ENVIS CENTER
on
ENVIRONMENTAL BIOTECHNOLOGY

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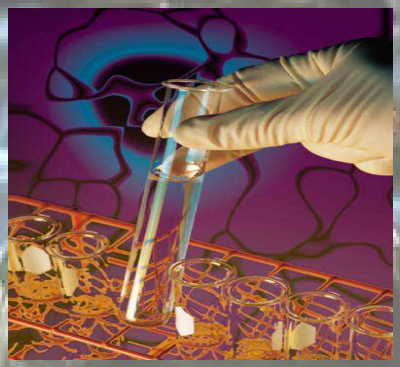

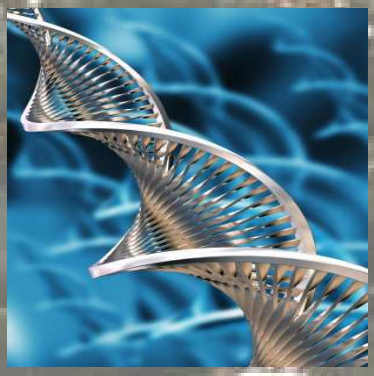

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ENVIS CENTRE

on

ENVIRONMENTAL BIOTECHBNOLOGY

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C O N T E N T S

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 biannualy Abstract Volume on our thematic area Environmental Biotechnology under fourteen subheads. The volume contains abstracts of scientific articles from relavent 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 12th publication of Abstract Volume of this ENVIS Centre. This contains the abstracts of research papers collected from the various areas of Environmental Biotechnology from different journals published from January, 2008 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 varity 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 warm. 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 varity of environments. These specific substances may include sugars, proteins, or humas and varity 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 allerginicity 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 ecofreindly 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	Biotechnique(s)	Endocrinol	Endocrinological
Biotechno	Biotechnology	Engg	Engineering
Biotechnol	Bitechnological	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	Occassional
Geol	Geological	Occupl	Occupational
Geosci	Geoscience	Oceanogr	Oceanogoraphy
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	Immunlogical	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	Transc	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

R.M. Godinho[a], H.Th. Wolterbeek[b], T. Verburg[b] and M.C. Freitas[a]. ([a]Instituto Tecnológico e Nuclear, Reactor, Apartado 21, E.N.10, 2686-953 Sacavém, Portugal, [b]Department of Radiation, Radionuclides and Reactors, Section RIH (Radiation and Isotopes in Health), Faculty of Applied Sciences, Technical University Delft, Mekelweg 15, 2629 JB Delft, The Netherlands). Bioaccumulation behaviour of transplants of the lichen *Flavoparmelia caperata* in relation to total deposition at a polluted location in Portugal. Environmental Pollution, Vol. 151(2) (2008): 318-325

This experiment compares the short and long time element accumulation behaviour of transplants of *Flavoparmelia caperata* lichen thalli and total deposition in an atmospheric polluted area.

It was found that lichens exposed for a short time behaved differently from lichens in cumulative exposition suggesting the presence of acclimatization behaviour. The lichen transplant elemental content does not unequivocally represent the average or cumulative environmental availability of the exposure period. Reflection characteristics depend on the element and the lichen physiological conditions. Good correlations between lichen elemental contents and total deposition were obtained when a physiological lichen parameter was introduced in a mathematical model, suggesting that metabolically mediated accumulation is important.

The length of the foregoing atmospheric availability period reflected by lichen elemental contents is element-specific and depends on lichen physiological conditions.

Keywords: Accumulation; Physiology; Atmospheric deposition; Trace elements; Biomonitor

Barbora Doušová[1], Alexandr Martaus[1], Michal Filippi[2] and David Koloušek[1]. ([1]Department of Solid State Chemistry, Institute of Chemical Technology in Prague, Technicka 5, 166 28 Prague 6, Czech Republic, [2]Institute of Geology, Academy of Science of the Czech Republic, Rozvojova 269, 165 02 Prague 6, Czech Republic). Stability of Arsenic Species in Soils Contaminated Naturally and in an Anthropogenic Manner. Water, Air, & Soil Pollution, Vol. 187(1-4)(2008): 233-241

Stability and transport of As species in soils were investigated in three contaminated Central European regions in the Czech Republic; one of them represents naturally contaminated area, the others are results of a former mining activity. Total As content varied from 60 to <18,000 ppm depending on locality and sampling layer. Sequential extraction procedure (SEP) enabled to distinguish five main fractions of As in soils based on different chemical and binding properties. Non-specifically and weakly sorbed As, as well as As remained in solid rests of samples did not exceed 10% of total As; specifically bounded As varied from 5 to 15%. The substantial portion of As was bound to hydrated Fe oxides (HFO) in amorphous and poorly-crystalline forms (10–30% of the total As) and/or to a well-crystallized forms of the same phases (50–80%). As sorption on HFO surface, particularly on well-crystallized phases represented the most significant and stable As bond in soils. Model leaching experiments illustrated the increased mobility of As species at pH ≈ 7.0 in the soil–groundwater–surface water systems.

