volume 58(3-4) (2006): 239-247**

Laboratory microcosm experiments were set up to model biodegradation of trichloroethylene (TCE). Groundwater samples from two contaminated sites were taken, one of them with low (70 mg L⁻¹), the other with high sulfate (685 mg L⁻¹) concentration. In order to assess the biodegradative potential of natural microbiota, supplementary substrates (whey or molasses) were added to the bottles. At day 54, 98, 155, and 318, chemical and bacteriological parameters (i.e., *Dehalococcoides* test) were investigated. Terminal restriction fragment length polymorphism (T-RFLP) based diversity assessments were carried out to observe the bacterial community changes. Whey and molasses enhanced degradation at different rates. In the case of samples with high sulfate content and amended with whey, no ethylene, ethane, or methane was generated. Both ethylene and methane production was detected in samples of low sulfate content with added whey. The results of *Dehalococcoides* tests were positive for all control and amended samples. Based on T-RFLP analysis, the bacterial communities of high sulfate concentration groundwater microcosms amended with molasses or whey were very similar, while the communities of groundwater samples with low sulfate concentration were different when supplemented with whey or molasses. The rRNA and rDNA based investigations suggest that the proportions of the active microbes and the microbes present in the microcosms differ.

Keywords: Reductive dechlorination; T-RFLP; Bacterial community; *Dehalococcoides*; Trichloroethylene

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The diuron degrading activity of 17 streptomycete strains, obtained from agricultural and non-agricultural soils, was determined in the laboratory. All strains were identified as *Streptomyces* sp. by phenotypic characteristics and PCR-based assays. The strains were cultivated in liquid medium with diuron (4 mg L⁻¹) at 25 °C for 15 days. Biodegradation activity was determined by high-performance liquid chromatography. The results indicated that all strains were able to degrade diuron, but to different amounts. Twelve strains degraded the herbicide by up to 50% and four of them by up to 70%. Strain A7-9, belonging to *S. albidoflavus* cluster, was the most efficient organism in the degradation of diuron, achieving 95% degradation after five days of incubation and no herbicide remained after 10 days. Overall, the strains isolated from agricultural soils exhibited higher degradation percentages and rates than those isolated from non-agricultural soils. Given the high degradation activity observed here, the streptomycete strains show a good potential for bioremediation of soils contaminated with diuron.

Keywords: Herbicide; Diuron; Actinomycetes; Streptomycetes; Soil

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A pure culture of 2,4-dichlorophenol (2,4-DCP)-degrading bacteria was isolated from a natural enrichment that had been adapted to chlorophenols in the aeration pond of the Baikalsk pulp and paper mill (Russia). The bacteria were identified by 16S rDNA intergenic region analysis, using PCR with universal primers. Comparative analysis of the 16S rDNA sequence (1545 bp) in the GenBank database revealed that these bacteria are related to *Bacillus cereus* GN1. Degradation of 2,4-DCP was studied using this culture in liquid medium under aerobic conditions, at initial concentrations of 20–560 µM 2,4-DCP. The 2,4-DCP degradation rates by *B. cereus* GN1 could be determined at concentrations up to 400 µM. However, higher concentrations of 2,4-DCP (560 µM) were inhibitory to cell growth.

Keywords: Baikalsk pulp and paper mill; 2,4-dichlorophenol; Degradation; *Bacillus*

Magdalena Jaszek^a, Jerzy Żuchowski^a, Elżbieta Dajczak^a, Kamila Cimek^a, Marcin Graż^a and Krzysztof Grzywnowicz^a. (^aDepartment of Biochemistry, M. Curie-Skłodowska University, M. Curie-Skłodowska Square 3, 20-031 Lublin, Poland). **Ligninolytic enzymes can participate in a multiple response system to oxidative stress in white-rot basidiomycetes: *Fomes fomentarius* and *Tyromyces pubescens*. *International Biodeterioration & Biodegradation*, Volume 58(3-4) (2006): 168-175**

The effect of menadione (MQ; 2-methyl-1,4-naphthoquinone) superoxide generating agent on the biological activity of two strains of white-rot fungi, *Fomes fomentarius* and *Tyromyces pubescens*, was determined. In this study 1 mM of MQ solution was added to 10-day-old idiophasic cultures. The application of MQ to *F. fomentarius* and *T. pubescens* cultures stimulated extracellular laccase (LAC) and manganese-dependent peroxidase (MnP) activities in comparison to the control values (without MQ). In the presence of MQ the concentration of oxalic acid in the medium of both fungi was dramatically decreased. MQ treatment also caused an increase of intracellular superoxide dismutase activity, formaldehyde and glutathione disulfide level in both strains. In the case of *F. fomentarius*, addition of MQ enhanced catalase activity. The rate of intra- and extracellular proteolysis decreased in *F. fomentarius* and increased in *T. pubescens* MQ treated cultures.

Keywords: White-rot basidiomycetes; Ligninolytic enzymes; Menadione; Oxidative stress response

E. Aranda^a, I. Sampedro^a, J.A. Ocampo^a and I. García-Romera^a. (^aDep. Microbiología del Suelo y Sistemas Simbióticos, Estación Experimental del Zaidín, C.S.I.C., Prof. Albareda 1, Apdo. 419, 18008 Granada, Spain). **Phenolic removal of olive-mill dry residues by laccase activity of white-rot fungi and its impact on tomato plant growth. *International Biodeterioration & Biodegradation*, Volume 58(3-4) (2006): 176-179**

We studied the influence of the laccase activity of two white-rot fungi on the toxic effect of water-soluble substances from dry residues of olives (ADOR) on tomato plants. *Pycnoporus cinnabarinus* and *Corioloropsis rigida* decreased the phenol content of ADOR to 73% after 15 days. *P. cinnabarinus* and *C. rigida* produced laccase activity after 5 and 15 days, respectively, and the highest activity in both fungi was detected at 20 days. The treatment of ADOR with these white-rot fungi decreased the phytotoxicity of this residue on tomato plants. A close relationship was found between the amount of laccase produced, the decrease in phenol content of ADOR by the saprobic fungi, decrease of phytotoxicity of ADOR, and the increase in dry weight of tomato plants. These results show that phenol removal by the laccase activity of white-rot fungi can be important in the elimination of phytotoxic substances present in olive-mill dry residues.

Keywords: Laccase; Olive-mill dry residue; White-rot fungi; Phytotoxicity

N. Carmona^a, L. Laiz^b, J.M. Gonzalez^b, M. Garcia-Heras^{a, c}, M.A. Villegas^a and C. Saiz-Jimenez^b. (^aCentro Nacional de Investigaciones Metalúrgicas, CSIC, Avda. Gregorio del Amo, 8, 28040 Madrid, Spain, ^bInstituto de Recursos Naturales y Agrobiología, CSIC, Apartado 1052, 41080 Sevilla, Spain, ^cInstituto de Historia, CSIC, Serrano, 13, 28001 Madrid, Spain). **Biodeterioration of historic stained glasses from the Cartuja de Miraflores (Spain). International Biodeterioration & Biodegradation, Volume 58(3-4) (2006): 155-161**

Glass samples obtained from five stained glass windows located on the northern side of the Cartuja de Miraflores Monastery (Burgos, Spain) were characterized using UV/Vis spectrophotometry, X-ray fluorescence, optical microscopy, field emission scanning electron microscopy and energy dispersive X-ray microanalysis. Every sample presented evidence of strong superficial deterioration. In general, the external sides of the glass fragments showed a worse state of conservation than did the internal ones. The superficial morphology of the glass exhibited numerous alterations, forming strongly adhered crusts of variable extension and colour, depending on the sample. On the external sides of the glass samples, heterogeneous, dark brown and interconnected crusts, covering most of the glass surfaces, appeared, together with craters and pits filled with whitish deposits. The internal sides showed small craters and pits and a slight accumulation of corrosion deposits. Microbial colonization on this historic glass was observed and both bacteria and fungi were characterized by molecular methods using polymer chain reaction and denaturing gradient gel electrophoresis (PCR-DGGE), complemented with cloning and sequencing of the PCR amplified products. Molecular characterization of the microflora colonizing the glass showed the presence of Eukaryotic genera such as the fungus *Aspergillus* and the stramenopile *Labyrinthula*, as well as an associated bacterial community.

Keywords: Biodeterioration; Historic stained glass; Microbial diversity; Bacteria; Fungi

J. Chirkova^a, I. Irbe^a, B. Andersons^a and I. Andersone^a. (^aLatvian State Institute of Wood Chemistry, 27 Dzerbenes St., LV-1006 Riga, Latvia). **Study of the structure of biodegraded wood using the water vapour sorption method. International Biodeterioration & Biodegradation, Volume 58(3-4) (2006): 162-167**

The dynamics of the biodegradation of wood by brown-rot fungi (*Coniophora puteana*, *Poria placenta*, and *Gloeophyllum trabeum*) was investigated by the water vapour sorption method. The change in wood microstructure characteristics (specific surface and concentration of surface hydrophilic centres) with increasing exposure time correlated with reduction in mass and change

in composition. Two-to-eight-nanometer-wide micropores, whose size and volume depended on the fungal species and exposure time, appeared in the wood. Methodological aspects of the application of sorption methods should be taken into account in the interpretation of the results.

Keywords: Wood; Brown-rot fungi; Biodegradation; Water vapour sorption method

Ying Zheng^a; Ernest K. Yanful^a; Amarjeet S. Bassi^b. (^a Department of Civil and Environmental Engineering, The University of Western Ontario. London, Ontario, Canada, ^b Department of Chemical and Biochemical Engineering, The University of Western Ontario. London, Ontario, Canada). A Review of Plastic Waste Biodegradation. *Critical Reviews in Biotechnology*, Volume 25(4) (2005): 243 – 250

With more and more plastics being employed in human lives and increasing pressure being placed on capacities available for plastic waste disposal, the need for biodegradable plastics and biodegradation of plastic wastes has assumed increasing importance in the last few years. This review looks at the technological advancement made in the development of more easily biodegradable plastics and the biodegradation of conventional plastics by microorganisms. Additives, such as pro-oxidants and starch, are applied in synthetic materials to modify and make plastics biodegradable. Recent research has shown that thermoplastics derived from polyolefins, traditionally considered resistant to biodegradation in ambient environment, are biodegraded following photo-degradation and chemical degradation. Thermoset plastics, such as aliphatic polyester and polyester polyurethane, are easily attacked by microorganisms directly because of the potential hydrolytic cleavage of ester or urethane bonds in their structures. Some microorganisms have been isolated to utilize polyurethane as a sole source of carbon and nitrogen source. Aliphatic-aromatic copolyesters have active commercial applications because of their good mechanical properties and biodegradability. Reviewing published and ongoing studies on plastic biodegradation, this paper attempts to make conclusions on potentially viable methods to reduce impacts of plastic waste on the environment.

Keywords: thermoplastics; polyolefins; additive; thermoset plastics; polyester; polyurethane

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Crystal violet (CV), which has been extensively used as a biological stain and a commercial textile dye, is a recalcitrant molecule. A strain of *Pseudomonas putida* was isolated that effectively degraded CV: up to 80% of 60 μ M CV as the sole carbon source, was degraded in liquid media within 1 week. Nine degradation products were isolated and identified. We propose that CV degradation occurs via a stepwise demethylation process to yield mono-, di-, tri-, tetra-, penta- and hexa-demethylated CV species.

Keywords: Biodegradation - Crystal violet - N-de-methylation - *Pseudomonas putida*

M. Ziagova^a and M. Liakopoulou-Kyriakides^a. (^aFaculty of Chemical Engineering, Department of Chemistry, Aristotle University of Thessaloniki, Thessaloniki 54124, Greece). Comparison of cometabolic degradation of 1,2-dichlorobenzene by *Pseudomonas* sp. and *Staphylococcus xylosus*. *Enzyme and Microbial Technology*, Volume 40(5) (2007): 1244-1250

Cometabolism of 1,2-DCB in the presence of glucose by *Pseudomonas* sp. and *Staphylococcus xylosus* was studied for the first time. The specific growth rates at 0.1 mM 1,2-dichlorobenzene, were estimated to 0.196 and 0.145 h⁻¹ for *Pseudomonas* sp. and *S. xylosus*, respectively, and were of the same range with the values obtained in the presence of glucose only. The percentage of 1,2-dichlorobenzene consumption is ranging between 78 and 51% for *Pseudomonas* sp. and between 45 and 22% for *S. xylosus*, respectively, depending on its initial concentration. Degradation of 1,2-dichlorobenzene was followed by its dechlorination and acidification, which started after the final addition and continued till the end of the exponential phase of growth. Furthermore, attempt was made to analyze and identify by HPLC and GC-MS analysis some intermediates or end catabolic products found in the culture medium. 3,4-Dichlorocatechol was identified in both bacterial species. In the case of *Pseudomonas* sp. 3,4-dichlorocatechol was depleted after 24 h, followed by the appearance of 2,3-dichloromuconic acid. Contrary to *Pseudomonas* sp., in *S. xylosus* 3,4-dichlorocatechol was still present after 24 h and 5-chlorodienelactone was identified as one of its transformation products.

Keywords: Biodegradation; 1,2-Dichlorobenzene; 3,4-Dichlorocatechol; *Pseudomonas* sp. *Staphylococcus xylosus*

Maria J. Lopez^a, Maria del Carmen Vargas-García^a, Francisca Suárez-Estrella^a, Nancy N. Nichols^b, Bruce S. Dien^b and Joaquin Moreno^a. (^aDepartamento de Biología Aplicada, CITE II-B, La Cañada de San Urbano, University of Almeria, 04120 Almeria, Spain, ^bFermentation Biotechnology Research Unit, NCAUR, USDA-ARS¹, 1815 N. University Street, Peoria, IL 61604, United States). Lignocellulose-degrading enzymes produced by the ascomycete *Coniochaeta ligniaria* and related species: Application for a lignocellulosic substrate treatment. *Enzyme and Microbial Technology*, Volume 40(4) (2007): 794-800

Lignocellulose-degrading microorganisms are of interest for biomass upgrading. In a previous work, we isolated the ascomycete *Coniochaeta ligniaria* NRRL 30616 that metabolized phenolics and furans in lignocellulosic acid hydrolysates. This fungal isolate was investigated in the present work for the ability to produce lignocellulose-degrading enzymes during batch cultivation using different substrates as carbon source. This microorganism produced cellulase, xylanase and two lignin peroxidases (manganese peroxidase, MnP and lignin peroxidase, LiP), but laccase activity was not detected. The same enzyme activities were also found in 23 related fungal strains, and *C. ligniaria* NRRL 30616 showed the highest levels for some of the enzymes. Treatment of pepper plant residues (PPR) with this fungus was monitored during 20 days in solid and semisolid-state cultures. It was found that all enzymes initially detected were produced under these conditions at the early culture stages (5 days) and lignocellulose polymers were consequently degraded. Losses of about 75%, 50% and 40% were obtained for hemicellulose, cellulose and lignin, respectively, in semisolid cultures after 20 days. The lignocellulolytic activity of *C. ligniaria* detected in this study may be exploited for lignocellulosic biomass treatment.

Keywords: Lignocellulose; Cellulose; Lignin peroxidase; Manganese peroxidase; *Coniochaeta ligniaria*

Xiao Zhang^a, David Nguyen^b, Mike G. Paice^a, Adrian Tsang^b and Sylvie Renaud^a. (^aPulp and Paper Research Institute of Canada (PAPRICAN), 570 Boul. St-Jean, Pointe-Claire, Quebec H9R 3J9, Canada, ^bCentre for Structural and Functional Genomics, Concordia University, 7141 Sherbrooke Street West, Montreal, Quebec H4B 1R6, Canada). **Degradation of wood extractives in thermo-mechanical pulp by soybean lipoxygenase. Enzyme and Microbial Technology, Volume 40(4) (2007): 866-873**

Fatty acids and their esters are major constituents of wood extractives and are known to cause a range of newsprint manufacturing problems including pitch deposition, poor paper machine runnability, low paper friction and strength. This study investigated the potential of using soybean lipoxygenase to degrade wood extractives present in thermomechanical pulp (TMP) samples. Lipoxygenase treatments of TMP resulted in a 15% reduction in total extractives. The enzyme showed a high specificity towards lipophilic extractives fractions, primarily consisting of fatty acids and their esters. After 2 h pulp treatments, the lipophilic extractives content was reduced by more than 25%, while there was little change in hydrophilic extractives. The activity of lipoxygenase towards individual wood extractives was determined by using a mixture extracted from TMP. It was found that several extractive compounds such as resin acids and lignans inhibited lipoxygenase catalyzed reactions with fatty acids. Transition metal ions present in the TMP contributed to further fragmentation of fatty acid hydroperoxides produced by lipoxygenase reaction with wood extractives.

Keywords: Lipoxygenase; Extractives; Thermo-mechanical pulp; Fatty acids

Jian Chen^a, Ying Zhang^a, Guo-Cheng Du^a, Zhao-Zhe Hua^a and Yang Zhu^a. (^aKey Laboratory of Industrial Biotechnology, Ministry of Education, School of Biotechnology, Southern Yangtze University, Wuxi 214036, China). **Biodegradation of polyvinyl alcohol by a mixed microbial culture. Enzyme and Microbial Technology, Volume 40(7) (2007): 1686-1691**

A mixed culture capable of degrading 1 g l⁻¹ polyvinyl alcohol (PVA) completely was screened from sludge samples at Pacific Textile Factory, Wuxi, China. This mixed culture had stronger capability of degrading PVA with low polymerization and high saponification than degrading PVA with high polymerization and low saponification. Inorganic nitrogen source was more suitable for the mixed culture to grow and degrade PVA than organic nitrogen source. Microorganisms and relative abundance of this mixed culture were explored by terminal restriction fragment length polymorphism (T-RFLP). Small PVA molecules were detected in cell extracts of the mixed culture. This indicated that PVA degradation in the mixed culture was in fact a combined action of extracellular and intracellular enzymes. Two strains producing extracellular PVA-degrading enzyme were isolated from the mixed culture. They could individually degrade PVA1799 with polymerization of 1700 from initial average molecular weight 112,981 to 98,827 Da and 84,803 Da, respectively. However, only small amount of PVA124 in polymerization of 400 could be degraded by these two strains.

Keywords: Polyvinyl alcohol (PVA); PVA-degrading enzyme; Mixed culture; T-RFLP; Biodegradation

Sarayu Mohana^a, Chirayu Desai^a and Datta Madamwar^a. (^aPost Graduate Department of Biosciences, Sardar Patel University, Vallabh Vidyanagar, Gujarat 388 120, India). Biodegradation and decolourization of anaerobically treated distillery spent wash by a novel bacterial consortium. *Bioresource Technology*, Volume 98(2) (2007): 333-339

The aim of this study was to isolate microorganisms capable of decolourizing and degrading anaerobically treated distillery spent wash. A bacterial consortium DMC comprising of three bacterial cultures was selected on the basis of rapid effluent decolourization and degradation, which exhibited $67 \pm 2\%$ decolourization within 24 h and $51 \pm 2\%$ chemical oxygen demand reduction within 72 h when incubated at 37 °C under static condition in effluent supplemented with 0.5% glucose, 0.1% KH₂PO₄, 0.05% KCl and 0.05% MgSO₄ · 7H₂O. Addition of organic or inorganic nitrogen sources did not support decolourization. The cultures were identified as *Pseudomonas aeruginosa* PAO1, *Stenotrophomonas maltophilia* and *Proteus mirabilis* by the 16S rDNA analysis.

Keywords: Bacterial consortium; Distillery spent wash; Decolourization; Melanoidins; 16S rDNA

Herbert H.P. Fang^a, Dawei Liang^a and Tong Zhang^a. (^aEnvironmental Biotechnology Laboratory, Department of Civil Engineering, The University of Hong Kong, Pokfulam Road, Hong Kong SAR, China). Aerobic degradation of diethyl phthalate by *Sphingomonas* sp. *Bioresource Technology*, Volume 98(3) (2007): 717-720

An aerobic diethyl phthalate (DEP) degrading bacterium, DEP-AD1, was isolated from activated sludge. Based on its 16S rDNA sequence, this isolate was identified belonging to *Sphingomonas* genus with 99% similarity to *Sphingomonas* sp. strain C28242 and 98% similarity to *S. capsulate*. The specific degradation rate of DEP was concentration dependent with a maximum of 14 mg-DEP/(L h). Results of degradation tests showed that DEP-AD1 could also degrade monoethyl phthalate (MEP), dimethyl phthalate (DMP), dibutyl phthalate (DBP), and diethylhexyl phthalate (DEHP), but not phthalate and benzoate.