Keywords: Arsenic forms - Mobility - HFO - Soils - Surface complexes

Sardar Khan[a, b], Lin Aijun[a], Shuzhen Zhang[a], Qinhong Hu[c] and Yong-Guan Zhu[a]. ([a]Department of Soil Environmental Science, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085, China, [b]Department of Environmental Sciences, University of Peshawar, 25120 Peshawar, Pakistan, [c]Chemical Sciences Division, Lawrence Livermore National Laboratory, University of California, 7000 East Avenue, Livermore, CA 94550, USA). **Accumulation of polycyclic aromatic hydrocarbons and heavy metals in lettuce grown in the soils contaminated with long-term wastewater irrigation. Journal of Hazardous Materials, Vol. 152(2) (2008): 506-515**

Accumulation of polycyclic aromatic hydrocarbons (PAHs) and heavy metals (HMs) by crop plants from contaminated soils may pose health risks. A greenhouse pot experiment using lettuce (*Lactuca satuva* L.) as a representative vegetable was conducted to assess the concentrations of PAHs and HMs in vegetables grown in wastewater-contaminated soils. The concentrations of total PAHs were ranged from 1.5 to 3.4 mg kg^{-1} in the contaminated soils, while 1.2 mg kg^{-1} in the reference soil. Linear regression analyses showed that the relationships between soil and shoot PAH concentrations were stronger for LMW-PAHs (R^2 between 0.51 and 0.92) than for HMW-PAHs (R^2 0.02 and 0.60), suggesting that translocation for LMW-PAHs is faster than HMW-PAHs. Furthermore, the data imply that root uptake was the main pathway for HMW-PAHs accumulation. The plant shoots were also highly contaminated with HMs, particularly Cd (0.4–0.9 mg kg^{-1}), Cr (3.4–4.1 mg kg^{-1}), Ni (11.7–15.1 mg kg^{-1}) and Pb (2.3–5.3 mg kg^{-1}), and exceed the guidance limits set by State Environmental Protection Administration (SEPA), China and the World Health Organization (WHO). This study highlights the potential health risks associated with cultivation and consumption of leafy vegetables on wastewater-contaminated soils.

Keywords: Heavy metals; Plant uptake; Polycyclic aromatic hydrocarbons; Soil contamination; Wastewater irrigation

A. Basile[a], S. Sorbo[b], G. Aprile[c], B. Conte[a] and R. Castaldo Cobianchi[a]. ([a]Dipartimento delle Scienze Biologiche, Università "Federico II", Plant Biology Division, via Foria 223, 80139 Napoli, Italy, [b]C.I.S.M.E., Università "Federico II", via Foria 223, 80139 Napoli, Italy, [c]Dipartimento di ARBOPAVE, Università "Federico II", Facoltà di Agraria, via Università 100, 80055 Portici (NA), Italy). **Comparison of the heavy metal bioaccumulation capacity of an epiphytic moss and an epiphytic lichen. Environmental Pollution, Vol. 151(2) (2008): 401-407**

This study compared the heavy metal bioaccumulation capacity in the epiphytic moss *Scorpiurum circinatum* and the epiphytic lichen *Pseudevernia furfuracea*, exposed in bags for 3 months in the urban area of Acerra (S Italy). The content of Al, As, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Ti, V, and Zn was measured by ICP-MS. The results showed that both species accumulated all the heavy metals assayed. The moss had the highest bioaccumulation capacity for all metals and showed a more constant and linear accumulation trend than the lichen. Intra-tissue heavy metal bioaccumulation was assessed by X-ray microanalysis applied to ESEM operated in high and low vacuum and ESEM modes.

The moss *Scorpiurum circinatum* has a higher capacity of accumulating heavy metals than the lichen *Pseudevernia furfuracea*.