Keywords: 16S rDNA; Degradation; Diethyl phthalate; Endocrine disruptor; *Sphingomonas*

S.D. Kalme^a, G.K. Parshetti^a, S.U. Jadhav^a and S.P. Govindwar^a. (^aDepartment of Biochemistry, Shivaji University, Kolhapur 416 004, India). Biodegradation of benzidine based dye Direct Blue-6 by *Pseudomonas desmolyticum* NCIM 2112. *Bioresource Technology*, Volume 98(7) (2007): 1405-1410

Pseudomonas desmolyticum NCIM 2112 was able to degrade a diazo dye Direct Blue-6 (100 mg l⁻¹) completely within 72 h of incubation with 88.95% reduction in COD in static anoxic condition. Induction in the activity of oxidative enzymes (LiP, laccase) and tyrosinase while decolorization in the batch culture represents their role in degradation. Dye also induced the activity of aminopyrine *N*-demethylase, one of the enzyme of mixed function oxidase system. The biodegradation was monitored by UV-Vis, IR spectroscopy and HPLC. The final products, 4-amino naphthalene and amino naphthalene sulfonic acid were characterized by GC-mass spectroscopy.

Keywords: Direct Blue-6; *Pseudomonas desmolyticum*; Biodegradation; Azo dye; Lignin peroxidase

S. Shailaja^a, M. Ramakrishna^a, S. Venkata Mohan^a and P.N. Sarma^a. (^aBiochemical and Environmental Engineering Center, Indian Institute of Chemical Technology, Hyderabad 500 007, India). Biodegradation of di-*n*-butyl phthalate (DnBP) in bioaugmented bioslurry phase reactor. *Bioresource Technology*, Volume 98(8) (2007) :1561-1566

Bioremediation of di-*n*-butyl phthalate (DnBP) in soil was studied with various concentrations in a bioslurry phase batch reactor operated in sequencing batch mode (bioaugmented with effluent treatment plant (ETP) microflora) for a total cycle period of 96 h. Process performance during the reactor operation was assessed by monitoring DnBP concentration and biochemical process parameters viz., pH, dissolved oxygen (DO), colony forming units (CFU) and oxygen uptake rate (OUR), during the sequence phase operation. The degradation rate was observed to be rapid at lower substrate concentrations and found to be slow as the substrate concentration increased. The potent bacterial strain was also isolated from the slurry phase reactor. Metabolites formed during the degradation of DnBP in the slurry phase reactor were identified. Studies on the kinetics and half-life of the reaction revealed that the degradation process followed zero-order kinetic model.

Keywords: Bioaugmentation; Bioslurry phase reactor; Di-*n*-butyl phthalate (DnBP); HPLC; NMR; Kinetics

Edward M. Fox^a and George L. Mendz^a. (^aSchool of Biotechnology and Biomolecular Sciences, The University of New South Wales, Sydney NSW 2052, Australia). Phosphonate degradation in microorganisms. *Enzyme and Microbial Technology*, Volume 40(1) (2006) :145-150

In most microorganisms studied to date, utilisation of phosphonate is induced under conditions of inorganic phosphate limitation, and the enzymes of phosphonate catabolism are encoded by orthologous genes. Four phosphonate breakdown pathways are known which differ in their substrate specificity and cleavage mechanisms. The degradation of phosphonates by common microbial pathogens belonging to 22 microbial species grown in phosphate-rich media was investigated employing nuclear magnetic resonance spectroscopy and bioinformatic searches. Fifteen bacterial and four fungal species were capable of cleaving phosphonate (C–P) bonds of α -aminomethylphosphonate, phosphonoacetate or phenylphosphonate, indicating that the enzymes responsible for these activities are expressed in the absence of phosphorus limitation. *In silico* analyses indicated that most of the microorganisms with phosphonate degradation activities did not have genes orthologous to those encoding C–P cleaving enzymes of the classical phosphonate catabolism pathways. The results suggested that phosphonate degradation in some bacteria and fungi, including human and animal pathogens, took place via novel pathways. These metabolic characteristics can be exploited to design potent antimicrobial prodrugs bearing phosphonate moieties that would be cleaved off when taken up by microorganisms releasing the active drug.

Keywords: Phosphonate; Microorganisms; Enzyme activity; Degradation

D. De Los Cobos-Vasconcelos^a, F. Santoyo-Tepole^a, C. Juárez-Ramírez^a, N. Ruiz-Ordaz^a and C.J.J. Galíndez-Mayer^a. (^aDepartamento de Ingeniería Bioquímica, Escuela Nacional de Ciencias Biológicas, IPN, Carpio y Plan de Ayala, Colonia Santo Tomás, s/n CP 11340, México D.F., Mexico). Cometabolic degradation of chlorophenols by a strain of

***Burkholderia* in fed-batch culture. Enzyme and Microbial Technology, Volume 40(1) (2006): 57-60**

This work deals with the study of mono and dichlorophenols degradation by a strain of *Burkholderia* isolated from the Santa Alejandrina marsh, Minatitlán, Veracruz, México. This strain also degrades benzene, toluene and xylene and was identified as the N₂-fixing bacteria *Burkholderia tropicalis*. In addition, the cometabolic degradation of 2-chlorophenol (2-CP), 4-chlorophenol (4-CP), 2,4-dichlorophenol (2,4-DCP) and 2,6-dichlorophenol (2,6-DCP) was evaluated in batch and fed-batch cultures, using phenol as the primary substrate. This bacterial strain was unable to degrade the highly substituted chlorophenols 2,4,5-TCP, 2,4,6-TCP and pentachlorophenol.

Except for 4-CP, the cometabolic degradation of chlorophenols in batch culture was slow and inefficient, but when *B. tropicalis* was cultivated in fed-batch system, the removal efficiencies obtained were 93% for 2-CP, 95% for 2,6-DCP, 96% for 2,4-DCP and 100% for 4-CP. However, low cell growth yields were obtained in both batch and fed-batch cultures. This could be attributed to the uncoupling action of the aromatic compounds involved and, except for 2,6 DCP, to the accumulation of metabolic by-products.

Keywords: Biodegradation; Biotransformation; *Burkholderia tropicalis*; Chlorophenol; Cometabolism; Fed-batch

Idil Arslan-Alaton ^a (^aDepartment of Environmental Engineering, Faculty of Civil Engineering, Istanbul Technical University, 34469 Maslak, Istanbul, Turkey), Degradation of a commercial textile biocide with advanced oxidation processes and ozone ^{†*}. Journal of Environmental Management, Volume 82(2) (2007): 145-154

The occurrence of significant amounts of biocidal finishing agents in the environment as a consequence of intensive textile finishing activities has become a subject of major public health concern and scientific interest only recently. In the present study, the treatment efficiency of selected, well-known advanced oxidation processes (Fenton, Photo-Fenton, TiO₂/UV-A, TiO₂/UV-A/H₂O₂) and ozone was compared for the degradation and detoxification of a commercial textile biocide formulation containing a 2,4,4'-trichloro-2'-hydroxydiphenyl ether as the active ingredient. The aqueous biocide solution was prepared to mimic typical effluent originating from the antimicrobial finishing operation (BOD_{5,0} ≪ 5 mg/L; COD₀=200 mg/L; DOC₀ (dissolved organic carbon)=58 mg/L; AOX₀ (adsorbable organic halogens)=48 mg/L; LC_{50,0} (lethal concentration causing 50% death or immobilization in *Daphnia magna*)=8% v/v). Ozonation experiments were conducted at different ozone doses (500–900 mg/h) and initial pH (7–12) to assess the effect of ozonation on degradation (COD, DOC removal), dearomatization (UV₂₈₀ and UV₂₅₄ abatement), dechlorination (AOX removal) and detoxification (changes in LC₅₀). For the Fenton experiments, the effect of varying ferrous iron catalyst concentrations and UV-A light irradiation (the Photo-Fenton process) was examined. In the heterogenous photocatalytic experiments, Degussa P25-type TiO₂ was used as the catalyst and the effect of reaction pH (3, 7 and 12) and H₂O₂ addition on the photocatalytic treatment efficiency was examined. Although in the photochemical (i.e. Photo-Fenton, TiO₂/UV-A and TiO₂/UV-A/H₂O₂) experiments appreciably higher COD and DOC removal efficiencies were obtained, ozonation appeared to be equally effective to achieve dearomatization (UV₂₈₀ abatement) at all studied reaction pH. During ozonation of the textile biocide effluent, AOX abatement proceeded significantly faster than dearomatization and was complete after 20 min ozonation (267 mg O₃).

On the other hand, for complete detoxification, ozonation had to be continued for at least 30 min (corresponding to 400 mg O₃). Effective AOX and acute toxicity removal was also obtained after heterogeneous photocatalytic treatment (TiO₂/UV-A and TiO₂/UV-A/H₂O₂). The Fenton-based treatment experiments and particularly the dark Fenton reaction resulted in relatively poor degradation, dearomatization, AOX and acute toxicity removals.

Keywords: Advanced Oxidation Processes (AOPS); Ozonation; Textile finishing biocides; Acute toxicity; AOX; Xenobiotics

Li Wang^a, Suzelle Barrington^b and Jin-Woo Kim^b. (^aFaculty of Environmental and biological Engineering, Shenyang Institute of Chemical Technology, Shenyang 110000, China, ^bDepartment of Bioresource Engineering, Macdonald Campus of McGill University, Ste Anne de Bellevue, Que., Canada H9X 3V9). Biodegradation of pentyl amine and aniline from petrochemical wastewater. *Journal of Environmental Management*, Volume 83(2) (2007): 191-197

The objectives of the project were to isolate a bacterial strain capable of degrading pentyl amine and aniline and to define the optimal pentyl amine and aniline degradation conditions for this bacterial strain. The bacterial strain was isolated from activated sludge obtained from a Northeastern China treatment facility for petrochemical wastewater rich in pentyl amine and aniline. Once the strain was isolated, five triplicate (5) batch tests were used to establish the conditions for maximum pentyl amine and aniline degradation, by varying one at a time the following five factors: temperature, pH, reaction time, pollutant concentrations and aeration rate. In a final test, oil refinery sludge was inoculated with the strain and tested for the degradation of pentyl amine and aniline under optimal conditions, while observing the degradation pathway of pentyl amine and aniline.

The isolated strain, PN1001, is a member of the *Pseudomonas* species and it was capable of degrading pentyl amine and aniline. The optimal reactor conditions for the degradation of a mixture of pentyl amine and aniline, at a concentration ranging between 150 and 200 mg/L, were found to be 30 °C at a pH of 7.0, under a reaction time of 24 h and a maximum solution dissolved oxygen level of 6 mg O₂/L. Under such conditions, the strain PN1001 degraded 93% and 89% of the pentyl amine and aniline, respectively, aniline being more toxic and demonstrating a more complex degradation pathway. The strain PN1001 degraded more contaminants when both were present because of the π and σ electron cloud coordination functions of aniline and pentyl amine, respectively, presumed to reduce the toxic effect of aniline. Once inoculated with the strain, oil refinery sludge degraded 93% and 88% of the pentyl amine and aniline, compared to the strain alone which degraded 72% and 82%, likely because of the sludge's buffering effect against the toxic environment.

Keywords: Biodegradation; Petrochemical wastewater; Pentyl amine; Aniline

Sebastian R. Sørensen,^{*} Maria S. Holtze, Allan Simonsen, and Jens Aamand. (Department of Geochemistry, Geological Survey of Denmark and Greenland (GEUS), Øster Voldgade 10, DK-1350 Copenhagen K, Denmark. Corresponding author. Mailing address: Department of Geochemistry, Geological Survey of Denmark and Greenland, Øster Voldgade 10, DK-1350 Copenhagen K, Denmark. Phone: 45 3814 2317. Fax: 45 3814 2050. E-mail: srs@geus.dk). Degradation and Mineralization of Nanomolar Concentrations of the Herbicide Dichlobenil and Its Persistent Metabolite 2,6-Dichlorobenzamide by

***Aminobacter* spp. Isolated from Dichlobenil-Treated Soils[▽]. Applied and Environmental Microbiology, Vol. 73(2) (2007): 399-406**

2,6-Dichlorobenzamide (BAM), a persistent metabolite from the herbicide 2,6-dichlorobenzonitrile (dichlobenil), is the pesticide residue most frequently detected in Danish groundwater. A BAM-mineralizing bacterial community was enriched from dichlobenil-treated soil sampled from the courtyard of a former plant nursery. A BAM-mineralizing bacterium (designated strain MSH1) was cultivated and identified by 16S rRNA gene sequencing and fatty acid analysis as being closely related to members of the genus *Aminobacter*, including the only cultured BAM degrader, *Aminobacter* sp. strain ASI1. Strain MSH1 mineralized 15 to 64% of the added [*ring*-U-¹⁴C]BAM to ¹⁴CO₂ with BAM at initial concentrations in the range of 7.9 nM to 263.1 μM provided as the sole carbon, nitrogen, and energy source. A quantitative enzyme-linked immunoassay analysis with antibodies against BAM revealed residue concentrations of 0.35 to 18.05 nM BAM following incubation for 10 days, corresponding to a BAM depletion of 95.6 to 99.9%. In contrast to the *Aminobacter* sp. strain ASI1, strain MSH1 also mineralized the herbicide itself along with several metabolites, including *ortho*-chlorobenzonitrile, *ortho*-chlorobenzoic acid, and benzonitrile, making it the first known dichlobenil-mineralizing bacterium. *Aminobacter* type strains not previously exposed to dichlobenil or BAM were capable of degrading nonchlorinated structural analogs. Combined, these results suggest that closely related *Aminobacter* strains may have a selective advantage in BAM-contaminated environments, since they are able to use this metabolite or structurally related compounds as a carbon and nitrogen source.

Chi-Wen Lin^{*}, Ya-Wen Cheng. (Department of Environmental Engineering, Da-Yeh University, 112 Shan-Jiau Road, Da-Tsuen, Changhua, Taiwan 515, ROC. email: Chi-Wen Lin: cwlin@mail.dyu.edu.tw). Biodegradation kinetics of benzene, methyl *tert*-butyl ether, and toluene as a substrate under various substrate concentrations. Journal of Chemical Technology & Biotechnology, Volume 82(1) (2007): 51 - 57

Owing to the complexity of conventional methods and shortcomings in determining kinetic parameters, a convenient approach using the nonlinear regression analysis of Monod or Haldane type nonlinear equations is presented. This method has been proven to provide accurate estimates of kinetic parameters. The major work in this study consisted of the testing of aromatic compound-degrading cultures in batch experiments for the biodegradation of benzene, methyl *tert*-butyl ether (MTBE), and toluene. Additionally, batch growth data of three pure cultures (i.e., *Pseudomonas aeruginosa* YAMT421, *Ralstonia* sp. YABE411 and *Pseudomonas* sp. YATO411) isolated from an industrial petrochemical wastewater treatment plant under aerobic conditions were assessed with the nonlinear regression technique and with a trial-and-error procedure to determine the kinetic parameters. The growth rates of MTBE-, benzene-, and toluene-degrading cultures on MTBE, benzene, and toluene were significant. Monod's model was a good fit for MTBE, benzene and toluene at low substrate concentrations. In contrast, Haldane's equation fitted well in substrate inhibition concentration. Monod and Haldane's expressions were found to describe the results of these experiments well, with fitting values higher than 98%. The kinetic parameters, including a maximum specific growth rate (μ_m), a half-saturation constant (K_s), and an inhibition constant (K_i), were given

KEYWORDS: biodegradation kinetics • methyl *tert*-butyl ether • Monod and Haldane equations • nonlinear regression analysis • substrate inhibition

P.A. Vieira^a, R.B. Vieira^a, F.P. de França^b and V.L. Cardoso^a. (^aUniversidade Federal de Uberlândia, Faculdade de Engenharia Química, Uberlândia, MG, Brazil, ^bUniversidade Federal do Rio de Janeiro, Escola de Química, Rio de Janeiro, RJ, Brazil). **Biodegradation of effluent contaminated with diesel fuel and gasoline, Journal of Hazardous Materials, Volume 140(1-2) (2007): 52-59**

We studied the effects of fuel concentration (diesel and gasoline), nitrogen concentration and culture type on the biodegradation of synthetic effluent similar to what was found at inland fuel distribution terminals. An experimental design with two levels and three variables (2^3) was used. The mixed cultures used in this study were obtained from lake with a history of petroleum contamination and were named culture C₁ (collected from surface sediment) and C₂ (collected from a depth of approximately 30 cm). Of the parameters studied, the ones that had the greatest influence on the removal of total petroleum hydrocarbons (TPH) were a nitrogen concentration of 550 mg/L and a fuel concentration of 4% (v/v) in the presence of culture C₁. The biodegradability study showed a TPH removal of $90 \pm 2\%$ over a process period of 49 days. Analysis using gas chromatography identified 16 hydrocarbons. The aromatic compounds did not degrade as readily as the other hydrocarbons that were identified.

Keywords: Biodegradation; Mixed cultures; Diesel oil; Gasoline; Hydrocarbons

Zhang Chaojie^a, Zhou Qi^a, Chen Ling^a, Wu Zhichao^a and Xu Bin^a. (^aPollution Control and Source Reuse State Key Laboratory, College of Environmental Science and Engineering, Tongji University, Shanghai 200092, China). **Biodegradation of *meta*-fluorophenol by an acclimated activated sludge. Journal of Hazardous Materials, Volume 141(1) (2007): 295-300**

An acclimated activated sludge was examined for its ability to degrade *meta*-fluorophenol as sole carbon source in aerobic batch cultures. The mechanism study revealed that the initial step in the aerobic biodegradation of *meta*-fluorophenol was their transformation to fluorocatechol. Following transformation of the fluorophenol to fluorocatechol, ring cleavage by catechol 1,2-dioxygenases proceeded *via* an *ortho*-cleavage pathway, then defluorination occurred.

Keywords: Aerobic biodegradation; *ortho*-Cleavage pathway; Defluorination; Fluorophenol

N. Daneshvar^a, A.R. Khataee^{a, 1}, M.H. Rasoulifard^{a, 1}, and M. Pourhassan^{b, 2}, (^aWater and Wastewater Treatment Research Laboratory, Department of Applied Chemistry, Faculty of Chemistry, University of Tabriz, Tabriz, Iran, ^bLaboratory of Ecological Research, Department of Biology, Faculty of Science, University of Tabriz, Tabriz, Iran). **Biodegradation of dye solution containing Malachite Green: Optimization of effective parameters using Taguchi method. Journal of Hazardous Materials, Volume 143(1-2) (2007): 214-219**

In this paper, optimization of biological decolorization of synthetic dye solution containing Malachite Green was investigated. The effect of temperature, initial pH of the solution, type of algae, dye concentration and time of the reaction was studied and optimized using Taguchi method. Sixteen experiments were required to study the effect of parameters on biodegradation of the dye. Each of experiments was repeated three times to calculate signal/noise (S/N). Our results showed that initial pH of the solution was the most effective parameter in comparison with others and the basic pH was favorable. In this study, we also optimized the experimental

parameters and chose the best condition by determination effective factors. Based on the S/N ratio, the optimized conditions for dye removal were temperature 25 °C, initial pH 10, dye concentration 5 ppm, algae type *Chlorella* and time 2.5 h. The stability and efficiency of *Chlorella* sp. in long-term repetitive operations were also examined.

Keywords: Biodegradation; Optimization; Algae; Malachite Green; Taguchi method

Ling Liu¹, James A. Tindall² and Michael J. Friedel³. (¹State Key Laboratory of Hydrology – Water Resources and Hydraulic Engineering, Hohai University, Nanjing, 210098, People’s Republic of China, ²National Research Program, US Geological Survey, M.S.413, Federal Center, Box 25046, Denver, CO 80225-0046, USA, ³US Geological Survey, WRD, M.S.418, Federal Center, Box 25046, Denver, CO 80225-0046, USA). **Biodegradation of PAHs and PCBs in Soils and Sludges. Water, Air, & Soil Pollution, Volume 181(1-4) (2007): 281-296**

Results from a multi-year, pilot-scale land treatment project for PAHs and PCBs biodegradation were evaluated. A mathematical model, capable of describing sorption, sequestration, and biodegradation in soil/water systems, is applied to interpret the efficacy of a sequential active–passive biotreatment process of organic chemicals on remediation sites. To account for the recalcitrance of PAHs and PCBs in soils and sludges during long-term biotreatment, this model comprises a kinetic equation for organic chemical intraparticle sequestration process. Model responses were verified by comparison to measurements of biodegradation of PAHs and PCBs in land treatment units; a favorable match was found between them. Model simulations were performed to predict on-going biodegradation behavior of PAHs and PCBs in land treatment units. Simulation results indicate that complete biostabilization will be achieved when the concentration of reversibly sorbed chemical (S_{RA}) reduces to undetectable levels, with a certain amount of irreversibly sequestered residual chemical (S_{IA}) remaining within the soil particle solid phase. The residual fraction (S_{IA}) tends to lose its original chemical and biological activity, and hence, is much less available, toxic, and mobile than the “free” compounds. Therefore, little or no PAHs and PCBs will leach from the treatment site and constitutes no threat to human health or the environment. Biotreatment of PAHs and PCBs can be terminated accordingly. Results from the pilot-scale testing data and model calculations also suggest that a significant fraction (10–30%) of high-molecular-weight PAHs and PCBs could be sequestered and become unavailable for biodegradation. Bioavailability (large K_d , i.e., slow desorption rate) is the key factor limiting the PAHs degradation. However, both bioavailability and bioactivity (K in Monod kinetics, i.e., number of microbes, nutrients, and electron acceptor, etc.) regulate PCBs biodegradation. The sequential active–passive biotreatment can be a cost-effective approach for remediation of highly hydrophobic organic contaminants. The mathematical model proposed here would be useful in the design and operation of such organic chemical biodegradation processes on remediation sites.