Keywords: Biomonitoring; ESEM; ICP-MS; *Pseudevernia furfuracea*; *Scorpiurum circinatum*

Mafalda S. Baptista[a], M. Teresa S.D. Vasconcelos[a, b], João Paulo Cabral[a, c], M. Carmo Freitas[d,] and Adriano M.G. Pacheco[e]. ([a]CIIMAR, Rua dos Bragas, 289, 4050-123 Porto, Portugal, [b]Chemistry Department, Faculty of Sciences, University of Porto, Rua do Campo Alegre, 687, 4169-071 Porto, Portugal, [c]Botany Department, Faculty of Sciences, University of Porto, Rua do Campo Alegre, 1191, 4150-181 Porto, Portugal, [d]ITN – Technological and Nuclear Institute, Reactor E.N. 10, 2686-953 Sacavém, Portugal, [e]CVRM-IST – Technical University of Lisbon, Avenida Rovisco Pais, 1, 1049-001 Lisboa, Portugal). Copper, nickel and lead in lichen and tree bark transplants over different periods of time. Environmental Pollution, **Vol. 151(2) (2008): 408-413**

This work aimed at comparing the dynamics of atmospheric metal accumulation by the lichen *Flavoparmelia caperata* and bark of *Platanus hybrida* over different periods of time. Transplants were exposed in three Portuguese coastal cities. Samples were retrieved (1) every 2 months (discontinuous exposure), or (2) after 2-, 4-, 6-, 8- and 10-month periods (continuous exposure), and analysed for Cu, Ni and Pb. Airborne accumulation of metals was essentially independent of climatic factors. For both biomonitors [Pb] > [Ni] > [Cu] but Pb was the only element for which a consistent pattern of accumulation was observed, with the bark outperforming the lichen. The longest exposure periods hardly ever corresponded to the highest accumulation. This might have been partly because the biomonitors bound and released metals throughout the exposure, each with its own dynamics of accumulation, but both according to the environmental metal availability.

Lichen and tree bark have distinct dynamics of airborne metal accumulation.

Keywords: Biomonitoring; Atmospheric deposition; Trace metals

Santosh Kumar Prajapati[a] and B.D. Tripathi[b]. ([a]Pollution Ecology Research Laboratory, Centre of Advanced Study in Botany, Banaras Hindu University, Varanasi 221005, India, [b]Centre of Advanced Study in Botany, Banaras Hindu University, Varanasi 221005, India). Biomonitoring seasonal variation of urban air polycyclic aromatic hydrocarbons (PAHs) using *Ficus benghalensis* leaves. Environmental Pollution, Vol. 151(3) (2008):543-548

Temporal and seasonal variations of polycyclic aromatic hydrocarbons (PAHs) concentrations in leaves of *Ficus benghalensis* were investigated in Varanasi city (India). Leaf samples were collected from six sites from urban area of Varanasi and from a control site. PAH extraction was done by sonication in dichloromethane-acetone and quantification by GC-MS. In January total leaf PAHs concentrations at all the urban sites were twice higher as compared to other season's viz. summer and rainy. In contrast, at the control site leaf PAHs concentrations showed lower values than urban sites. The maximum concentrations of total PAHs in winter were due to the medium molecular weight PAHs which increases with respect to both low and high molecular weight PAHs. The temporal variation of medium molecular weight PAHs was similar both at the urban and remote sites. These results support biomonitoring ability of *Ficus benghalensis* leaves to temporal variations in PAHs contamination.

Biomonitoring PAHs in atmosphere using F. benghalensis leaves for its temporal and seasonal variation is cost effective as well as easier.

Keywords: PAHs; Temporal pattern; Urban area; Biomonitoring

M. Metian[a, b], P. Bustamante[b], L. Hédouin[a, b, c] and M. Warnau[a]. ([a]International Atomic Energy Agency – Marine Environment Laboratories, 4 Quai Antoine Ier, MC-98000 Monaco, [b]Centre de Recherche sur les Ecosystèmes Littoraux Anthropisés, UMR 6217, CNRS-IFREMER-Université de La Rochelle, 22 avenue Michel Crépeau, F-17042 La Rochelle Cedex 01, France, [c]IRD-Centre de Nouméa, BP A5, 98848 Nouméa Cedex, New Caledonia). **Accumulation of nine metals and one metalloid in the tropical scallop *Comptopallium radula* from coral reefs in New Caledonia. Environmental Pollution, Vol. 152(3) (2008) : 543-552**