Keywords: PAHs - PCBs - biodegradation - land treatment - mathematical model and application - intraparticle

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Brazil, ³Departamento de Química, Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio), Rio de Janeiro, Brazil). Study of Biodegradation Processes of BTEX-ethanol Mixture in Tropical Soil. *Water, Air, & Soil Pollution, Volume 181(1-4) (2007): 303-317*

In Brazil, gasoline is currently blended with ethanol and both compounds may contaminate the environment when spills occur. Ethanol preferential biodegradation delays gasoline degradation in the aquifer, as previously observed; in unsaturated soil a delayed recovery of culturable bacteria and removal of residues in the presence of ethanol suggest a similar situation. This study monitors microbial degrading activity in unsaturated soil with BTEX and BTEX-ethanol mixtures under tropical conditions as well as the effects of bioventing on contaminants degradation. Enzymatic activity was quantified by measuring fluorescein-diacetate hydrolysis by microorganisms, which determines total degrading activity in soil. As microbial enhanced activity may alter soil electromagnetic properties, soil dielectric constant shifts were monitored using Time Domain Reflectometry (TDR), while chemical analyses evaluated contamination residues throughout the experiment. Results suggest that ethanol delays BTEX biodegradation and that bioventing may compensate for this delay by providing oxygen for the continuation of microbial activity. Contamination and bioventing stimulated soil microbiota, while culturable populations were inhibited by contamination, showing soil toxicity. The presence of ethanol caused a higher and longer-lasting boost in enzymatic activity; TDR measurements did not follow these activity shifts, proving not to be an adequate tool for evaluating microbial activity in these experimental conditions. Residual BTEX were detected only in ethanol-containing non-ventilated soils after contamination. The set of results suggests that ethanol could delay BTEX degradation because of its constitutive degradation by soil microbiota, but this effect may be bypassed by bioventing.

Keywords: tropical residual soil - ethanol-amended gasoline - microbial activity - bioventing - dielectric constant - TDR

Abhay Raj¹, Ram Chandra¹, M.M.K. Reddy², Hemant J. Purohit³ and Atya Kapley³. (¹Environmental Microbiology Section, Industrial Toxicology Research Centre, M.G. Marg, Post Box No. 80, Lucknow, 226 001, Uttar Pradesh, India, ²Analytical Chemistry Section, Industrial Toxicology Research Centre, M.G. Marg, Post Box No. 80, Lucknow, 226 001, Uttar Pradesh, India, ³Environmental Genomics Unit, National Environmental Engineering Research Institute, Nehru Marg, Nagpur, Maharashtra, 440020, India). Biodegradation of kraft lignin by a newly isolated bacterial strain, *Aneurinibacillus aneurinilyticus* from the sludge of a pulp paper mill. *World Journal of Microbiology and Biotechnology, Volume 23(6) (2007): 793-799*

A kraft lignin-degrading bacterium (ITRC *S*₇) was isolated from sludge of pulp and paper mill and characterized as *Aneurinibacillus aneurinilyticus* by biochemical tests and 16SrRNA gene sequencing. The bacterium did not utilize kraft lignin (KL) as the sole source of carbon and energy. However, this strain reduced the color (58%) and lignin content (43%) from kraft lignin-mineral salt medium when supplemented with glucose at pH 7.6 and 30°C after 6 days. The degradation on addition of glucose in culture medium is clear evidence of co-metabolism of KL by *A. aneurinilyticus*. The analysis of lignin degradation products by GC-MS in ethyl acetate extract from an *A. aneurinilyticus*-inoculated sample revealed the formation of low molecular weight aromatic compounds such as guaiacol, acetoguaiacone, gallic acid and ferulic acid, indicating that the bacterium can oxidize of the sinapylic (G units) and coniferylic (S units) alcohol units which are the basic moieties that build the hardwood lignin structure. The low

molecular weight aromatic compounds identified in extracts of the inoculated sample favors the idea of biochemical modification of the KL to a single aromatic unit.

Keywords: Bacterial isolation - KL-MSM - Biodegradation - Decolorisation - *Aneurinibacillus aneurinilyticus* - GC-MS - Pulp paper sludge

Xue-Qin Tao¹, Gui-Ning Lu¹, Zhi Dang¹, Xiao-Yun Yi¹ and Chen Yang¹. (¹School of Environmental Science and Engineering, South China University of Technology, Guangzhou, Guangdong, 510640, PR China). **Isolation of phenanthrene-degrading bacteria and characterization of phenanthrene metabolites. World Journal of Microbiology and Biotechnology, Volume 23(5) (2007): 647-654**

Three aerobic bacterial consortia GY2, GS3 and GM2 were enriched from polycyclic aromatic hydrocarbon-contaminated soils with water-silicone oil biphasic systems. An aerobic bacterial strain utilizing phenanthrene as the sole carbon and energy source was isolated from bacterial consortium GY2 and identified as *Sphingomonas* sp. strain GY2B. Within 48 h and at 30°C the strain metabolized 99.1% of phenanthrene (100 mg/l) added to batch culture in mineral salts medium and the cell number increased by about 40-fold. Three metabolites 1-hydroxy-2-naphthoic acid, 1-naphthol and salicylic acid, were identified by gas chromatographic mass spectrometry and UV-visible spectroscopy analysis. A degradation pathway was proposed based on the identified metabolites. In addition to phenanthrene, strain GY2B could use other aromatic compounds such as naphthalene, 2-naphthol, salicylic acid, catechol, phenol, benzene and toluene as a sole source of carbon and energy.

Keywords: Degradation pathway - Degradation products - Phenanthrene - Polycyclic aromatic hydrocarbons (PAHs) - *Sphingomonas* sp.

Danelle Mohammed¹, Adesh Ramsubhag¹ and Denise M. Beckles². (¹Department of Life Sciences, Faculty of Science and Agriculture, University of the West Indies, St. Augustine, Trinidad & Tobago, West Indies, ²Department of Chemistry, University of the West Indies, St. Augustine, Trinidad & Tobago, West Indies). **An Assessment of the Biodegradation of Petroleum Hydrocarbons in Contaminated Soil Using Non-indigenous, Commercial Microbes. Water, Air, & Soil Pollution, Volume 182(1-4) (2007): 349-356**

A study was conducted to determine the efficiency and effectiveness of two commercial microbial based bioremediation products compared to indigenous tropical microorganisms in a small-scale trial. The oil and grease content of the samples was monitored as an indication of the levels of petroleum hydrocarbon during the experiment. The indigenous enriched culture generally biodegraded the petroleum hydrocarbon to a greater extent than the commercial products and media controls early in the bioremediation process (0–5 days). However, as time progressed the extents of biodegradation were not significantly different between treatments until late in the bioremediation process (after 18 days). Of the two commercial products, one was more effective, reducing the level of oil and grease by 52.5% over the 3 week study. However, neither commercial product was able to meet the manufacturer's stated level of 95% removal within three weeks. Commercial microbial-based bioremediation products may be used with some success in tropical environments, however location-specific trials may be required to ensure that the best commercial product is selected. As an alternative, the selective enrichment of indigenous microorganisms may result in similar performance at a reduced cost.

Keywords: Biodegradation - Contaminated soil non-indigenous microorganisms - Petroleum tropical environments

Biosensor

E. Zacco^a, R. Galve^a, M.P. Marco^b, S. Alegret^a and M.I. Pividori^a. (^aGrup de Sensors i Biosensors, Departament de Química, Universitat Autònoma de Barcelona, 08193 Bellaterra, Catalonia, Spain, ^bApplied Molecular Receptors Group (AMRg), IQAB-CSIC, 08034 Barcelona, Catalonia, Spain. Corresponding author. Tel.: +34 581 1976; fax: +34 581 2379). **Electrochemical biosensing of pesticide residues based on affinity biocomposite platforms. *Biosensors and Bioelectronics*, Volume 22(8) (2007): 1707-1715**

A novel and very sensitive electrochemical immunosensing strategy for the detection of atrazine based on affinity biocomposite transducers is presented. Firstly, the graphite–epoxy composite transducer was bulk-modified with different universal affinity biomolecules, such as avidin and Protein A. Two strategies for the immobilization of the anti-atrazine antibodies on both biocomposite transducers were evaluated: ‘wet-affinity’ and ‘dry-assisted affinity’ immobilization. Finally, the performance of a novel anti-atrazine immunocomposite bulk-modified with anti-atrazine antibodies was also evaluated. The better immobilization performance of the anti-atrazine antibodies was achieved by ‘dry-assisted affinity’ immobilization on Protein A (2%) graphite–epoxy biocomposite (ProtA(2%)-GEB) as a transducer. The immunological reaction for the detection of atrazine performed on the ProtA(2%)-GEB biosensors is based on a direct competitive assay using atrazine-HRP tracer as the enzymatic label. The electrochemical detection is thus achieved through a suitable substrate and a mediator for the enzyme HRP. This novel strategy was successfully evaluated using spiked orange juice samples. The detection limit for atrazine in orange juices using the competitive electrochemical immunosensing assay was found to be $6 \times 10^{-3} \mu\text{g L}^{-1}$ (0.03 nmol L^{-1}) thus this biosensing method accomplishes by far the LODs required for the European Community directives for potable water and food samples ($0.1 \mu\text{g L}^{-1}$). This strategy offers great promise for rapid, simple, cost effective, and on-site biosensing of biological, food, and environmental samples.

Keywords: Graphite–epoxy biocomposite; Protein A; Avidin; Atrazine; Electrochemical biosensing; Immunoassay

Justin C. Biffinger^a, Jeremy Pietron^a, Ricky Ray^b, Brenda Little^b and Bradley R. Ringeisen^a. (^aChemistry Division, Naval Research Laboratory, 4555 Overlook Avenue, SW, Washington, DC 20375, United States, ^bOceanography Division, Naval Research Laboratory, Building 1009, John C. Stennis Space Center, MS 39529, United States. Corresponding author. Tel.: +1 202 767 0719; fax: +1 202 404 8119 **A biofilm enhanced miniature microbial fuel cell using *Shewanella oneidensis* DSP10 and oxygen reduction cathodes. *Biosensors and Bioelectronics*, Volume 22(8) (2007): 1672-1679**

A miniature-microbial fuel cell (mini-MFC, chamber volume: 1.2 mL) was used to monitor biofilm development from a pure culture of *Shewanella oneidensis* DSP10 on graphite felt (GF) under minimal nutrient conditions. ESEM evidence of biofilm formation on GF is supported by substantial power density (per device cross-section) from the mini-MFC when using an acellular minimal media anolyte (1500 mW/m^2). These experiments demonstrate that power density per

volume for a biofilm flow reactor MFC should be calculated using the anode chamber volume alone (250 W/m^3), rather than with the full anolyte volume. Two oxygen reduction cathodes (uncoated GF or a Pt/vulcanized carbon coating on GF) were also compared to a cathode using uncoated GF and a 50 mM ferricyanide catholyte solution. The Pt/C-GF (2–4% Pt by mass) electrodes with liquid cultures of DSP10 produced one order of magnitude larger power density (150 W/m^3) than bare graphite felt (12 W/m^3) in this design. These advances are some of the required modifications to enable the mini-MFC to be used in real-time, long-term environmental power generating situations.

Keywords: Microbial fuel cell; *Shewanella oneidensis*; DSP10; Mini-MFC; Biofilm

Dan Shan^a, Mingjuan Zhu^a, Huaiguo Xue^a, and Serge Cosnier^b. (^aSchool of Chemistry & Chemical Engineering, Yangzhou University, Yangzhou 225002, China, ^bLaboratoire d'Electrochimie Organique et de Photochimie Rédox, UMR CNRS 5630, Institut de Chimie Moléculaire de Grenoble (FR CNRS 2607), Université Joseph Fourier, 38041 Grenoble, France. Corresponding author. Tel.: +86 514 7975436; fax: +86 514 7975244). Development of amperometric biosensor for glucose based on a novel attractive enzyme immobilization matrix: Calcium carbonate nanoparticles. *Biosensors and Bioelectronics*, Volume 22(8) (2007): 1612-1617

Calcium carbonate nanoparticles (nano- CaCO_3) may be a promising material for enzyme immobilization owing to their high biocompatibility, large specific surface area and their aggregation properties. This attractive material was exploited for the mild immobilization of glucose oxidase (GOD) in order to develop glucose amperometric biosensor. The GOD/nano- CaCO_3 -based sensor exhibited a marked improvement in thermal stability compared to other glucose biosensors based on inorganic host matrixes. Amperometric detection of glucose was evaluated by holding the modified electrode at 0.60 V (versus SCE) in order to oxidize the hydrogen peroxide generated by the enzymatic reaction. The biosensor exhibited a rapid response (6 s), a low detection limit ($0.1 \mu\text{M}$), a wide linear range of 0.001–12 mM, a high sensitivity ($58.1 \text{ mA cm}^{-2} \text{ M}^{-1}$), as well as a good operational and storage stability. In addition, optimization of the biosensor construction, the effects of the applied potential as well as common interfering compounds on the amperometric response of the sensor were investigated and discussed herein.

Keywords: Calcium carbonate; Nanoparticles; Inorganic matrix; Glucose oxidase; Biosensor

Frank Davis^a and Séamus P.J. Higson^a. (^aCranfield Health, Cranfield University, Silsoe, Bedfordshire MK45 4DT, UK. Corresponding author. Tel.: +44 1525 863455; fax: +44 1525 863533). Biofuel cells—Recent advances and applications. *Biosensors and Bioelectronics*, Volume 22(7) (2007): 1224-1235

In 2006, the journal *Biosensors and Bioelectronics* published a special issue devoted exclusively to biofuel cells, including several research papers and an extensive review of the field [Bullen, R.A., Arnot, T.C., Lakeman, J.B., Walsh, F.C., 2006. *Biosens. Bioelectron.*]. Within this review a brief description will firstly be given of the history of biofuel cells together with coverage of some of the major historical advances. The review is intended, however, to largely concentrate on and give an overview of the advances made in recent years in this area together with a discussion surrounding the practical application of biofuel cells.

There are several classes of biofuel cells: we shall firstly discuss the recent advances in biofuel cells that convert chemical fuels to produce electrical power by use of catalytic enzymes. This will be followed by a section on similar cells where micro-organisms rather than enzymes are used to convert the fuel to energy. Thirdly we shall consider hybrid biofuel cells that combine the utilisation of photochemical chemistries and biological systems for the generation of electricity.

Finally we will discuss some of the proposed uses of biofuel cells together with a short consideration of future research possibilities and applications of these systems.

Keywords: Bioelectronics; Biofuel cells; Glucose oxidase; Microbial fuel cells

Shihong Chen^a, Ruo Yuan^a, Yaqin Chai^a, Lingyan Zhang^a, Na Wang^a and Xuelian Li^a. (^aChongqing Key Laboratory of Analytical Chemistry, College of Chemistry and Chemical Engineering, Southwest University, Chongqing 400715, China. Corresponding author. Tel.: +86 23 68252277; fax: +86 23 68254000) Amperometric third-generation hydrogen peroxide biosensor based on the immobilization of hemoglobin on multiwall carbon nanotubes and gold colloidal nanoparticles. *Biosensors and Bioelectronics* Volume 22 (7)(2007): 1268-1274

A convenient and effective strategy for preparation nanohybrid film of multi-wall carbon nanotubes (MWNT) and gold colloidal nanoparticles (GNPs) by using proteins as linker is proposed. In such a strategy, hemoglobin (Hb) was selected as model protein to fabricate third-generation H₂O₂ biosensor based on MWNT and GNPs. Acid-pretreated, negatively charged MWNT was first modified on the surface of glassy carbon (GC) electrode, then, positively charged Hb was adsorbed onto MWNT films by electrostatic interaction. The {Hb/GNPs}_n multilayer films were finally assembled onto Hb/MWNT film through layer-by-layer assembly technique. The assembly of Hb and GNPs was characterized with cyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS) and transmission electron microscopy (TEM). The direct electron transfer of Hb is observed on Hb/GNPs/Hb/MWNT/GC electrode, which exhibits excellent electrocatalytic activity for the reduction of H₂O₂ to construct a third-generation mediator-free H₂O₂ biosensor. As compared to those H₂O₂ biosensors only based on carbon nanotubes, the proposed biosensor modified with MWNT and GNPs displays a broader linear range and a lower detection limit for H₂O₂ determination. The linear range is from 2.1×10^{-7} to 3.0×10^{-3} M with a detection limit of 8.0×10^{-8} M at 3σ . The Michaelies–Menten constant K_M^{app} value is estimated to be 0.26 mM. Moreover, this biosensor displays rapid response to H₂O₂ and possesses good stability and reproducibility.

Keywords: Carbon nanotubes; Gold colloidal nanoparticles; Hemoglobin; Hydrogen peroxide biosensor

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Dibromochloropropane Using a Hydrogen-based Membrane Biofilm Reactor. Biodegradation, Volume 18(2) (2007): 199-209

We tested the hypothesis that the H₂-based membrane biofilm reactor (MBfR) is capable of reducing multiple oxidized contaminants, a common situation for groundwater contamination. We conducted bench-scale experiments with three groundwater samples collected from California's San Joaquin Valley and on two synthetic groundwaters containing selenate and chromate. The actual groundwater sources had nitrate levels exceeding 10 mg-N l⁻¹ and different combinations of anthropogenic perchlorate + chlorate, arsenate, and dibromochloropropane (DBCP). For all actual groundwaters, the MBfR reduced nitrate to less than 0.01 mg-N l⁻¹. Present in two groundwaters, perchlorate + chlorate was reduced to below the California Notification Level, 6 µg-ClO₄ l⁻¹. As(V) was substantially reduced to As(III) for two groundwaters samples, which had influent As(V) concentrations from 3 to 8.8 µg-As l⁻¹. DBCP, present in one groundwater at 1.4 µg l⁻¹, was reduced to below its detection limit of 0.01 µg l⁻¹, which is well below California's 0.2 µg l⁻¹ MCL for DBCP. For the synthetic groundwaters, two MBfRs initially reduced Se(VI) or Cr(VI) stably to Se⁰ or Cr(III). When we switched the influent oxidized contaminants, the new oxidized contaminant was reduced immediately, and its reduction soon was approximately the same or greater than it had been reduced in its original MBfR. These results support that the H₂-based MBfR can reduce multiple oxidized contaminants simultaneously.

Keywords: Arsenate - Bioreduction - Chromate, Dibromochloropropane - Hydrogen - Membrane biofilm reactor - Oxidized contaminants - Perchlorate - Selenate

Xiao Jun Wu^a, Martin M.F. Choi^a, Chang Shun Chen^{1, a} and Xiao Min Wu^{2, a}. (^aDepartment of Chemistry, Hong Kong Baptist University, Kowloon Tong, Hong Kong SAR, PR China). **On-line monitoring of methanol in *n*-hexane by an organic-phase alcohol biosensor. Biosensors and Bioelectronics, Volume 22(7) (2007): 1337-1344**

An organic-phase alcohol biosensor has been developed by co-entrapping alcohol oxidase and horseradish peroxidase within an ionotropy polymer hydrogel matrix fabricated from silica gel particles, hydroxyethyl carboxymethylcellulose, an adduct of 3-methoxy-4-ethoxybenzaldehyde and 4-*tert*-butylpyridinium acetohydrazone, and octadecylsilica particles. The viability of the immobilised enzymes for the biocatalytic reaction of methanol in *n*-hexane was comparatively studied by using a bulk cell or a volume-changeable flow-through cell coupled with an oxygen optical transducer. It was found that the microenvironment around the enzyme, the deterioration property of the enzyme, the substrate throughput and the mass transfer process of the reactant in the bioreactor were the crucial parameters affecting the performance of the alcohol organic-phase biosensor. Our optimal biosensor was constructed from a flow-through cell packed with small particles of immobilised enzymes and it could maintain the biocatalytic reaction at high and stable rate for on-line detection of methanol in *n*-hexane under flow operation mode. The biosensor had an analytical working range of 2.3–90 mM methanol in *n*-hexane. The response times (*t*₉₅) were 4.5 and 7.5 min for 60 and 10 mM methanol, respectively. The operational lifetime of the biosensor was more than 45 assays and the shelf lifetime was longer than 2 weeks. The biosensor has been successfully applied to determine the methanol content in a commercial gasoline–methanol blend sample with good recovery.

Keywords: Organic-phase; Alcohol oxidase; Biosensor; Methanol

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A surface plasmon resonance (SPR) based immunosensor has been developed for the monitoring of environmentally persistent pollutants like DDT, its metabolites and analogues in real water samples. A reusable immunosurface is provided via the covalent attachment of the analyte derivative to a self-assembled alkanethiol monolayer formed onto the SPR gold-thin layer. The regeneration of the sensor surface allowed the performance of 270 assay cycles within an analysis time of 20 min for each assay cycle. Immunoassays based on a binding inhibition format were performed by using two monoclonal antibodies (MAbs) with different selectivity. Low limits of detection (LODs), in the sub-nanogram per litre range, were attained for DDT-selective (15 ng L^{-1}) and DDT group-selective immunoassays (31 ng L^{-1}). Both assays were carried out in spiked river water samples without significant effect of the matrix. SPR measurements were validated using gas-chromatography–mass spectrometry. The comparison between methods was in good agreement showing an excellent correlation coefficient ($r^2 = 0.995$). The SPR analysis of DDT proved to be three times more sensitive than colorimetric ELISAs without the need of labelling and a much lower time of response. Our SPR biosensor portable platform (β -SPR) is already commercialised by the company SENSIA, S.L. (Spain).

Keywords: Optical immunosensor; SPR; DDT; Environmental analysis; Cross-reactivity

W. Franks^a, S. Tosatti^b, F. Heer^a, P. Seif^a, M. Textor^b and A. Hierlemann^a. (^aETH Zürich, Physical Electronics Laboratory, ETH Hönggerberg, Wolfgang-Pauli-Strasse 16, HPT H 4.2, 8122 Binz bei Maur, Switzerland, ^bETH Zürich, Laboratory of Surface Technology, ETH Hönggerberg, Wolfgang-Pauli-Strasse 10, HCI H 5.25, 8122 Binz bei Maur, Switzerland). **Patterned cell adhesion by self-assembled structures for use with a CMOS cell-based biosensor. Biosensors and Bioelectronics, Volume 22(7) (2007): 1426-1433**

A strategy for patterned cell adhesion based on chemical surface modification is presented. To confine cell adhesion to specific locations, an engineered surface for high-contrast protein adsorption and, hence, cell attachment has been developed. Surface functionalization is based on selective molecular-assembly patterning (SMAP). An amine-terminated self-assembled monolayer is used to define areas of cell adhesion. A protein-repellent grafted copolymer, poly(l-lysine)-*graft*-poly(ethylene glycol) (PLL-*g*-PEG), is used to render the surrounding silicon dioxide resistant to protein adsorption. X-ray photoelectron spectroscopy, scanning ellipsometry and fluorescence microscopy techniques were used to monitor the individual steps of the patterning process. Successful guided growth using these layers is demonstrated with primary neonatal rat cardiomyocytes, up to 4 days *in vitro*, and with the HL-1 cardiomyocyte cell line, up to 7 days *in vitro*. The advantage of the presented method is that high-resolution engineered surfaces can be realized using a simple, cost-effective, dip-and-rinse process. The technique has been developed for application on a CMOS cell-based biosensor, which comprises an array of microelectrodes to extracellularly record electrical activity from cardiomyocytes.

Keywords: Biosensor; CMOS; Patterned cell adhesion; PLL-g-PEG Self-assembled PEG monolayer based SPR immunosensor for label-free detection of insulin

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A simple and rapid continuous-flow immunosensor based on surface plasmon resonance (SPR) has been developed for detection of insulin as low as 1 ng ml⁻¹ (ppb) with a response time of less than 5 min. At first, a heterobifunctional oligo(ethyleneglycol)-dithiocarboxylic acid derivative (OEG-DCA) containing dithiol and carboxyl end groups was used to functionalize the thin Au-film of SPR chip. Insulin was covalently bound to the Au-thiolate monolayer of OEG-DCA for activating the sensor surface to immunoaffinity interactions. An on-line competitive immunosensing principle is examined for detection of insulin, in which the direct affinity binding of anti-insulin antibody to the insulin on sensor surface is examined in the presence and absence of various concentrations of insulin. Immunoreaction of anti-insulin antibody with the sensor surface was optimized with reference to antibody concentration, sample analysis time and flow-rate to provide the desired detection limit and determination range. With the immunosensor developed, the lowest detectable concentration of insulin is 1 ng ml⁻¹ and the determination range covers a wide concentration of 1–300 ng ml⁻¹. The developed OEG-monolayer based sensor chip exhibited high resistance to non-specific adsorption of proteins, and an uninterrupted highly sensitive detection of insulin from insulin-impregnated serum samples has been demonstrated. After an immunoreaction cycle, active sensor surface was regenerated simply by a brief flow of an acidic buffer (glycine·HCl; pH 2.0) for less than 1 min. A same sensor chip was found reusable for more than 25 cycles without an appreciable change in the original sensor activity.

Keywords: Insulin detection; Surface plasmon resonance; Polyethyleneglycol (PEG) monolayer; Label-free optical immunosensor; Insulinoma; Diabetes

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Fibre-optic biosensors for Hg and As were developed by attaching alginate-immobilised recombinant luminescent Hg- and As-sensor bacteria onto optical fibres. The optimised biosensors (consisting of seven layers of fibre-attached bacteria pre-grown till mid-logarithmic growth phase) enabled quantification of environmentally relevant concentrations of the target analytes: 2.6 µg l⁻¹ of Hg(II) and 141 µg l⁻¹ of As(V) or 18 µg l⁻¹ of As(III). The highest viability and sensitivity for target analyte was obtained when fibre tips were stored in CaCl₂ solution at –80 °C.

Applicability of the fibre-optic biosensors in parallel to the respective non-immobilised sensors was assessed on 10 natural soil and sediment samples from Aznalcollar mining area (Spain). On the average 0.2% of the total Hg and 0.87% of the total As proved bioavailable to fibre-attached bacteria. Interestingly, about 20-fold more Hg and 4-fold more As was available to non-immobilised sensor bacteria indicating the importance of direct cell contact (possible only for non-immobilised cells) for enhanced bioavailability of these metals in solid samples.

Keywords: Mercury; Arsenic; Pollution; Recombinant bioreporter bacteria; Bioluminescence; Fibre-optic biosensor

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A novel analytical immunosensor array, based on a microtiter plate coupled to a multichannel electrochemical detection (MED) system using the intermittent pulse amperometry (IPA) technique, is proposed for the detection of aflatoxin B₁ (AFB₁). In the present work, the electrochemical behaviour and electroanalytical performance of the thick-film carbon sensors (also designated as screen-printed electrodes) incorporated in the multichannel electrochemical plate were first evaluated. Then the 96-well screen-printed microplate was modified in accord with a competitive indirect enzyme-linked immunoassay (ELISA) format for aflatoxin B₁ detection. The measurements were performed using both spectrophotometric and electrochemical procedures and the results of the calibration curves, detection limit (LOD), sensitivity and reproducibility of the respective assay systems were evaluated.

The immunoassay was then applied for analysis of corn samples spiked with AFB₁ before and after the extraction treatment, in order to study the extraction efficiency and the matrix effect, respectively. These studies have shown that using this system, AFB₁ can be measured at a level of 30 pg/mL and with a working range between 0.05 and 2 ng/mL. Good recoveries (103 ± 8%) were obtained, demonstrating the suitability of the proposed assay for accurate determination of the AFB₁ concentration in corn samples.

The specificity of the assay was assessed by studying the cross-reactivity of PAb relative to AFB₁. The results indicated that the PAb could readily distinguish AFB₁ from other aflatoxins, with the exception for AFG₁.

Keywords: Aflatoxin B₁; 96-Well screen-printed microplate; Intermittent pulse amperometry; ELISA; Corn

Tzyy-Jiann Wang^a, Wen-Shao Lin^a and Fu-Kuen Liu^b. (^aInstitute of Electro-optical Engineering, National Taipei University of Technology, Taipei 106, Taiwan, ^bDepartment of Applied Chemistry, National University of Kaohsiung, Kaohsiung 811, Taiwan). **Integrated-optic biosensor by electro-optically modulated surface plasmon resonance. Biosensors and Bioelectronics, Volume 22(7) (2007): 1441-1446**

We present a new integrated-optic surface plasmon resonance (SPR) biosensor based on electro-optical modulation. The SPR characteristics for the analyte concentration detection can be electro-optically modulated by applying the voltage on the electrodes of the biosensor fabricated on lithium niobate, which is an excellent electro-optic material. Two measurement methods, electro-optically modulated SPR spectral measurement and electro-optically modulated SPR intensity measurement, are demonstrated and their measurands are the SPR wavelength and the output optical intensity, respectively. Human serum albumin is coated on the gold film surface of the proposed biosensor to detect the concentration of beta-blocker, which is a remedy for heart disease. As the applied voltage increases such that the effective index of guided mode rises, the SPR wavelength shifts toward the long wavelength side and the output optical intensity at the wavelength of 632.8 nm diminishes. The linear regression slope of the relation between the measurand and the applied voltage is dependent on the analyte concentration and can be used to determine the concentration variation. Experimental results measured by the electro-optically modulated SPR methods are compared with those measured by the conventional spectral and intensity methods, and the effects of waveguide width on the biosensor performance are discussed.

Keywords: Surface plasmon resonance; Optical biosensor; Integrated optics

Lu Gao^a and Qiuming Gao^a. (^aState Key Laboratory of High Performance Ceramics and Superfine Microstructure, Graduate School, Shanghai Institute of Ceramics, Chinese Academy of Sciences, 1295 Dingxi Rd., Shanghai 200050, PR China). Hemoglobin niobate composite based biosensor for efficient determination of hydrogen peroxide in a broad pH range. *Biosensors and Bioelectronics*, Volume 22(7) (2007): 1454-1460

Inorganic layered niobates ($\text{HfCa}_2\text{Nb}_3\text{O}_{10}$) were used as immobilization matrices of hemoglobin (Hb) because of their tunable interlayer spaces, large surface areas and good biocompatibilities. A pair of well-defined, quasi-reversible cycle voltammetric peaks were obtained at the Hb- $\text{HfCa}_2\text{Nb}_3\text{O}_{10}$ modified pyrolytic graphite electrode, suggesting that the layered niobates facilitate the electron transfer between the proteins and the electrode. Hb- $\text{HfCa}_2\text{Nb}_3\text{O}_{10}$ modified electrode exhibited electrocatalytic response for monitoring H_2O_2 with a large linear detection range from 25 μM to 3.0 mM and a relatively high sensitivity of 172 $\mu\text{A mM}^{-1} \text{cm}^{-2}$. Based on the stabilizing effect of the layered niobates, Hb- $\text{HfCa}_2\text{Nb}_3\text{O}_{10}$ modified electrode can detect H_2O_2 in strongly acidic and basic solutions with pH of 1–12, which greatly expands the application fields of biosensors.

Keywords: Biosensors; Hemoglobin; Layered niobates; Direct electron transfer; Hydrogen peroxide

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Biosensors were fabricated at neutral pH by sequentially depositing the polycation polyethyleneimine (PEI), the stereoselective enzyme l-glutamate oxidase (GluOx) and the

permselective barrier poly-*ortho*-phenylenediamine (PPD) onto 125- μ m diameter Pt wire electrodes (Pt/PEI/GluOx/PPD). These devices were calibrated amperometrically at 0.7 V versus SCE to determine the Michaelis–Menten parameters for enzyme substrate, l-glutamate (Glu) and co-substrate, dioxygen. The presence of PEI produced a 10-fold enhancement in the detection limit for Glu (\approx 20 nM) compared with the corresponding PEI-free configurations (Pt/GluOx/PPD), without undermining their fast response time (\approx 2 s). Most remarkable was the finding that, although some designs of PEI-containing biosensors showed a 10-fold increase in linear region sensitivity to Glu, their oxygen dependence remained low.

Keywords: Glutamate oxidase; Polyethyleneimine; PEI; Poly(*o*-phenylenediamine); PPD; Michaelis–Menten; Brain monitoring; Neurochemistry

R. Guntupalli^a, J. Hu^{a, d}, Ramji S. Lakshmanan^a, T.S. Huang^b, James M. Barbaree^c and Bryan A. Chin^a. (^aMaterials Research and Education center, Auburn University, Auburn, AL 36849, USA, ^bDepartment of Nutrition and Food Science, Auburn University, Auburn, AL 36849, USA, ^cDepartment of Biological Sciences, Auburn University, 101 Life Sciences Bldg., Auburn, AL 36849, USA, ^dDepartment of Material Science and Engineering, Jiangsu Polytechnic University, Changzhou 213016, PR China). **A magnetoelastic resonance biosensor immobilized with polyclonal antibody for the detection of *Salmonella typhimurium*. Biosensors and Bioelectronics, Volume 22(7) (2007): 1474-1479**

Mass-sensitive, magnetoelastic resonance sensors have a characteristic resonant frequency that can be determined by monitoring the magnetic flux emitted by the sensor in response to an applied, time varying, magnetic field. This magnetostrictive platform has a unique advantage over conventional sensor platforms in that measurement is wireless and remote. A biosensor for the detection of *Salmonella typhimurium* was constructed by immobilizing a polyclonal antibody (the bio-molecular recognition element) onto the surface of a magnetostrictive platform. The biosensor was then exposed to solutions containing *S. typhimurium* bacteria. Binding between the antibody and antigen (bacteria) occurred and the additional mass of the bound bacteria caused a shift in the sensor's resonant frequency. Sensors with different physical dimensions were exposed to different concentrations of *S. typhimurium* ranging from 10^2 to 10^9 CFU/ml. Detection limits of 5×10^3 CFU/ml, 10^5 CFU/ml and 10^7 CFU/ml were obtained for sensors with the size of $2 \text{ mm} \times 0.4 \text{ mm} \times 15 \mu\text{m}$, $5 \text{ mm} \times 1 \text{ mm} \times 15 \mu\text{m}$ and $25 \text{ mm} \times 5 \text{ mm} \times 15 \mu\text{m}$, respectively. Good agreement between the measured number of bound bacterial cells (as measured by scanning electron microscopy (SEM)) and frequency shifts was obtained.

Keywords: Magnetoelastic; Magnetostrictive; Biosensor; Antibody; *Salmonella typhimurium*; Langmuir Blodgett

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Technology, Ben-Gurion University of the Negev, Beer-Sheva 84105, Israel). Chemiluminescent optical fiber immunosensor for detection of autoantibodies to ovarian and breast cancer-associated antigens. Biosensors and Bioelectronics, Volume 22 (7) (2007): 1508-1516

We report herein the development of an optical fiber based chemiluminescent immunosensor for detection of the native autoimmune response to GIPC-1, a PDZ containing protein involved in regulation of G-protein signaling. The recombinant protein GIPC-1 was expressed in bacteria, purified, refolded and conjugated to the tip of an optical fiber. A human monoclonal 27.B1 IgM isolated from a breast cancer patient, which targets the GIPC-1 protein, was used for calibration of the immunosensor and was detected down to a concentration of 30 pg/ml. We determined that the fiber-optic immunosensor had a detection limit 50 times lower than chemiluminescent ELISA, and approximately 500 times lower than colorimetric ELISA. In addition, sera from 11 ovarian cancer patients, 22 breast cancer patients and asymptomatic controls were tested for the presence of IgM anti-GIPC-1 autoantibodies in their serum using the two methods. The immunosensor assay detected 54% and 77% GIPC-1 positive sera within ovarian and breast cancer patients, respectively, as compared to chemiluminescent ELISA, which only detected 18% and 27%, respectively. We envision that this immunosensor may serve as a diagnostic tool for screening women for ovarian and breast cancer at an early stage, thus increasing their chance of survival.

Keywords: Optical fiber immunosensor; GIPC-1; Chemiluminescence; Ovarian and breast cancer; Human monoclonal antibody; Cancer-associated antigen

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An approach to the glucose determination by amperometric biosensing in wine industry applications is presented. Integrated screen-printed biosensors based on horseradish peroxidase (HRP) and glucose oxidase (GOx) have been developed. The experimental design methodology has been used to find the optimum conditions of the experimental variables, in such a way that a chronoamperometric response specific for glucose was recorded. Under these conditions, repeatability and reproducibility of the modified electrodes have been analyzed. The detection limit for glucose has been calculated taking into account the probability of false positive (α) and negative (β), reaching a medium value of $4.37 \pm 0.21 \mu\text{mol dm}^{-3}$ ($\alpha = \beta = 0.05$, and a replicate $n = 4$). The biosensor was applied to the determination of glucose in white wine samples.

Keywords: Screen-printed electrodes; Biosensors; Glucose; Experimental design; Grape juice

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The electrochemical detection of *Escherichia coli* β -D-glucuronidase activity as a means of monitoring water pollution by faecal material was investigated using separate *Moraxella*- and *Pseudomonas putida*-modified glassy carbon electrodes. The former was more sensitive and selective. The *Moraxella*-modified biosensor was 100 times more rapid and sensitive than the spectrophotometric detection of β -D-glucuronidase activity. The experimental limit of detection of the biosensor was two c.f.u. per 100 ml polluted water sample within 20 min. The biosensor gave a linear response to commercial β -D-glucuronidase concentration between 0.2 ng and 2 $\mu\text{g ml}^{-1}$. The biosensor detected activity of β -D-glucuronidase from viable but non-culturable (VBNC) cells and can therefore serve as a presence or absence device for rapid water quality monitoring.

Keywords: Biosensor - Drinking water - Electro-oxidation - Faecal - Hydroquinone - *Moraxella*

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An accumulating process based on electric field-assisted biosorption is described to facilitate the accumulation and enhanced detection of organic fluorogenic marker species in aqueous solution. Fluorescein was detected at concentrations as low as 0.6 $\mu\text{g l}^{-1}$. Using a mammalian cell-based bioassay, we demonstrate the use of the system to remove the toxic effects of species such as ethidium bromide and doxorubicin from complex solutions such as tissue culture medium. The use of such a system for the detection and removal of trace contaminants is discussed.

Keywords: Biosorption - Detoxification - Electric field - Viability

V.C. Wutor^a, C.A. Togo^a, J.L. Limson^{ab} and B.I. Pletschke^a. (^aDepartment of Biochemistry, Microbiology and Biotechnology, Rhodes University, P.O. Box 94, Grahamstown 6140, South Africa). **A novel biosensor for the detection and monitoring of β -d-galactosidase of faecal origin in water. *Enzyme and Microbial Technology*, Volume 40(6) (2007): 1512-1517**

A voltammetric sensor prepared by the immobilization of metallophthalocyanine complexes onto a glassy carbon electrode has been developed for the detection of β -d-galactosidase (B-GAL) of faecal origin in water. Electrooxidation of chlorophenol red, a breakdown product of the chromogenic substrate chlorophenol red β -d-galactopyranoside, was used as a measure of β -d-galactosidase activity. At metallophthalocyanine modified electrodes, in particular copper(II) phthalocyanine, a decrease in electrode fouling was observed. The sensor was sensitive to fluctuations in pH, not significantly affected by temperature variations and could detect one colony forming unit/100 mL in 15 min. Loss of 40% sensitivity was observed over a period of 30 days. A strong correlation between sensor sensitivity and colony forming units was observed. The sensor is capable of detecting viable but nonculturable bacteria, overcoming this drawback of the use of culture media for detection of coliforms.

Keywords: Chlorophenol red; Chlorophenol red β -d-galactopyranoside; Coliforms; Voltammetry; Phthalocyanine; Biosensor

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The development of an acetylcholinesterase (AChE) based biosensor is described. As transducers cobalt(II) phthalocyanine (CoPC)-modified screen-printed carbon electrodes (SPCEs) were used. Through the study of the AChE catalytic activity and by using acetylthiocholine (ATCh) as enzyme substrate, it was possible to detect pesticides, such as Carbofuran, by means these modified SPCEs under optimised chronoamperometric conditions. The method was based on the incubation of the AChE-based biosensor with the pesticide. The inhibitory effect of the pesticide determined a decrease of the catalytic activity of AChE; as a consequence, less thiocholine (TCh) was produced from ATCh. Therefore, the current value, due to the oxidation of TCh at the modified SPCEs, was lower than that recorded in a blank solution. This current decrease was correlated with the pesticide concentration. A detection limit of 4.9×10^{-10} M for Carbofuran was found with an analysis time of 15 min. The study of the immobilisation layer composition (enzyme units and cross-linker amounts) was emphasised. A comparison of the inhibitory effect of pesticides among AChE in solution as well as immobilised was also reported.

Keywords: Acetylcholinesterase (AChE); Cobalt(II) phthalocyanine; Screen-printed electrodes; Biosensor; Pesticides

Declan A. Healy¹, Conor J. Hayes¹, Paul Leonard¹, Louise McKenna² and Richard O’Kennedy¹. (¹School of Biotechnology and Biomedical Diagnostics Institute, National Centre for Sensor Research, Dublin City University, Dublin 9, Ireland, ²Forensic Science Laboratory, Garda Headquarters, Phoenix Park, Dublin 8, Ireland). **Biosensor developments: application to prostate-specific antigen detection. Trends in Biotechnology, Volume 25(3) (2007): 125-131**

Prostate-specific antigen (PSA) is the best serum marker currently available for the detection of prostate cancer and is the forensic marker of choice for determining the presence of azoospermic semen in some sexual assault cases. Most current assays for PSA detection are processed on large analyzers at dedicated testing sites, which require that samples be sent away for testing. This leads to delays in patient management and increased administration costs. The recent emphasis placed on the need for point-of-care patient management has led to the development of novel biosensor detection strategies that are suitable for the miniaturization of assays for various targets including PSA. This review highlights the current and novel analytical technologies used for PSA detection, which will benefit clinicians, patients and forensic workers in the future.

Bioengineering

J. Morales¹, P. Medina¹ and E. Viñuela¹. (¹Unidad de Protección de Cultivos, P. Medina, Email: pilar.medina@upm.es). The influence of two endoparasitic wasps, *Hyposoter didymator* and *Chelonus inanitus*, on the growth and food consumption of their host larva *Spodoptera littoralis*. *BioControl*, Volume 52(2) (2007): 145-160

The influence of parasitism by *Hyposoter didymator* (Thunberg; Hymenoptera: Ichneumonidae) and *Chelonus inanitus* (Linnaeus) (Hymenoptera: Braconidae) on the growth and food consumption of their host *Spodoptera littoralis* (Boisduval) (Lepidoptera: Noctuidae) was studied in the laboratory. Parasitised larvae consumed significantly less artificial diet than unparasitised ones. Egg parasitisation by *C. inanitus* affected host larval consumption from the second day after emergence and it was significantly different from that of unparasitised ones. *H. didymator*, however, started to reduce larval consumption 4 days after parasitisation on the third instar host larvae. The overall reduction achieved by the larval endoparasitoid *H. didymator* is higher than that caused by the egg-larval endoparasitoid *C. inanitus*. The final body weight of a parasitised host larva by *H. didymator* and *C. inanitus* was only 6.7 and 13.0% of the maximum weight of an unparasitised sixth instar larva respectively. Moreover, parasitised larvae never reached the last instar. Results indicated that parasitised larvae might cause considerable less damage to the host plant than unparasitised ones.

Keywords: *Chelonus inanitus* - food consumption - Hymenoptera - *Hyposoter didymator* - Lepidoptera - *Spodoptera littoralis* - weight gain

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Water hyacinth (*Eichhornia crassipes* (Mart.) Solms-Laub.) remains a problem waterweed worldwide, for which biological control offers a sustainable solution. Under laboratory conditions, we investigated the interaction between two established weevil species *Neochetina eichhorniae* (Warner), *Neochetina bruchi* Hustache and the mirid *Eccritotarsus catarinensis* (Carvalho) which have been released together in several countries. Adult and immatures of *E. catarinensis* had high mortality on plants with high levels of old feeding scars from adult *N. eichhorniae* and *N. bruchi* and was significantly different at $p < 0.05$. In contrast, mirid survived well on plants with recent feeding scars from *Neochetina* spp. or on undamaged plants. Our results indicate that the mirid is compatible with the two weevil species for improving biological control of the weed.

Keywords: adult weevil feeding scars - *Eichhornia crassipes* - *Eccritotarsus catarinensis* - *Neochetina eichhorniae* - *N. bruchi* - weed biological control

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Nitidulid beetles (Coleoptera) are considered serious pests of date palms throughout the world. They attack the ripe fruit, causing it to rot, and damage is reflected in both reduced yield and lower fruit quality. Previous studies demonstrated the susceptibility of larvae of this pest to entomopathogenic nematodes from the genus *Heterorhabditis*. In the present study nematode efficacy was evaluated in greenhouse and field. In containers filled with soil, moderate reduction in insect emergence was achieved when the nematodes were applied at concentrations of 25 and 50 IJs/cm². However, the highest concentration (100 IJs/cm²) treatment resulted in a drastic reduction (by 70–90%) in emergence of the beetles. The lowest emergence was achieved by the IS-19 and IS-21 strains (>10%). Efficacy of the IS-19 strain was retained up to 7 days after application at a rate of 100 IJs/cm². When the insect larvae were introduced to the soil 2 weeks after nematode application, the percentage emergence of insects increased by 2–2.5 fold as compared to previous introductions but was still lower than in the control. Insect density per container did not have an effect on efficacy of the nematodes when the strains IS-19 and IS-12 were used. Two field trials were conducted in different sites in Israel. In the first trial, conducted in date palm orchard, four strains of *Heterorhabditis* sp. were tested. No significant difference in insect emergence was recorded among the various treatments or the control. Whereas in the second trial conducted in a fig orchard, substantial reduction (by 50–70%) in insect emergence was recorded following nematode treatment. Further studies, under natural conditions, are needed to optimize application efficiency and evaluate the commercial utilization of these biological control agents.

Keywords: sap beetles - entomopathogenic nematodes - biological control - date orchards - fig orchards - *Carpophilus humeralis* - *Heterorhabditis* sp

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Termites, *Coptotermes formosanus*, reared individually, were highly susceptible to the entomopathogenic fungus, *Metarhizium anisopliae*, while termites reared in groups were highly resistant. When reared in groups, the termites treated with *M. anisopliae* conidia on the body surface were groomed by their nestmates and more than 80% of the conidia were removed from the cuticle within 3 h. However, there was not a significant reduction in the numbers of conidia on the body surfaces of termites reared individually. For the termites maintained in groups, conidia were found in foreguts, midguts and hindguts, but very few conidia were detected in the guts of termites reared individually. Conidia in the alimentary tracts did not germinate, but some of were alive. As a result, it seems that the removal of foreign bodies, such as fungal conidia, from the cuticle is one function of termite mutual grooming behavior and that conidia removed

from the cuticle are eliminated through alimentary tracts. This study indicates that mutual grooming behavior is very effective in protecting these termites from *M._anisopliae* infection.

Keywords: alimentary tract - *Coptotermes formosanus* - entomopathogenic fungi - grooming behavior - *Metarhizium anisopliae*

W. A. Palmer¹ and K. A. D. W. Senaratne¹. (¹Queensland Department of Natural Resources and Mines, Alan Fletcher Research Station, P.O. Box 36, Sherwood, Qld, Australia, 4075. W. A. Palmer, Email: palmerwa@nrm.qld.gov.au). **The host range and biology of *Cometaster pyrula*; a biocontrol agent for *Acacia nilotica* subsp. *indica* in Australia. *BioControl*, Volume 52(1) (2007): 129-143**

Prickly acacia, *Acacia nilotica* subsp. *indica* (Benth.) Brenan, a major weed of the Mitchell Grass Downs of northern Queensland, Australia, has been the target of biological control projects since the 1980s. The leaf-feeding caterpillar *Cometaster pyrula* (Hopffer) was collected from *Acacia nilotica* subsp. *kraussiana* (Benth.) Brenan during surveys in South Africa to find suitable biological control agents, recognised as a potential agent, and shipped into a quarantine facility in Australia. *Cometaster pyrula* has a life cycle of approximately 2 months during which time the larvae feed voraciously and reach 6 cm in length. Female moths oviposit a mean of 339 eggs. When presented with cut foliage of 77 plant species, unfed neonates survived for 7 days on only *Acacia nilotica* subsp. *indica* and *Acacia nilotica* subsp. *kraussiana*. When unfed neonates were placed on potted plants of 14 plant species, all larvae except those on *Acacia nilotica* subsp. *indica* and *Acacia nilotica* subsp. *kraussiana* died within 10 days of placement. *Cometaster pyrula* was considered to be highly host specific and safe to release in Australia. Permission to release *C. pyrula* in Australia was obtained and the insect was first released in north Queensland in October 2004. The ecoclimatic model CLIMEX indicated that coastal Queensland was climatically suitable for this insect but that inland areas were only marginally suitable.

Key words: biological control - Fabales - host specificity - Lepidoptera - Mimosaceae - Noctuidae - prickly acacia

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The phytopathogenic fungus *Verticillium dahliae* Kleb. causes high yield losses in strawberry production. As effective chemical control of this fungus is no longer available, biological control based on natural antagonists might provide new control strategies. The aim of this study was to assess the impact of the two biological control agents *S. plymuthica* HRO-C48 and *Streptomyces* sp. HRO-71 on the rhizosphere community of the *Verticillium* host plant strawberry in field trials at two different sites in Germany. Therefore, we determined the abundances of culturable bacteria and investigated the community structure of the total rhizosphere microbiota by PCR-single strand conformation polymorphism analysis of the 16S rRNA and fungal ITS1 region.

The abundances of culturable rhizobacteria on R2A medium as well as the proportion of *in vitro* *Verticillium* antagonists did not differ significantly. Additionally, no treatment specific differences were obtained in the composition of species of the non-target antagonistic bacteria in the rhizospheres. The culture-independent analysis revealed only transient differences between the bacterial communities not due to the treatments rather than to the plant growth stage. Fungal and bacterial community fingerprints showed the development of a microbiota, specific for a field site. However, no sustainable impact of the bacterial treatments on the indigenous microbial communities was found using culture-dependent and -independent methods.

Key words: biocontrol - rhizosphere - risk assessment - *Serratia* - SSCP - *Streptomyces*

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Postal 02372, Brasília, DF, 70770-900, Brasil. e Bergmann Morais Ribeiro, Email:
bergmann@unb.br). Introduction of the anti-apoptotic baculovirus *p35* gene in passion
fruit induces herbicide tolerance, reduced bacterial lesions, but does not inhibits passion
fruit woodiness disease progress induced by cowpea aphid-borne mosaic virus (CABMV).
Biotechnology Letters, Volume 29(1) (2007): 79-87**

The introduction of anti-apoptotic genes into plants leads to resistance to environmental stress and broad-spectrum disease resistance. The anti-apoptotic gene (*p35*) from a baculovirus was introduced into the genome of passion fruit plants by biobalistics. Eleven regenerated plants showed the presence of the *p35* gene by PCR and/or dot blot hybridization. Transcriptional analysis of regenerated plants showed the presence of specific *p35* transcripts in 9 of them. Regenerated plants containing the *p35* gene were inoculated with the cowpea aphid-borne mosaic virus (CABMV), the bacterium *Xanthomonas axonopodis* pv *passiflorae*, and the herbicide, glufosinate, (Syngenta). None of the plants showed resistance to CABMV. Regenerated plants (*p35*+) showed less than half of local lesions showed by non-transgenic plants when inoculated with *X. axonopodis* and some *p35*+ plants showed increased tolerance to the glufosinate herbicide when compared to non-transgenic plants.

Keywords: Apoptosis - Baculovirus - Herbicide tolerance - *Passiflora* - *p35* gene

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Hueih-Min Chen^a. (^aInstitute of Bioagricultural Sciences, Academia Sinica, Taipei 115,
Taiwan, ROC, ^bGraduate Institute of Chemistry, Chung Yuan Christian University,
Taoyuan 320, Taiwan, ROC). Anti-fungal activity of crude extracts and essential oil of
Moringa oleifera Lam. *Bioresource Technology*, Volume 98(1) (2007): 232-236**

Investigations were carried out to evaluate the therapeutic properties of the seeds and leaves of *Moringa oleifera* Lam as herbal medicines. Ethanol extracts showed anti-fungal activities *in vitro* against dermatophytes such as *Trichophyton rubrum*, *Trichophyton mentagrophytes*, *Epidermophyton floccosum*, and *Microsporum canis*. GC-MS analysis of the chemical composition of the essential oil from leaves showed a total of 44 compounds. Isolated extracts could be of use for the future development of anti-skin disease agents.

Keywords: Anti-fungal activity; Crude extract; Essential oil; *Moringa oleifera*

Pollen Biotechnology

Ya-Qin Hu, Zhong-Li Zhang, Subir Bera, David K. Ferguson, Cheng-Sen Li, Wen-Bin Shao and Yu-Fei Wang. What can pollen grains from the Terracotta Army tell us? *Journal of Archaeological Science*, Volume 34(7) (2007): 1153-1157.

The provenance of more than 2200-year-old terracotta warriors and horses in the Qin Shihuang Mausoleum is still a mystery, even though some researchers have inferred that the terracotta figures were produced near the mausoleum. The sporomorphs (pollen and spores) extracted from terracotta fragments of a warrior and a horse and compared with those obtained from soil samples from the Qin Dynasty layer in Pit No. 2 of the Qin Shihuang Mausoleum indicate that the pollen spectrum from the terracotta horse is different from that of the warrior, but similar to the local soil samples. Herbaceous pollen was dominant in the warrior sample, while arboreal pollen predominates in the horse and soil samples. Palynological evidence suggests that the terracotta horses were produced at a locality near the mausoleum, while the warrior came from a site which was further afield.

Graciela Gil-Romera, Louis Scott, Eugène Marais and George A. Brook. Late Holocene environmental change in the northwestern Namib Desert margin: New fossil pollen evidence from hyrax middens. *Palaeogeography, Palaeoclimatology, Palaeoecology*, Volume 249(1-2) (2007): 1-17.

The lack of anoxic environments in arid lands makes well-preserved fossil pollen difficult to find. The scarcity of continental palaeobotanical data in tropical arid zones restricts the understanding of aridification processes in these endangered ecosystems. It is essential to improve the knowledge about their environmental histories during the Holocene, and therefore we attempt to investigate the causes and describe the patterns of vegetation change in northern Namibia. With that aim we analyzed pollen from fossil hyrax dung that accumulated over long periods of time by sampling stratigraphically coherent sequences in five radiocarbon-dated middens. The fossil hyrax middens were found in rock shelters on the eastern desert edge in the northwestern Kaokoveld, within the so-called Nama-Karoo biome. This is an ecotonal area between the Namib Desert and the Savanna biomes which reflects features from both systems and its life form composition largely depends on an erratic rainfall pattern. Thirty-three samples were analyzed for pollen and the pollen record reflects a non-continuous vegetation history over the last 5200 yr with a hiatus between ca. 4200 and 1690 yr BP. The pollen spectra reflect arid savanna vegetation with a marked increase in the tree/grass ratio from ca. 1300 cal yr BP. The most likely cause for this change is a decline in moisture that we relate to intrinsic savanna dynamics, with early pastoralism, megaherbivore migration and changes in the hyrax diet playing a minor role.

Raymond W. Arritt, Craig A. Clark, A. Susana Goggi, Higinio Lopez Sanchez, Mark E. Westgate and Jenny M. Riese. Lagrangian numerical simulations of canopy air flow effects on maize pollen dispersal. *Field Crops Research*, Volume 102(2) (2007): 151-162.

A three-dimensional Lagrangian random flight model was constructed for numerical simulations of maize pollen dispersion. The model simulates the paths of tracer particles which are interpreted as individual pollen grains, with particle motion determined by the mean flow and a stochastic turbulent velocity. The Lagrangian approach was chosen because it can be extended to

complex flow regimes. The capacity of the model to simulate measured patterns of pollen deposition was tested by comparing simulations to measurements for a small maize canopy isolated within a large field of soybeans near Ames, Iowa, USA in August 2003. For this application, measurements from a single point meteorological observation were used to generate a surface layer wind profile over the maize canopy and surrounding soybean field. The method used to construct the wind field included development of internal boundary layers as the airflow passed from one canopy surface to another. The dispersion model produced spatial patterns of particle deposition that included the sharp near-source deposition gradient consistent with observations. The model tended to over-predict particle deposition near the source field and under-predict deposition at greater distances. Inclusion of the effect of the roughness difference between the maize canopy and the surrounding soybean canopy on the flow field was found to be essential for simulation accuracy. Agreement with observations improved considerably by including an approximation for vertical motions induced by changes in surface cover. These results indicate that the Lagrangian random flight model provides a realistic simulation of pollen dispersal from an isolated maize canopy. A more complete hydrodynamic model should be explored to better represent the influence of surface inhomogeneities on winds and turbulence.

Kyung W. Kim. Physico-chemical characteristics of visibility impairment by airborne pollen in an urban area. *Atmospheric Environment*, Volume 41(17) (2007): 3565-3576.

The number of airborne pollen produced from plants is visible as a haze mixed with urban air pollution in an urban area when atmospheric conditions are proper for pollination of pollen from April to May in Korea. The big loading of airborne pollen can cause further visibility degradation in an urban area. In order to investigate physico-chemical characteristics of visibility impairment by airborne pollen, chemical aerosol measurements, optical aerosol monitoring, and scenic monitoring were performed during the intensive monitoring period from April 19 to May 2, 2005 in the urban area of Seoul, Korea. The particles collected on filters were examined with a scanning electron microscope (SEM) interfaced with an energy dispersive X-ray analysis to characterize size, elemental composition, and count of airborne pollen. During the airborne pollen period, the daily averaged number concentrations of airborne pollen; $P_{PM_{2.5}}$ and $P_{PM_{10}}$ were calculated to be 8.4 ± 6.9 and $113.7 \pm 91.1 \text{ m}^{-3}$, respectively. The daily averaged light extinction coefficient (b_{ext}), light scattering coefficient for open path (b_{scat}), light scattering coefficient for dry particle in the fine regime ($b_{\text{scat, fine}}$), and light absorption coefficient in the fine regime ($b_{\text{abs, fine}}$) were measured to be 459 ± 267 , 357 ± 214 , 263 ± 165 , and $44 \pm 30 \text{ Mm}^{-1}$, respectively. And mass concentration of $PM_{2.5}$ and PM_{10} were measured to be 46.5 ± 29.1 and $97.0 \pm 41.7 \text{ } \mu\text{g m}^{-3}$. The average light absorption coefficient by airborne pollen was estimated to be about 30 M m^{-1} and the average light scattering coefficient by airborne pollen was estimated to be $67 \pm 57 \text{ Mm}^{-1}$. During the airborne pollen period the average contribution of airborne pollen to visibility impairment was roughly estimated to be 19–25%.

Lingyun Zhang, Huaiqing Hao, Qinli Wang, Kefeng Fang, Zhixia Hou and Jinxing Lin. The localization of Rac GTPase in *Picea willsonii* pollen tubes implies roles in tube growth and the movement of the tube nucleus and sperm cells. *Plant Science*, Volume 172(6) (2007): 1210-1217.

The Rac/Rop small GTPases are central regulators of important cellular processes in plants. But their roles in pollen and pollen tube development in plants are still not well understood, especially in gymnosperms. In the present paper, a 23-kDa polypeptide was detected in pollen tube plasma membrane and cytosolic fractions in *Picea willsonii* pollen tubes using the antisera

against the NtRac1 protein and Arabidopsis Rops. The Rac1 protein appears to be associated with the plasma membrane based on detergent experiments. Subcellular localization using indirect immunofluorescence and confocal microscopy showed that the detected Rac1 is concentrated in the cortical region of the tube apex, especially in the growing fast tubes, and that little is present in arrested tubes. Interestingly, a Rac/Rop protein was observed in the tube nucleus and sperm cells of *P. willsonii* pollen tubes, and almost little exist while these cells inside pollen grains. These results suggest that Rac/Rop GTPases are involved in the signaling mechanism that controls pollen tube growth and might point to a potential function in signaling to the migration of the tube nucleus and sperm cells in pollen tubes in *P. willsonii*.

K. Bińska, R. Stachowicz-Rybka, H. Winter and J. Nitychoruk. Microevolutionary trends in fossil *Oenanthe* pollen and mericarps (subgenus *Phellandrium*) evidenced by material from selected Pleistocene sites in Poland. Review of Palaeobotany and Palynology, Volume 145(1-2) (2007):25-34.

Mericarps and pollen grains collected in the Pleistocene lacustrine deposits in Poland were analyzed. Well-developed mericarps, resembling recent fruits of water dropwort *Oenanthe* (*Phellandrium* subgenus), are found since the Eemian. Mericarps found in the Pliocene and in the Augustovian Interglacial (= Bavelian Complex or Cromerian I), in the Mazovian Interglacial (= Holsteinian interglacial) and in one of the interstadials after this interglacial are a distinct morphological type. They differ from recent mericarps of *Oenanthe aquatica* in shape and size. As late as the Vistulian, pollen grains are decidedly smaller and in parts with different microsculpture than recent reference material of pollen of *O. aquatica*. Probably, changes of vegetation in the late Pleistocene and in the Holocene could have induced changes in the composition of the pollinator assemblages, and as a consequence increase in size of pollen. Compared to mericarp evolution, the evolution of pollen of *O. aquatica* is somewhat delayed.

Annie Vincens, Anne-Marie Lézine, Guillaume Buchet, Dorothée Lewden and Annick Le Thomas. African pollen database inventory of tree and shrub pollen types. Review of Palaeobotany and Palynology, Volume 145(1-2) (2007): 135-141.

African pollen data have been used in many empirical or quantitative palaeoenvironmental reconstructions. However, the pollen types used in these studies were not controlled and standardised, preventing the precise understanding of pollen–plant and pollen–climate relation that is necessary for the accurate quantification of continental scale climate change or ecological processes in the past. This paper presents a summary of the progress made with the African Pollen Database (APD) inventory of plant diversity from pollen data extracted from 276 fossil sites and more than 1500 modern samples, with a focus on tropical tree pollen types. This inventory (1145 taxa) gives, for each pollen taxon whose nomenclature is discussed, information on the habit, habitat and phytogeographical distribution of the plants they come from. Special attention has been paid to pollen types with similar morphology, which include several plant species or genera, whose biological or environmental parameters can differ considerably.

Ya Tang, Jia-Sui Xie and Hui Sun. The pollination ecology of *Pedicularis rex* subsp. *lipkyana* and *P. rex* subsp. *rex* (Orobanchaceae) from Sichuan, southwestern China. Flora - Morphology, Distribution, Functional Ecology of Plants, Volume 202(3) (2007): 209-217.

Pedicularis is one of few genera for which pollination ecology has been studied extensively. Although over half of the species of *Pedicularis* are found in the mountains of southwestern

China, pollination ecology has been studied there on a few species only. The present paper reports pollination ecology of *Pedicularis rex* subsp. *lipskyana* and *P. rex* subsp. *rex* from Sichuan, southwestern China. The two subspecies are nectariferous, with sugar content 28% in *P. rex lipskyana* and 22% in *P. rex*, respectively. The flowers of the two subspecies are adapted to pollination by bumblebee workers. Bumblebees are the primary and effective pollinators although honeybees were also observed pollinating *P. rex* subsp. *lipskyana* at one studied population. Usually bumblebees entered the corolla tube from the right side in an upright or a nearly half-inverted position to imbibe nectar located at the base of the corolla tube. The stigma usually contacts the side region of the thorax and abdomen or occasionally directly contacted pollen loads, leading to pollination of flowers. Much less commonly, bumblebees foraged on flowers of *P. rex* subsp. *rex* in an inverted position for pollen, which pollinated flowers sternotribically. We suggest that pollination mechanism is closely associated with floral morphology. Some important differences were found from a previous study on *P. rex* in floral morphology and the primary pollination mechanism.

Fuli Wu, Xiaomin Fang, Yuzhen Ma, Mark Herrmann, Volker Mosbrugger, Zhisheng An and Yunfa Miao. Plio–Quaternary stepwise drying of Asia: Evidence from a 3-Ma pollen record from the Chinese Loess Plateau. *Earth and Planetary Science Letters*, Volume 257(1-2) (2007): 160-169

A 3-Ma pollen record was obtained from a continuous red clay–loess–paleosol sequence at Chaona in the central Chinese Loess Plateau (CLP). The record shows a permanent change of a domination of typical Cupressaceae forest vegetation representative of an ecological environment with a relative warm and humid climate during 3.0–2.6 Ma to largely steppe vegetation under dry climate conditions after 2.6 Ma. The later is further manifested itself as steppe to forest or forest–steppe (spruce forest — mostly mesophilous herbs) between 2.6 Ma and 1.5 Ma, forest–steppe (pine–grass) between 1.5 Ma and 0.95 Ma, open forest–steppe (mesophilous and xeromorphic herbs–pine) between 0.95 Ma and 0.5 Ma, and steppe (xeromorphic herbs) after 0.5 Ma, suggesting a process of stepwise aridification in Central Asia at the late Pliocene and the Quaternary.

José Luis Aznarte M., José Manuel Benítez Sánchez, Diego Nieto Lugilde, Concepción de Linares Fernández, Consuelo Díaz de la Guardia and Francisca Alba Sánchez. Forecasting airborne pollen concentration time series with neural and neuro-fuzzy models. *Expert Systems with Applications*, Volume 32(4) (2007): 1218-1225.

Forecasting airborne pollen concentrations is one of the most studied topics in aerobiology, due to its crucial application to allergology. The most used tools for this problem are single lineal regressions and autoregressive models (ARIMA). Notwithstanding, few works have used more sophisticated tools based in Artificial Intelligence, as are neural or neuro-fuzzy models. In this work, we applied some of these models to forecast olive pollen concentrations in the atmosphere of Granada (Spain). We first studied the overall performance of the selected models, then considering the data segmented into intervals (low, medium and high concentration), to test how they behave on each interval. Experimental results show an advantage of the neuro-fuzzy models against classical statistical methods, although there is still room for improvement.¹

Andrei A. Andreev, Roberto Pierau, Ivan A. Kalugin, Andrei V. Daryin, Lyubov G. Smolyaninova and Bernhard Diekmann. Environmental changes in the northern Altai

during the last millennium documented in Lake Teletskoye pollen record. *Quaternary Research*, Volume 67(3) (2007): 394-399.

A high-resolution pollen record from Lake Teletskoye documents the climate-related vegetation history of the northern Altai Mountain region during the last millennium. Siberian pine taiga with Scots pine, fir, spruce, and birch dominated the vegetation between ca. AD 1050 and 1100. The climate was similar to modern. In the beginning of the 12th century, birch and shrub alder increased. Lowered pollen concentrations and simultaneous peaks in herbs (especially *Artemisia* and *Poaceae*), ferns, and charcoal fragments point to colder and more arid climate conditions than before, with frequent fire events. Around AD 1200, regional climate became warmer and more humid than present, as revealed by an increase of Siberian pine and decreases of dry herb taxa and charcoal contents. Climatic conditions were rather stable until ca. AD 1410. An increase of *Artemisia* pollen may reflect slightly drier climate conditions between AD 1410 and 1560. Increases in *Alnus*, *Betula*, *Artemisia*, and *Chenopodiaceae* pollen and in charcoal particle contents may reflect further deterioration of climate conditions between AD 1560 and 1810, consistent with the Little Ice Age. After AD 1850 the vegetation gradually approached the modern one, in conjunction with ongoing climate warming.

Biotechnology Policy Issue

Jeannette A. Colyvas. From divergent meanings to common practices: The early institutionalization of technology transfer in the life sciences at Stanford University. *Research Policy*, Volume 36(4) (2007): 456-476.

The formation of Stanford University's technology transfer program in the life sciences is analyzed from 1968 to 1982. The program evolved from multiple models based on divergent definitions of invention, inventor, rewards, and university–industry boundaries. The eventual program that emerged proved to be widely emulated. The norms of the academy shaped the uses of resources and the conditions of their appropriation. In turn, the currency of industrial science prompted the rethinking of academic norms. The analysis offers insight into the early stages of institutionalization, as the ambiguity of important categories and flexibility of policies were transformed into organizational routines. Today's ‘settled’ outcomes are the product of highly divergent practices.

Peter Mc Namara and Charles Baden-Fuller. Shareholder returns and the exploration–exploitation dilemma: R&D announcements by biotechnology firms. *Research Policy*, Volume 36(4) (2007): 548-565.

We explore a financial returns dimension of the exploration–exploitation dilemma. Using 1277 R&D announcements by 178 listed bio-pharmaceutical firms, we examine whether investors are myopic along the continuum of exploration (patenting and preclinical trials) to exploitation (human clinical trials and NDA). We find that investors respond positively at every stage, but there are differences between small and large firms. For small firms exploration is favored, provided it is focused. For large firms, there is value in both exploration and exploitation. Projects which are part of an alliance are no more likely to generate abnormal returns. Policy implications are discussed.

Michael M. Hopkins, Paul A. Martin, Paul Nightingale, Alison Kraft and Surya Mahdi. The myth of the biotech revolution: An assessment of technological, clinical and organisational change. *Research Policy*, Volume 36(4) (2007): 566-589

This paper argues that despite being widely promoted by academics and consultants, the empirical evidence does not support the existence of a biotech revolution. Nor does the data support the widely held expectations that biotechnology is having a revolutionary impact on healthcare or economic development. The revolutionary model is therefore a misleading basis for policy making as it over-estimates the speed and extent of any changes in productivity or the quality of therapeutics. Instead, the evidence suggests biotechnology is following a well-established incremental pattern of technological change and 'creative accumulation' that builds upon, rather than disrupts, previous drug development heuristics.

David J. Spielman. Pro-poor agricultural biotechnology: Can the international research system deliver the goods? *Food Policy*, Volume 32(2) (2007): 189-204

While global investment in agricultural research by the private sector is increasing with growth in developing country markets and the emergence of new technologies, complementary public sector investment is stagnating or declining in many developing countries. This review argues that the changing roles of the public and private sectors in generating new scientific knowledge may adversely affect the diffusion of explicitly pro-poor technologies—technologies that are simultaneously yield-enhancing and poverty-reducing. Comparing historical evidence from the Green Revolution with recent evidence from the emerging era of agricultural biotechnology, this review argues that a more pluralistic international system for agricultural research will be more responsive to poverty only if the strategic leadership role of the public sector is strengthened, certain research functions are reallocated to the private sector, and new policy and organizational mechanisms are used to stimulate pro-poor research in and for developing-country agriculture.

Claudio Jommi and Silvia Paruzzolo. Public administration and R&D localisation by pharmaceutical and biotech companies: A theoretical framework and the Italian case-study. *Health Policy*, Volume 81(1) (2007): 117-130.

This article has two objectives. It firstly provides a general framework for variables that influence R&D (Research and Development) localisation by pharmaceutical and biotech companies. The analysis of R&D localization includes both in-house R&D and contracted R&D. Following a systematic literature search, these variables were classified into four distinct categories: regulatory environment, institutional framework, national systems of innovation and local development and specialisation. The authors highlight that some of these factors directly depend on the action of public administrations (e.g., patent protection, price regulation, public investments in research, and incentives to private companies); others are indirectly influenced by public policies (e.g., GDP growth rate, infrastructures). This theoretical framework was used to analyse the Italian case-study. Pros and cons of the Italian context were investigated from the point of view of multinational pharmaceutical companies and the Italian Association of Biotech Companies. Interviews were chosen as the most appropriate data gathering technique given the exploratory nature of the study of the Italian context.

The paper is divided into five parts. A brief introduction provides figures showing that Europe has been losing positions compared with other Continents and the same has occurred in Italy compared with other EU countries. The second one illustrates the methodology. The third one is

focused on variables affecting R&D localisation. In the fourth section the Italian case-study is discussed. Theoretical and empirical findings are summarised and discussed in the conclusions.

Henry I. Miller. Biotech's defining moments, Trends in Biotechnology, Volume 25(2) (2007): 56-59.

Confusion about terms related to biotechnology – genetic modification, GMOs, genetic engineering, transgenic, and all the rest – has been around for decades. This definitional dysfunction has created myriad opportunities for mischief and given rise to widespread over-regulation, diminished agricultural R&D, ill-advised conferences and risk assessment studies, flawed analyses (including a recent tome from the OECD), fear-mongering by NGOs, and a perplexed public. Greater precision in terminology would improve the lot of scientists, the quality of public policy and, eventually, human and environmental health.

H.P.S. Kochhar and B.R. Evans. Current status of regulating biotechnology-derived animals in Canada—animal health and food safety considerations. Theriogenology, Volume 67(1) (2007): 188-197.

Development of an effective regulatory system for genetically engineered animals and their products has been the subject of increasing discussion among researchers, industry and policy developers, as well as the public. Since transgenesis and cloning are relatively new scientific techniques, transgenic animals are ‘novel’ organisms for which there is limited information. The issues associated with the regulation of transgenic animals pertain to environmental impact, human food safety, animal health and welfare, trade and ethics. It is a challenge for the developers to prove the safety of the products of biotechnology-derived animals and also for regulators to regulate this increasingly powerful technology with limited background information. In principle, an effective regulatory sieve should permit safe products while forming a formidable barrier for those posing an unacceptable risk. Regulatory initiatives for biotechnology-derived animals and their products should be able to ensure high standards for human and animal health, a sound scientific basis for evaluation; transparency and public involvement, and maintenance of genetic diversity. This review proposes a regulatory regime that is based on scientific risk based assessment and approval of products or by-products of biotechnology-derived animals and its application in context to Canadian regulations.

Agricultural Biotechnology

Monika Walter, Christopher Miles Frampton, Kirsty Sarah Helen Boyd-Wilson, Patricia Harris-Virgin, and Nicholas William Waipara. Agrichemical impact on growth and survival of non-target apple phyllosphere microorganisms. Can. J. Microbiol. 53(1)(2007): 45–55

The impact of conventional agrichemicals commonly used in New Zealand apple production on non-target, culturable phyllosphere microbial populations was studied in the laboratory (agar, leaf, and seedling assays) and field (apple orchard). Morphologically distinct bacteria (three), yeasts (five), and filamentous microfungi (two) were used as indicator species. The agar assay showed that agrichemical toxicity to microorganisms was dependent on product type, product rate, and organism studied. While the fungicides metiram and captan stopped or severely reduced growth of nearly all microorganisms studied, the insecticides tebufenozide and

lufenuron and the fungicide nitrothal-isopropyl showed the least amount of microbial toxicity, each affecting 2 of the 10 indicator organisms studied. In the leaf assay a single agrichemical application at field rate either reduced or increased microbial population counts, again depending on product and microorganism. Repeated agrichemical applications, however, reduced microbial population numbers from 10- to 10 000-fold in planta. Further field research validated these findings, although differences in microbial numbers before and after agrichemical applications were less dramatic. In the orchard, total organism numbers recovered within 2–6 days, but species richness (sum of recognizable taxonomic units) declined. Agrichemicals clearly affected non-target, culturable surface microorganisms. The importance of diversity and stability of microbial populations for disease control still needs to be established.

Key words: apple, microbial abundance, microbial richness, 6-benzyladenine, buprofezin, captan, cyprodinil, difenoconazole, dithianon, dodine, kresoxim-methyl, lufenuron, metiram, myclobutanil, nitrothal-isopropyl, tebufenozide, triadimefon.

David J. Spielman. Pro-poor agricultural biotechnology: Can the international research system deliver the goods? *Food Policy*, Volume 32(2) (2007): 189-204

While global investment in agricultural research by the private sector is increasing with growth in developing country markets and the emergence of new technologies, complementary public sector investment is stagnating or declining in many developing countries. This review argues that the changing roles of the public and private sectors in generating new scientific knowledge may adversely affect the diffusion of explicitly pro-poor technologies—technologies that are simultaneously yield-enhancing and poverty-reducing. Comparing historical evidence from the Green Revolution with recent evidence from the emerging era of agricultural biotechnology, this review argues that a more pluralistic international system for agricultural research will be more responsive to poverty only if the strategic leadership role of the public sector is strengthened, certain research functions are reallocated to the private sector, and new policy and organizational mechanisms are used to stimulate pro-poor research in and for developing-country agriculture.

Annik Dollacker and Claire Rhodes. Integrating crop productivity and biodiversity conservation pilot initiatives developed by Bayer CropScience. *Crop Protection*, Volume 26(3) (2007): 408-416

Wildlife habitat loss driven by human activities, including conversion of land to agriculture, represents a major threat to biodiversity. Agricultural technologies, for example, irrigation, mechanization, enhanced seeds, crop protection and nutrition products contribute to productivity increases on land already cultivated and, therefore, play a role in preventing further land conversion to agriculture. However, such technologies must be adapted and employed within the context of locally appropriate land management strategies that take an integrated approach to achieving agricultural production, rural livelihoods and biodiversity conservation goals.

This paper was developed for presentation at a workshop on ‘Conservation Technologies for Sustainable Agriculture’, held during the 4th International Weed Society Congress, [4th International Weed Society Congress, Durban, South Africa, 19–25 June 2004. <http://www.olemiss.edu/orgs/iws/4intlweedcong.htm>]. It highlights the potential roles a plant science company can play in addressing the challenge of jointly achieving crop productivity and biodiversity conservation objectives. These relate to activities that integrate biodiversity conservation objectives into technology research and development (R&D) of crop

protection products and into land management approaches. Three pilot initiatives developed by Bayer CropScience in Brazil, Guatemala and the UK in collaboration with a variety of local stakeholders illustrate how conservation objectives can be embedded in land management practices that sustainably enhance agricultural productivity and profitability, simultaneously addressing food security and biodiversity conservation challenges.

Bayer CropScience, a subsidiary of Bayer AG, is a market leader in the areas of crop protection, non-agricultural pest control, seeds and plant biotechnology. The company has a global workforce of about 19,000 and is represented in more than 120 countries.

Bioenergy

Shishir P.S. Chundawat^{*}, Balan Venkatesh, Bruce E. Dale. (*Correspondence to Shishir P.S. Chundawat, Biomass Conversion Research Lab (BCRL), Department of Chemical Engineering and Materials Science, Michigan State University, East Lansing, Michigan 48824; telephone: 516-353-6777; fax: 517-432-1105, email: Shishir P.S. Chundawat (chundawa@msu.edu)). Effect of particle size based separation of milled corn stover on AFEX pretreatment and enzymatic digestibility. *Biotechnology and Bioengineering*, Volume 96(2)(2007): 219 - 231

Particle size and compositional variance are found to have a substantial influence on ammonia fiber explosion (AFEX) pretreatment and enzymatic hydrolysis of lignocellulosic biomass. Corn stover was milled and fractionated into particle sizes of varying composition. The larger particle size fractions (rich in corn cob and stalk portions) were found to be more recalcitrant to hydrolysis compared to the smaller size fractions (rich in leaves and husk portion). Electron spectroscopy for chemical analysis (ESCA) and Fourier transform infrared spectroscopy (FTIR) were used for biomass surface and bulk compositional analysis, respectively. The ESCA results showed a 15-30% decrease in the O/C (oxygen to carbon) ratio after the pretreatment indicating an increase in the hydrophobic nature of biomass surface. FTIR results confirmed cleavage of the lignin-carbohydrate complex (LCC) for the AFEX-treated fractions. The spectroscopic results indicate the extraction of cleaved lignin phenolic fragments and other cell wall extractives to the biomass surface upon AFEX. Water washing of AFEX-treated fractions removed some of the hydrophobic extractives resulting in a 13% weight loss (dry weight basis). Phenolic content of wash stream was evaluated by the modified Prussian blue (MPB) method. Removal of ligno-phenolic extractives from the AFEX-treated biomass by water washing vastly improved the glucan conversion as compared to the unwashed samples. Reduction in substrate particle size was found to affect the AFEX process and rate of hydrolysis as well. Implications of the stover particle size, composition, and inhibitory role of the phenolic fragments on an integrated biorefinery are discussed.

Keywords: enzymatic hydrolysis • AFEX pretreatment • corn stover • lignin phenolic

• ESCA • FTIR • Prussian blue • biorefinery

L.E. Macaskie^{*}, N.J. Creamer, A.M.M. Essa, N.L. Brown. (*Correspondence to L.E. Macaskie, School of Biosciences, The University of Birmingham, Edgbaston, Birmingham B15 2TT, UK; telephone: (44)1214145889; fax: (44)1214145925 email: L.E. Macaskie (l.e.macaskie@bham.ac.uk). A new approach for the recovery of precious metals from solution and from leachates derived from electronic scrap. *Biotechnology and Bioengineering*, Volume 96(4)(2007): 631 – 639

A new approach is described for the recovery of precious metals (PMs: Au, Pd and Ag) with >99% efficiency from aqueous solution utilising biogas produced during the aerobic growth of *Klebsiella pneumoniae*. Gold was recovered from electronic scrap leachate (~95%) by this method, with some selectivity against Cu. The recovered PM solids all contained metal and sulphur as determined by energy dispersive X-ray microanalysis (EDX). X-ray powder diffraction analysis (XRD) showed no crystalline metal sulphur compounds but a crystalline palladium amine was recorded. Silver was recovered as a sulphide (found by EDX), carbonate and oxide (found by XRD). EDX analysis of the Au-precipitate showed mainly gold and sulphur, with some metallic Au(0) detected by XRD. The gold compound was shock-sensitive; upon grinding it detonated to leave a sooty black deposit.

Keywords: *Klebsiella pneumoniae* • gold recovery • palladium recovery • silver recovery • biogas

C. Dayananda^a, R. Sarada^a, M. Usha Rani^b, T.R. Shamala^b and G.A. Ravishankar^a. (^aPlant Cell Biotechnology Department, Central Food Technological Research Institute, Mysore 570 020, India, ^bFood Microbiology Department, Central Food Technological Research Institute, Mysore 570 020, India). Autotrophic cultivation of *Botryococcus braunii* for the production of hydrocarbons and exopolysaccharides in various media. *Biomass and Bioenergy*, Volume 31(1)(2007): 87-93

Growth of *Botryococcus braunii* was studied using different autotrophic media such as bold basal medium (BBM), and bold basal with ammonium carbonate (BBMa), BG11, modified Chu 13 medium. Among the different autotrophic media used, BG11 was found to be the best medium for biomass and hydrocarbon production, although *B. braunii* showed appreciable level of growth and biomass production in all the tested media. The culture maintained at 16:8 h light and dark cycle with 1.2 ± 0.2 klux light intensity at 25 ± 1 °C temperature was found to be the best for growth (2.0 and 2.8 g L⁻¹ of biomass was produced by the *B. braunii* strains SAG 30.81 and LB-572, respectively) and hydrocarbon production (46% and 33%, respectively, by SAG 30.81 and LB 572 strains on dry weight basis) whereas continuous illumination with agitation at 90 rpm had maximum influence for the production of exopolysaccharides. The results of the present study indicate that the organism can acclimatize to different culture conditions and to a wide range of culture media with production of more than one metabolite.

Keywords: *Botryococcus braunii*; Microalgae; Autotrophic media; Hydrocarbon; Biomass; Exopolysaccharide

YuHong Qin^a, HaiFeng Huang^a, ZhiBin Wu^a, Jie Feng^a, Wenying Li^a and KeChang Xie^a. (^aKey Laboratory of Coal Science and Technology of Shanxi Province and Ministry of Education, Taiyuan University of Technology, No. 79, Yingze West Street, Shanxi 030024, PR China. *Corresponding author. Tel./fax: +86 351 601 8453). **Characterization of tar from sawdust gasified in the pressurized fluidized bed. Biomass and Bioenergy, Volume 31(4)(2007): 243-249**

The paper investigated the features of tar releasing from sawdust gasification in a new designed pressurized fluidized bed. Gel permeation chromatography (GPC) was used to determine the average molecular weight and the molecular weight distribution of sawdust gasified tar, also a photodiode array (PDA) detector was used in parallel to analyze the Ultraviolet (UV) spectra from 210 to 380 nm. At the pressure of 0.5–2.0 MPa and 800 °C, tar had the similar molecular weight distribution and the average molecular weight, the UV spectra absorbed at 254 nm revealed tar of sawdust air gasification at different pressures had aromatic character which increased with the increment of the pressure. By increasing the temperature from 700 to 900 °C, the relative amount of different molecular weight distribution fractions showed that tar contained higher fractions of small molecular weight components. It so gave an indication that tar progressively broke down with the increment of temperature under gasification conditions. The results from the UV absorbed in 254 nm showed a similar aromatic characteristic between 700 and 900 °C, which expressed the presence of larger polynuclear aromatic ring systems, unsaturated conjugated long chain alkyl, heterocyclic structures and alkyl of heteroatom substitutions.

Keywords: Tar; Sawdust air gasification; Gel permeation chromatography; Ultraviolet spectra

Mao-Lin Zhang^a, Yao-Ting Fan^a, Yan Xing^a, Chun-Mei Pan^a, Gao-Sheng Zhang^a and Jiunn-Jyi Lay^b. (^aDepartment of Chemistry, Zhengzhou University, Zhengzhou 450052, PR China, ^bDepartment of Safety, Health, and Environmental Engineering, National Kaohsiung First University of Science and Technology, Kaohsiung, Taiwan, ROC. Corresponding authors. Tel./fax: +86 371 67766017; +886 7 6011000x2303). **Enhanced biohydrogen production from cornstalk wastes with acidification pretreatment by mixed anaerobic cultures. Biomass and Bioenergy, Volume 31(4) (2007): 250-254**

Biohydrogen production from the cornstalk wastes with acidification pretreatment was reported in this paper. Batch tests were carried out to analyze influences of several environmental factors on biohydrogen production from cornstalk wastes. Two predominant bacterial morphologies, namely *spore-forming* rod shape bacteria and micrococcus were screened, purified, and identified after enriched from a hydrogen-producing fermentor with cow dung composts. The maximum cumulative H₂ yield of 149.69 ml H₂ g⁻¹ TVS was obtained at initial pH 7.0 and substrate concentration 15 g l⁻¹, the value is about 46-fold as compared with that of raw cornstalk wastes. The maximum hydrogen production rate was 7.6 ml H₂ h⁻¹. The hydrogen concentration in biogas was 45–56% (v/v) and there was no significant methane observed in the biogas throughout this study. In addition, biodegradation characteristics of the substrate by microorganisms were also discussed. During the conversion of cornstalk wastes into hydrogen, the acetate, propionate, butyrate, and the ethanol were main by-products in the metabolism of hydrogen fermentation. The test results showed that the acidification pretreatment of the substrate plays a crucial role in conversion of the cornstalk wastes into biohydrogen gas by the cow dung composts generating hydrogen.

Keywords: Biohydrogen production; Acid pretreatment; Alkali pretreatment; Cornstalk; Mixed culture

N. Martínez-Pérez^a, S.J. Cherryman^b G.C. Premier^a, R.M. Dinsdale^b, D.L. Hawkes^b, F.R. Hawkes^b, G. Kyazze^b and A.J. Guwy^b. (^aSchool of Technology, Hydrogen Research Unit, University of Glamorgan, Pontypridd CF37 1DL, UK, ^bSchool of Applied Sciences, Hydrogen Research Unit, University of Glamorgan, Pontypridd CF37 1DL, UK). **The potential for hydrogen-enriched biogas production from crops: Scenarios in the UK. Biomass and Bioenergy, Volume 31(2-3) (2007): 95-104**

There is increasing international interest in developing low carbon technologies to provide hydrogen renewably. Hydrogen can be produced through dark anaerobic fermentation using carbohydrate-rich substrates, and methane can be produced in a methanogenic second stage. The suitability of a range of crops for hydrogen and methane production in the UK is examined, using selection criteria including yield, harvest window and composition of the crops. The annual potential for hydrogen and methane production is calculated using the selected crops, taking into account the energy required to grow and harvest the biomass and run the process. The fermentable energy crops fodder beet, forage maize, sugar beet and rye grass were identified as the most suitable substrates for this farm-scale process. A conservative estimate of the amount of agricultural land in the UK excluding permanent grassland not already used for food production or energy crops (currently unused “set-aside” land) has been made (294,960 ha). If this was used to grow a rotation of the selected crops, 9.6 TW h net energy could be produced per year. This equates to electrical power for 2.2 million homes in the UK annually and a reduction of CO₂ emissions by over 2.3 million tones per annum in the UK.

Keywords: Sustainable hydrogen production; Fermentation; Biomass; Energy crop

Brian L. Polagye^a, Kevin T. Hodgson^b and Philip C. Malte^a. (^aDepartment of Mechanical Engineering, University of Washington, Box 352600, Seattle, WA, USA, ^bCollege of Forest Resources, University of Washington, Box 352100, Seattle, WA, USA. **Corresponding author. Mobile: +1 206 909 1771; fax: +1 206 685 8047).** **An economic analysis of bio-energy options using thinnings from overstocked forests. Biomass and Bioenergy, Volume 31(2-3) (2007): 105-125**

The economic feasibility of producing bio-fuels and ultimately bio-energy by utilizing thinnings from overstocked forests is examined. Large areas of forest in the western US are severely overstocked with small diameter trees, and as such, pose extreme risk for catastrophic wildfires. Physical removal of such small diameter trees, or forest “thinning,” is the best solution to the wildfire problem, and represents a potential raw material for the production of bio-fuels. Production of (1) wood pellets, (2) bio-oil, and (3) methanol all represent potential conversion pathways which would utilize unmerchantable forest thinnings as the feedstock. Wood can also be directly combusted, either in conjunction with another fuel such as coal or on its own to generate steam and electricity. This study examines the potential for accomplishing both forest wildfire reduction and the generation of energy using a single integrated pathway. The economic effects of thinning scale, thinning duration, and distance to end-use markets are quantified. Co-firing of thinnings with coal is currently found to be the most viable option for transportation distances of less than 500 km. Beyond 300 km transportation distance, pelletization, fast pyrolysis, and methanol synthesis become increasingly cost competitive for different ranges of thinning yield and duration. Bio-energy options are economically preferable to landfill or open

burning disposal of thinned biomass; however, revenue from bio-fuels will not cover the cost of thinning. Results for a range of thinning scenarios are visualized using technology maps.

Keywords: Bio-energy; Forest thinning; Pelletization; Fast pyrolysis; Methanol

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Yeast-based biomass, immobilised in polyvinyl alcohol (PVA) cryogels, was used as a biosorbant material for the recovery of platinum (PtCl_6^{2-}) from aqueous solutions. The resulting biomass-Pt matrices were then employed directly as an electro-catalytic anode in a fuel cell configuration to generate electrical energy from renewable sources such as glucose and ethanol. We suggest an integrated strategy incorporating the derivation of a high-value product from a bioremediative process with a view towards producing energy from renewable fuels such as glucose and ethanol.

Keywords: Biomass - Biosorption - Energy - Fuel-cell - Platinum

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The transesterification reactions of triolein with ethanol using various ion-exchange resin catalysts were conducted to produce ethyl oleate as a biodiesel. The anion-exchange resins exhibited much higher catalytic activities than the cation-exchange resin. The anion-exchange resin with a lower cross-linking density and a smaller particle size gave a high reaction rate as well as a high conversion. By combining the three-step regeneration method, the resin could be repeatedly used for the batch transesterification without any loss in the catalytic activity. A continuous transesterification reaction was carried out using an expanded bed reactor packed with the most active resin. The reactor system permitted the continuous production of ethyl oleate with a high conversion.

Keywords: Biodiesel; Continuous production; Expanded bed reactor; Ion-exchange resin; Transesterification

M.A. Dubé^a, A.Y. Tremblay^a and J. Liu^a .(^aDepartment of Chemical Engineering, University of Ottawa, Ottawa, Ont., Canada K1N 6N5. Corresponding author. Tel.: +1 613 562 5800x6108; fax: +1 613 562 5172). Biodiesel production using a membrane reactor. *Bioresource Technology*, Volume 98, Issue 3, February 2007, Pages 639-647

The immiscibility of canola oil in methanol provides a mass-transfer challenge in the early stages of the transesterification of canola oil in the production of fatty acid methyl esters (FAME or biodiesel). To overcome or rather, exploit this situation, a two-phase membrane reactor was developed to produce FAME from canola oil and methanol. The transesterification of canola oil was performed via both acid- or base-catalysis. Runs were performed in the membrane reactor in semi-batch mode at 60, 65 and 70 °C and at different catalyst concentrations and feed flow rates. Increases in temperature, catalyst concentration and feedstock (methanol/oil) flow rate significantly increased the conversion of oil to biodiesel. The novel reactor enabled the separation of reaction products (FAME/glycerol in methanol) from the original canola oil feed. The two-phase membrane reactor was particularly useful in removing unreacted canola oil from the FAME product yielding high purity biodiesel and shifting the reaction equilibrium to the product side.

Keywords: Biodiesel; Methanol; Acid-catalyzed transesterification; Base-catalyzed transesterification; Two-phase membrane reactor

Shireen Meher Kotay^a and Debabrata Das^a .(^aFermentation Technology Laboratory, Department of Biotechnology, Indian Institute of Technology, Kharagpur 721 302, India. Corresponding author. Tel.: +91 3222 278053/283758; fax: +91 3222 255303). Microbial hydrogen production with *Bacillus coagulans* IIT-BT S1 isolated from anaerobic sewage sludge. *Bioresource Technology*, Volume 98(6) (2007): 1183-1190

Bacillus coagulans strain IIT-BT S1 isolated from anaerobically digested activated sewage sludge was investigated for its ability to produce H₂ from glucose-based medium under the influence of different environmental parameters. At mid-exponential phase of cell growth, H₂ production initiated and reached maximum production rate in the stationary phase. The maximal H₂ yield (2.28 mol H₂/mol glucose) was recorded at an initial glucose concentration of 2% (w/v), pH 6.5, temperature 37 °C, inoculum volume of 10% (v/v) and inoculum age of 14 h. Cell growth rate and rate of hydrogen production decreased when glucose concentration was elevated above 2% w/v, indicating substrate inhibition. The ability of the organism to utilize various carbon sources for H₂ fermentation was also determined.

Keywords: *Bacillus coagulans*; Fermentation; H₂ yield; Microbial hydrogen production; Process optimization

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In the temperate zone, agroforestry systems come increasingly into focus as they offer an approach for the production of fuelwood, thus matching the increasing demand for a self-supply with bioenergy in rural decentralized areas. Because of the large area potential of marginal land, research activities aimed at a reliable estimation of the minimum productivity of fast-growing tree species under most unfavourable site conditions.

Two agroforestry systems were established on reclaimed mine sites in NE-Germany (Lusatia) and Central Germany (Helmstedt). The yield potential and the sustainability of yields were studied for different clones of poplar (*Populus* spp.), willow (*Salix viminalis* L.), and black locust (*Robinia pseudoacacia* L.), considering different rotation periods (3-, 6-, and 9-year-rotation) and approaches of soil amelioration (mineral fertiliser, compost).

On both sites the highest yields of woody biomass were found for *R. pseudoacacia* L. regardless of rotation period and amelioration measures. On loamy substrates in the Helmstedt mining district, all tree species and clones responded positively to soil amelioration measures.

In the agroforestry system in Lusatia, special emphasis was given to the interaction between trees (*R. pseudoacacia*) and crops (*Medicago sativa* L.). Considering the land equivalent ratio (LER), *R. pseudoacacia* hedgerows have practically no negative influence on yields of *M. sativa*. Hence, with regard to an increasing demand for woody biomass, alley cropping with *R. pseudoacacia* and crops such as *M. sativa* may provide a promising alternative for future land use in the temperate zone.

Keywords: Agroforestry; Alley cropping; Biomass production; Multiple land use; Reclamation; Short rotation coppice (SRC); Woodfuels

Jeppe Rass-Hansen, Hanne Falsig, Betina Jørgensen, Claus H Christensen^{*}. (Center for Sustainable and Green Chemistry, Department of Chemistry, NanoDTU, Technical University of Denmark, DK-2800 Kgs. Lyngby, Denmark. email: Claus H Christensen (chc@kemi.dtu.dk)^{*}Correspondence to Claus H Christensen, Center for Sustainable and Green Chemistry, Department of Chemistry, NanoDTU, Technical University of Denmark, DK-2800 Kgs. Lyngby, Denmark). **Bioethanol: fuel or feedstock? *Journal of Chemical Technology & Biotechnology*, Volume 82(4) (2006): 329 – 333**

Increasing amounts of bioethanol are being produced from fermentation of biomass, mainly to counteract the continuing depletion of fossil resources and the consequential escalation of oil prices. Today, bioethanol is mainly utilized as a fuel or fuel additive in motor vehicles, but it could also be used as a versatile feedstock in the chemical industry. Currently the production of carbon-containing commodity chemicals is dependent on fossil resources, and more than 95% of these chemicals are produced from non-renewable carbon resources. The question is: what will be the optimal use of bioethanol in a longer perspective?

Keywords: bioethanol • fuel • feedstock

Fei Liu, Baishan Fang, Dr. * (Province Key Laboratory of Industrial Biotechnology, Hua Qiao University, Quanzhou, Fujian, P. R. China, email: Baishan Fang (fangbs@hqu.edu.cn). *Correspondence to Baishan Fang, Department of Bioengineering and Biotechnology, Huaqiao University, 362021 Quanzhou, Fujian, P. R. China, Fax: +86-595-22691560). **Optimization of bio-hydrogen production from biodiesel wastes by *Klebsiella pneumoniae*. Biotechnology Journal, Volume 2(3) (2007): 374 – 380**

Biodiesel wastes containing glycerol were utilized by *Klebsiella pneumoniae* DSM 2026 to produce hydrogen. The optimization of medium components was performed using both Plackett-Burman and uniform design methods. Using the Plackett-Burman design, glycerol, yeast extract, NH₄Cl, KCl and CaCl₂ were found to be the most important components, which were further investigated by uniform design and second-order polynomial stepwise regression analysis. The optimized medium containing 20.4 g·L⁻¹ glycerol, 5.7 g·L⁻¹ KCl, 13.8 g·L⁻¹ NH₄Cl, 1.5 g·L⁻¹ CaCl₂ and 3.0 g·L⁻¹ yeast extract resulted in 5.0-fold increased level of hydrogen (57.6 mL/50 mL medium) production compared to initial level (11.6 mL/50 mL medium) after 24 h of fermentation. The optimization of fermentation condition (pH, temperature and inoculum) was also conducted. When the strain grew in the optimized medium under optimal fermentation condition in a 5-L stirred tank bioreactor for batch production, hydrogen yield and production reached 0.53 mol/mol and 117.8 mmol/L, respectively. The maximum hydrogen evolution rate was 17.8 mmol/(L·h). Furthermore, 1,3-propanediol (6.7 g·L⁻¹) was also obtained from the liquid medium as a by-product.

Keywords: Biodiesel wastes • Hydrogen • *Klebsiella pneumoniae* • Regression analysis • Uniform design

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108. Water, Air and Soil Pollution
109. World Journal of Biotechnology
110. World Journal of Microbiology and Biotechnology
111. Bio-metallurgy and Hydro-metallurgy

Authors Index

| | |
|---|-----|
| A. Yanagawa ¹ and S. Shimizu ¹ | 90 |
| A.A. Abia* and O.B. Didi..... | 51 |
| A.K. Gupta ^a and S. Sinha ^a | 28 |
| Abdelaal Shamseldin ¹ | 45 |
| Abhay Raj ¹ , Ram Chandra ¹ , M.M.K. Reddy ² , Hemant J. Purohit ³ and Atya Kapley ³ | 75 |
| Ajay Singh ^a ; Kate Billingsley ^b ; Owen Ward ^a | 48 |
| Aldre Jorge Morais Barros ^a , Shiva Prasad ^b , Valderi Duarte Leite ^c and Antonio Gouveia Souza ^a | 17 |
| Andrei A. Andreev, Roberto Pierau, Ivan A. Kalugin, Andrei V. Daryin, Lyubov G. Smolyaninova and Bernhard Diekmann..... | 96 |
| Andrew C. Singer ^a , Thomas Bell ^b , Chloe A. Heywood ^a , J.A.C. Smith ^c and Ian P. Thompson ^a | 34 |
| Angela Ivask ^{a, b} , Tal Green ^c , Boris Polyak ^c , Amit Mor ^c , Anne Kahru ^c , Marko Virta ^d and Robert Marks ^{c, e} | 82 |
| Anjali Pandey ^a , Poonam Singh ^a and Leela Iyengar ^a | 59 |
| Annie Vincens, Anne-Marie Lézine, Guillaume Buchet, Dorothée Lewden and Annick Le Thomas..... | 95 |
| Annik Dollacker and Claire Rhodes..... | 100 |
| B. D. Trivedi ² and K. C. Patel ¹ | 21 |
| B. K. Taşeli..... | 52 |
| B. Suresh ^{ab} ; G. A. Ravishankar ^a | 27 |
| Bilge Alpaslan Kocamemi ¹ and Ferhan Çeçen ² | 55 |
| Brian L. Polagye ^a , Kevin T. Hodgson ^b and Philip C. Malte ^a | 104 |
| C. Dayananda ^a , R. Sarada ^a , M. Usha Rani ^b , T.R. Shamala ^b and G.A. Ravishankar ^a | 102 |
| C. O. Nweke*, C. Ntinugwa, I. F. Obah, S. C. Ike, G. E. Eme, E. C. Opara, J. C. Okolo and C. E. Nwanyanwu..... | 49 |
| C.S. Benimeli ^a , G.R. Castro ^a , A.P. Chaile ^c and M.J. Amoroso ^{a, b} | 58 |
| Chamunorwa Aloius Togo ¹ , Victor Collins Wutor ¹ , Janice Leigh Limson ¹ and Brett Ivan Pletschke ¹ | 86 |
| Charles J. Everett ^a , Ivar L. Frithsen ^a , Vanessa A. Diaz ^a , Richelle J. Koopman ^a , William M. Simpson, Jr. ^a and Arch G. Mainous III ^a | 14 |
| Chiing-Chang Chen ¹ , Hung-Ju Liao ² , Chiu-Yu Cheng ³ , Chia-Yuen Yen ³ and Ying-Chien Chung ³ | 65 |
| Chi-Wen Lin [*] , Ya-Wen Cheng..... | 72 |
| Chi-Wen Lin ^a , Hung-Chun Lin ^a and Chi-Yung Lai ^b | 60 |
| Christos S. Akratos ^a and Vassilios A. Tsihrintzis ^a | 40 |

| | |
|--|------------|
| Chung-Yen Lu^a, Yee-Chung Ma^a, Jia-Min Lin^{a,b}, Chun-Yu Chuang^c and Fung-Chang Sung^{a,b,d} | 44 |
| Claudio Jommi and Silvia Paruzzolo..... | 98 |
| Colm P. McMahon^a, Gaia Rocchitta^{a,b}, Sarah M. Kirwan^a, Sarah J. Killoran^a, Pier A. Serra^{a,b}, John P. Lowry^b and Robert D. O'Neill^a | 84 |
| Cristiano Raminelli^a, Edna Kagohara^a, Vivian H. Pellizari^b, João V. Comasseto^a, Leandro H. Andrade^a and André L.M. Porto^a | 38 |
| D. Bera, D. Lahiri, Antonella De Leonardis, K.B. De and A. Nag | 46 |
| D. De Los Cobos-Vasconcelos^a, F. Santoyo-Tepole^a, C. Juárez-Ramírez^a, N. Ruiz-Ordaz^a and C.J.J. Galíndez-Mayer^a..... | 69 |
| Dan Shan^a, Mingjuan Zhu^a, Huaiguo Xue^a, and Serge Cosnier^b..... | 78 |
| Danelle Mohammed¹, Adesh Ramsubhag¹ and Denise M. Beckles²..... | 76 |
| Daniele Scandiucci de Freitas¹, Marly C. Felipe Coelho², Manoel T. Souza Jr.², Abi Marques² and e Bergmann Morais Ribeiro¹..... | 92 |
| Danielle M. Pala^a, Denize D. de Carvalho^b, José Carlos Pinto^a and Geraldo L. Sant'Anna, Jr.^a | 25 |
| David J. Spielman | 100 |
| David J. Spielman..... | 98 |
| Declan A. Healy¹, Conor J. Hayes¹, Paul Leonard¹, Louise McKenna² and Richard O'Kennedy¹..... | 88 |
| Denise Fernandes^{a,b}, Cinta Porte^b and Maria João Bebianno^a | 14 |
| Douglas Hayward^a, Jon Wong^a and Alexander J. Krynitsky^a..... | 13 |
| E. Aranda, I. García-Romera, J.A. Ocampo, V. Carbone, A. Malorni, F. Sannino, A. De Martino and R. Capasso. | 47 |
| E. Aranda^a, I. Sampedro^a, J.A. Ocampo^a and I. García-Romera^a..... | 63 |
| E. Kudjo Dzantor[*] | 31 |
| E. Mauriz^a, A. Calle^a, J.J. Manclús^b, A. Montoya^b, A. Hildebrandt^c, D. Barceló^c and L.M. Lechuga^a | 81 |
| E. Zacco^a, R. Galve^a, M.P. Marco^b, S. Alegret^a, and M.I. Pividori^a | 77 |
| Edward M. Fox^a and George L. Mendz^a..... | 69 |
| Ernesto Alfaro-Moreno^{a,1}, Rebeca López-Marure^b, Angélica Montiel-Dávalos^b, Peter Symonds^c, Alvaro R. Osornio-Vargas^a, Irma Rosas^d and J. Clifford Murray^c..... | 43 |
| Eugenia J. OlguÃn¹, Gloria SÃnchez-GalvÃn¹ and Teresa PÃ©rez-PÃ©rez¹..... | 36 |
| F. Rigas^a, K. Papadopoulou^a, V. Dritsa^a and D. Doulia^a | 31 |
| Fei Liu, Baishan Fang, Dr. * | 108 |
| Frank Davis^a and S amus P.J. Higson^a | 78 |
| Fuli Wu, Xiaomin Fang, Yuzhen Ma, Mark Herrmann, Volker Mosbrugger, Zhisheng An and Yunfa Miao. | 96 |

| | |
|--|------------|
| G. F. Koopmans¹, P. F. A. M. Römken², J. Song³, E. J. M. Temminghoff¹ and J. Japenga². | 35 |
| G. Martinez-Garcia^a, Robert Th. Bachmann^a, Ceri J. Williams^a, Andrea Burgoyne^a and Robert G.J. Edyvean^a. | 26 |
| G. Mohebal^a, A.S. Ball^b, B. Rasekh^a and A. Kaytash^a. | 29 |
| G.B.Raje and D.V.Muley*. | 51 |
| Galina Matafonova^a, Galina Shirapova^a, Christian Zimmer^b, Friedrich Giffhorn^b, Valeriy Batoev^a and Gert-Wieland Kohring^b. | 63 |
| Gaye Öngen¹, Gaye Güngör¹ and Bahar Kanberoglu¹. | 50 |
| Graciela Gil-Romera, Louis Scott, Eugène Marais and George A. Brook | 93 |
| Gurusamy Annadurai, Lai Yi Ling and Jiunn-Fwu Lee * | 52 |
| H. Claus¹, T. Bausinger², I. Lehmler¹, N. Perret³, G. Fels³, U. Dehner², J. Preuß² and H. König¹. | 37 |
| H.P.S. Kochhar and B.R. Evans | 99 |
| Hefa Cheng^a, Weipu Xu^b, Junliang Liu^c, Qingjian Zhao^d, Yanqing He^b and Gang Chen^c. 48 | |
| Henry I. Miller. | 99 |
| Herbert H.P. Fang^a, Dawei Liang^a and Tong Zhang^a. | 68 |
| Hiren Doshi¹, Arabinda Ray¹ and I. L. Kothari². | 15 |
| Hironori Taki^{1,2}, Kazuaki Syutsubo^{1,3}, Richard G. Mattison¹ and Shigeaki Harayama^{1,4}. | 23 |
| Holger Gruenewald^{a,1}, Barbara K.V. Brandt^a, B. Uwe Schneider^a, Oliver Bens^a, Gerald Kendzia^{b,1} and Reinhard F. Hüttl^a. | 107 |
| Hui Ye^a, Sheng Yuan^a and Xiaodong Cong^b. | 38 |
| I. Glazer^{1,2}, M. Eliyau², L. Salame^{1,2}, Y. Nakash³ and D. Blumberg². | 90 |
| Idil Arslan-Alaton^a. | 70 |
| Ivana Ribeiro de Nardi¹, Marcelo Zaiat² and Eugenio Foresti². | 55 |
| J. Chirkova^a, I. Irbe^a, B. Andersons^a and I. Andersone^a. | 64 |
| J. Morales¹, P. Medina¹ and E. Viñuela¹. | 89 |
| Jae Woong Hwang¹, Young Bum Choi², Sunghoon Park², Cha Yong Choi¹ and Eun Yeol Lee³. | 56 |
| Janjit Iamchaturapatr^{a,b}, Su Won Yi^a and Jae Seong Rhee^{a,b}. | 30 |
| Javier Gonzalo-Ruiz^a, M. Asunción Alonso-Lomillo^a and F. Javier Muñoz^a. | 86 |
| Jeannette A. Colyvas. | 97 |
| Jeppe Rass-Hansen, Hanne Falsig, Betina Jørgensen, Claus H Christensen * | 107 |
| Jessica Kojadinovic^{a,b,c}, Michel Potier^d, Matthieu Le Corre^a, Richard P. Cosson^b and Paco Bustamante^c. | 19 |
| Jian Chen^a, Ying Zhang^a, Guo-Cheng Du^a, Zhao-Zhe Hua^a and Yang Zhu^a. | 67 |
| Jinwook Chung^{1,4}, Bruce E. Rittmann^{1,4}, William F. Wright² and Reid H. Bowman³. | 79 |

| | |
|---|-----|
| Joong Kyun Kim ^a , Jeong Bo Kim ^a , Kyoung Sook Cho ^a and Yong-Ki Hong ^a | 58 |
| Jose A. Perales ¹ , Manuel A. Manzano ¹ , M. Carmen Garrido ¹ , Diego Sales ¹ and Jose M. Quiroga ¹ | 54 |
| José Luis Aznarte M., José Manuel Benítez Sánchez, Diego Nieto Lugilde, Concepción de Linares Fernández, Consuelo Díaz de la Guardia and Francisca Alba Sánchez. | 96 |
| Justin C. Biffinger ^a , Jeremy Pietron ^a , Ricky Ray ^b , Brenda Little ^b and Bradley R. Ringeisen ^a | 77 |
| K. Bińka, R. Stachowicz-Rybka, H. Winter and J. Nitychoruk | 95 |
| K. Parvathi ¹ , R. Naresh Kumar ¹ and R. Nagendran ¹ | 21 |
| K. Suresh Kumar ^a , K. Ganesan ^a and P.V. Subba Rao ^a | 33 |
| K. Vengatajalabathy Gobi ^a , Hiroyuki Iwasaka ^b and Norio Miura ^a | 82 |
| Katarína Dercová ^a , Zuzana Sejková ^a , Marianna Skokanová ^a , Gabriela Barančíková ^b and Jarmila Makovniková ^c | 24 |
| Katja Scherwinski ^{1,2} , Arite Wolf ¹ and Gabriele Berg ^{1,3} | 91 |
| Krista D. Vandermeer ¹ and Andrew J. Daugulis ¹ | 56 |
| Krzysztof Ulfig ^a , Grażyna Plaza ^a , Maciej Terakowski ^a and Tadeusz Mańko ^a | 61 |
| Kyung W. Kim. | 94 |
| L.E. Macaskie [*] , N.J. Creamer, A.M.M. Essa, N.L. Brown. | 102 |
| Lenka Vesela ^a , Jan Nemecek ^b , Martina Siglova ^c and Martin Kubal ^d | 25 |
| Leticia Pizzul ^{2a} , María del Pilar Castillo ^a and John Stenström ^a | 60 |
| Li Wang ^a , Suzelle Barrington ^b and Jin-Woo Kim ^b | 71 |
| Ling Liu ¹ , James A. Tindall ² and Michael J. Friedel ³ | 74 |
| Lingyun Zhang, Huaiqing Hao, Qinli Wang, Kefeng Fang, Zhixia Hou and Jinxing Lin. | 94 |
| Lu Gao ^a and Qiuming Gao ^a | 84 |
| M. Murakami ^a , N. Ae ^{1, a} , and S. Ishikawa ^a | 35 |
| M. Ziagova ^a and M. Liakopoulou-Kyriakides ^a | 66 |
| M.A. Castillo ^a , N. Felis ^a , P. Aragón ^b , G. Cuesta ^a and C. Sabater ^a | 62 |
| M.A. Dubé ^a , A.Y. Tremblay ^a and J. Liu ^a | 106 |
| Magdalena Jaszek ^a , Jerzy Żuchowski ^a , Elżbieta Dajczak ^a , Kamila Cimek ^a , Marcin Graz ^a and Krzysztof Grzywnowicz ^a | 63 |
| Magdalena Klimek-Ochab ¹ , Agnieszka Obojska ¹ , Anna M. Picco ² and Barbara Lejczak ¹ | 57 |
| Mao-Lin Zhang ^a , Yao-Ting Fan ^a , Yan Xing ^a , Chun-Mei Pan ^a , Gao-Sheng Zhang ^a and Jiunn-Jyi Lay ^b | 103 |
| Maria J. Lopez ^a , Maria del Carmen Vargas-García ^a , Francisca Suárez-Estrella ^a , Nancy N. Nichols ^b , Bruce S. Dien ^b and Joaquin Moreno ^a | 66 |
| Marie-Françoise Hullo, ^{1†} Sandrine Auger, ^{1‡} Olga Soutourina, ^{1,2} Octavian Barzu, ¹ Mireille Yvon, ³ Antoine Danchin, ¹ and Isabelle Martin-Verstraete ^{1,2*} | 40 |

| | |
|---|------------|
| Märt Öövel^a, Antti Tooming^a, Tõnu Muring^{a, b} and Ülo Mander^a. | 39 |
| Michael M. Hopkins, Paul A. Martin, Paul Nightingale, Alison Kraft and Surya Mahdi. . | 98 |
| Min Wang^a, Jinhua Zou^a, Xuchuan Duan^a, Wusheng Jiang^a and Donghua Liu^a. | 16 |
| Mineshi Sakamoto^a, Tsuyoshi Kaneoka^b, Katsuyuki Murata^c, Kunihiro Nakai^d, Hiroshi Satoh^d and Hirokatsu Akagi^c. | 42 |
| Monika Walter, Christopher Miles Frampton, Kirsty Sarah Helen Boyd-Wilson, Patricia Harris-Virgin, and Nicholas William Waipara. | 99 |
| N. Carmona^a, L. Laiz^b, J.M. Gonzalez^b, M. Garcia-Heras^{a, c}, M.A. Villegas^a and C. Saiz-Jimenez^b. | 64 |
| N. Daneshvar^a, A.R. Khataee^{a, 1}, M.H. Rasoulifard^{a, 1}, and M. Pourhassan^{b, 2}. | 73 |
| N. Daneshvar^a, M. Ayazloo^{b, 1}, A.R. Khataee^{a, 2} and M. Pourhassan^{b, 3}. | 37 |
| N. Gottschall^a, C. Boutin^b, A. Crolla^c, C. Kinsley^c and P. Champagne^d. | 39 |
| N. Martínez-Pérez^a, S.J. Cherryman^b G.C. Premier^a, R.M. Dinsdale^b, D.L. Hawkes^b, F.R. Hawkes^b, G. Kyazze^b and A.J. Guwy^b. | 104 |
| Naomi Shibasaki-Kitakawa^a, Hiroki Honda^a, Homare Kuribayashi^a, Takuji Toda^a, Takuya Fukumura^b and Toshikuni Yonemoto^a. | 105 |
| Nazish Bostan¹, Muhammad Ashraf¹, Abdul S. Mumtaz¹ and Iftikhar Ahmad². | 44 |
| Niansheng Wan^a, Ji-Dong Gu^{a, b, ,} and Yan Yan^a. | 59 |
| Nikolitsa Nomikou^{1, 2} and Anthony P. McHale¹. | 87 |
| O. Ajuonu¹, M. Byrne², M. Hill³, P. Neuenschwander¹ and S. Korie¹. | 89 |
| Okoh, A. I.^{1*} and Trejo-Hernandez, M. R.². | 22 |
| Okoronkwo, N. E.^{1*}, ¹Igwe, J. C.¹ and Okoronkwo, I. J.². | 22 |
| Orly Salama^a, Sebastien Herrmann^a, Alina Tziknovsky^b, Benjamin Piura^c, Michael Meirovich^c, Ilya Trakht^d, Brent Reed^c, Leslie I. Lobel^b and Robert S. Marks^{a, f}. | 85 |
| Owabor, C. N.* and Ogunbor, O. F. | 52 |
| P. F. X. Corvini¹, R. Meesters², M. Mundt⁴, A. Schäffer¹, B. Schmidt¹, H. -Fr. Schröder², W. Verstraete³, R. Vinken¹ and J. Hollender⁴. | 57 |
| P.A. Vieira^a, R.B. Vieira^a, F.P. de França^b and V.L. Cardoso^a. | 73 |
| P.G. Silva and H.J. Silva. | 47 |
| Parul Sharma^a, Pushpa Kumari^a, M.M. Srivastava^a and Shalini Srivastava^a. | 16 |
| Patricia Österreicher-Cunha^{1, 2}, Jean Rémy Davée Guimarães¹, Eurípedes do Amaral Vargas Jr.² and Maria Isabel Pais da Silva³. | 74 |
| Patrick Audet^a and Christiane Charest^a. | 35 |
| Peter Mc Namara and Charles Baden-Fuller. | 97 |
| Ping-Hsien Chuang^{a, b}, Chi-Wei Lee^b, Jia-Ying Chou^a, M. Murugan^a, Bor-Jinn Shieh^b and Hueih-Min Chen^a. | 92 |
| Praveena Bhatt^a, M. Suresh Kumar^a and Tapan Chakrabarti^a. | 32 |

| | |
|--|-----|
| Quan-Ying Cai ^{a, d} , Ce-Hui Mo ^b , Qi-Tang Wu ^a , Qiao-Yun Zeng ^a , Athanasios Katsoyiannis ^c and Jean-François Férard ^d | 32 |
| R. Guntupalli ^a , J. Hu ^{a, d} , Ramji S. Lakshmanan ^a , T.S. Huang ^b , James M. Barbaree ^c and Bryan A. Chin ^a | 85 |
| R. Nisha, A. Kaushik and C.P. Kaushik..... | 46 |
| R.A. Sudmeyer ^a and A. Goodreid ^a | 30 |
| Raymond W. Arritt, Craig A. Clark, A. Susana Goggi, Higinio Lopez Sanchez, Mark E. Westgate and Jenny M. Riese..... | 93 |
| Rosanna S. Valitutto ¹ , Silvia M. Sella ¹ , Emmanoel V. Silva-Filho ¹ , Roberto Guimarães Pereira ² and Norbert Miekeley ³ | 19 |
| S. Dimitriadis ¹ , N. Nomikou ^{1,2} and A. P. McHale ¹ | 105 |
| S. K. Mehta ^a ; J. P. Gaur ^a | 15 |
| S. Mohapatra ^a , S. Bohidar ^a , N. Pradhan ^a , R.N. Kar ^a and L.B. Sukla ^a | 18 |
| S. Piermarini ^a , L. Micheli ^a , N.H.S. Ammida ^{a, b} , G. Palleschi ^a and D. Moscone ^a | 83 |
| S. Shailaja ^a , M. Ramakrishna ^a , S. Venkata Mohan ^a and P.N. Sarma ^a | 69 |
| S. Venkata Mohan ^a , S.V. Ramanaiah ^a , B. Rajkumar ^b and P.N. Sarma ^a | 17 |
| S.D. Kalme ^a , G.K. Parshetti ^a , S.U. Jadhav ^a and S.P. Govindwar ^a | 68 |
| S.K. Ghosh, J. Chaudhuri, R. Gachhui, A. Mandal, S. Ghosh..... | 13 |
| S.M.*Dharmadhikari, S.B.Brahmane and M.S.Andhale..... | 41 |
| Sára Révész ^a , Rita Sipos ^a , Anikó Kende ^b , Tamás Rikker ^b , Csaba Romsics ^a , Éva Mészáros ^a , Anita Mohr ^a , András Tánicsics ^a and Károly Márialigeti ^a | 62 |
| Sarayu Mohana ^a , Chirayu Desai ^a and Datta Madamwar ^a | 68 |
| Sathiyamoorthi, P. ^{1*} , Periyar selvam, S. ² , Sasikalaveni, A. ³ Murugesan, K. ² , and Kalaichelvan, P. T. ² | 53 |
| Scott Gifford ¹ , R. Hugh Dunstan ¹ , Wayne O'Connor ² , Claudia E. Koller ¹ and Geoff R. MacFarlane ¹ | 33 |
| Sebastian R. Sørensen, * Maria S. Holtze, Allan Simonsen, and Jens Aamand..... | 71 |
| Serena Laschi ^a , Dominika Ogończyk ^b , Ilaria Palchetti ^a and Marco Mascini ^a | 88 |
| Shihong Chen ^a , Ruo Yuan ^a , Yaqin Chai ^a , Lingyan Zhang ^a , Na Wang ^a and Xuelian Li ^a .. | 79 |
| Shireen Meher Kotay ^a and Debabrata Das ^a | 106 |
| Shishir P.S. Chundawat [*] , Balan Venkatesh, Bruce E. Dale..... | 101 |
| Shu-Hsien Tsai, Ching-Piao Liu and Shang-Shyng Yang..... | 46 |
| Sikander Sultan ^{1, a} and Shahida Hasnain ^a | 28 |
| Slaoui M ^{1*} , Ouhssine M ¹ , Berny E ² and Elyachioui M ¹ | 53 |
| Sunil C. Dubey ^a , M. Suresh ^a and Birendra Singh ^a | 49 |
| Teris A. van Beek ^a , Bram Kuster ^a , Frank W. Claassen ^a , Taisto Tienvieri ^b , Frédérique Bertaud ^c , Gilles Lenon ^c , Michel Petit-Conil ^c and Reyes Sierra-Alvarez ^d | 27 |

| | |
|--|-----|
| Tomoyuki Makino ^a , Takashi Kamiya ^b , Hiroyuki Takano ^b , Tadashi Itou ^c , Naoki Sekiya ^c , Kouta Sasaki ^b , Yuji Maejima ^a and Kazuo Sugahara ^a | 34 |
| Tzyy-Jiann Wang ^a , Wen-Shao Lin ^a and Fu-Kuen Liu ^b | 83 |
| V.C. Wutor ^a , C.A. Togo ^a , J.L. Limson ^{a,b} and B.I. Pletschke ^a | 87 |
| V.K. Verma ^a , Y.P. Singh ^a and J.P.N. Rai ^a | 29 |
| Van Brian Driessel ^a ; Lew Christopher ^{ab} | 26 |
| W. A. Palmer ¹ and K. A. D. W. Senaratne ¹ | 91 |
| W. Franks ^a , S. Tosatti ^b , F. Heer ^a , P. Seif ^a , M. Textor ^b and A. Hierlemann ^a | 81 |
| Wilfried Sanchez ¹ , Sélim Aït-Aïssa ¹ , Olivier Palluel ¹ , Jean-Maxence Ditché ² and Jean- Marc Porcher ¹ | 45 |
| XianZhi Xiong ^c , JunLing Liu ^{a,b} , WeiHong He ^{a,b} , Tao Xia ^{a,b} , Ping He ^{a,b} , XueMin Chen ^{a,b} , KeDi Yang ^{a,b} and AiGuo Wang ^{a,b} | 42 |
| Xiao Jun Wu ^a , Martin M.F. Choi ^a , Chang Shun Chen ^{1,a} and Xiao Min Wu ^{2,a} | 80 |
| Xiao Zhang ^a , David Nguyen ^b , Mike G. Paice ^a , Adrian Tsang ^b and Sylvie Renaud ^a | 67 |
| Xiaolin Wang ¹ and Marc A. Deshusses ¹ | 24 |
| Xue-Qin Tao ¹ , Gui-Ning Lu ¹ , Zhi Dang ¹ , Xiao-Yun Yi ¹ and Chen Yang ¹ | 76 |
| Ya Tang, Jia-Sui Xie and Hui Sun..... | 95 |
| Yaomin Jin, Ling Guo, María C. Veiga, Christian Kennes [*] | 23 |
| Ya-Qin Hu, Zhong-Li Zhang, Subir Bera, David K. Ferguson, Cheng-Sen Li, Wen-Bin Shao and Yu-Fei Wang. | 93 |
| Yasar Avsar ^a , Hussein Tarabeah ^b , Shlomo Kimchie ^c and Izzet Ozturk ^d | 18 |
| Yi Su ² , B. B. Maruthi Sridhar ^{1,2} , F. X. Han ² , S. V. Diehl ¹ and D. L. Monts ^{2,3} | 20 |
| Ying Zheng ^a ; Ernest K. Yanful ^a ; Amarjeet S. Bassi ^b | 65 |
| YuHong Qin ^a , HaiFeng Huang ^a , ZhiBin Wu ^a , Jie Feng ^a , Wenying Li ^a and KeChang Xie ^a , | 103 |
| Yunus Pamukoglu ^a and Fikret Kargi ^a | 17 |
| Zaki A. Siddiqui ¹ , G. Baghel ¹ and M. S. Akhtar ¹ | 50 |
| Zhang Chaojie ¹ , Zhou Qi ¹ , Chen Ling ¹ , Yuan Yuan ¹ and Yu Hui ¹ | 54 |
| Zhang Chaojie ^a , Zhou Qi ^a , Chen Ling ^a , Wu Zhichao ^a and Xu Bin ^a | 73 |

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