Uptake of waterborne Cd, Co, Mn and Zn was determined in laboratory experiments using radiotracer techniques (^{109}Cd, ^{57}Co, ^{54}Mn and ^{65}Zn). Labelled Zn was mainly accumulated in the digestive gland (65%) and Co in kidneys (81%); Cd and Mn were similarly distributed in digestive gland and gills. In a complementary field study, Ag, As, Cd, Co, Cr, Cu, Fe, Mn, Ni, and Zn were analysed in scallops collected at two stations showing different contamination levels. Digestive gland and kidneys displayed the highest concentrations. Ag, As, Cd, and Fe differed in soft tissues from the two stations, suggesting that *Comptopallium radula* could be a valuable local biomonitor species for these elements. Low Mn and Zn concentrations found in kidneys suggest that their content in calcium-phosphate concretions differs from the other pectinids. Preliminary risk considerations suggest that As would be the only element potentially leading to exposure of concern for seafood consumers.

This study investigates metal accumulation behaviour in the tropical scallop *Comptopallium radula* and preliminary risk assessment for consumers.

Keywords: Tropical environment; Trace elements; Arsenic; Radiotracers; Pectinidae; Risk assessment; Bioindicator species

Ivano Brunner[a], Jörg Luster[a], Madeleine S. Günthardt-Goerg[a] and Beat Frey[a]. ([a]Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Zürcherstrasse 111, CH-8903 Birmensdorf, Switzerland). **Heavy metal accumulation and phytostabilisation potential of tree fine roots in a contaminated soil. Environmental Pollution, Vol. 152(3) (2008): 559-568**

Root systems of Norway spruce (*Picea abies*) and poplar (*Populus tremula*) were long-term exposed to metal-contaminated soils in open-top chambers to investigate the accumulation of the heavy metals in the fine roots and to assess the plants suitability for phytostabilisation. The heavy metals from the contaminated soil accumulated in the fine roots about 10–20 times more than in the controls. The capacity to bind heavy metals already reached its maximum after the first vegetation period. Fine roots of spruce tend to accumulate more heavy metals than poplar. Copper and Zinc were mainly detected in the cell walls with larger values in the epidermis than in the cortex. The heavy metals accumulated in the fine roots made up 0.03–0.2% of the total amount in the soils. We conclude that tree fine roots adapt well to conditions with heavy metal contamination, but their phytostabilisation capabilities seem to be very low.

Long-term exposed fine roots of trees are well adapted to soils with high heavy metal contents, but their phytostabilisation capabilities are rather low.

Keywords: Fine roots; Heavy metals; Norway spruce; Phytostabilisation; Poplar

Lingli Guo[a], Yaowen Qiu[a, b], Gan Zhang[a], Gene J. Zheng[c], Paul K.S. Lam[c] and Xiangdong Li[d]. ([a]State Key Laboratory of Organic Geochemistry, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou, Guangdong 510640, China, [b]Key Laboratory of Tropic Marine Environmental Dynamics, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou 510301, China, [c]Department of Biology and Chemistry, Centre for Coastal Pollution and Conservation, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong SAR, China, [d]Department of Civil and Structural Engineering, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong SAR, China). **Levels and bioaccumulation of organochlorine pesticides (OCPs) and polybrominated diphenyl ethers (PBDEs) in fishes from the Pearl River estuary and Daya Bay, South China. Environmental Pollution, Vol. 152(3) (2008): 604-611**

Fifty fish samples were collected from the Pearl River estuary (PRE) and Daya Bay, South China and were analyzed for DDTs, HCHs, chlordanes and polybrominated biphenyl ethers (PBDEs). Except the high concentrations of DDT observed in fishes, the concentrations of HCHs, chlordanes and PBDEs were low when compared to other regions. BDE-47 was the predominant PBDE congener and the BDE-209 concentrations were relatively low, despite its high concentration in surface sediments. The absence of significant increase of DDT, HCH, chlordane and PBDE concentrations towards higher δ^{15}N values, as well as the lack of a significant correlation ($p < 0.1$) between log concentrations (lipid normalized) and δ^{15}N, may indicate a weak biomagnification of these chemicals in the food webs. Good agreement was observed between their concentrations and lipid contents of the organisms. Bioconcentration was suggested to be responsible for the accumulation of OCPs and PBDEs in the lower trophic organisms in the studied subtropical waters.

Bioconcentration was suggested to be responsible for the accumulation of OCPs and PBDEs in the lower trophic organisms of subtropical waters.

Keywords: Polybrominated diphenyl ethers (PBDEs); Organochlorine pesticides (OCPs); Fishes; Pearl River estuary; Daya Bay; South China

H. De Wolf[a] and R. Rashid[a]. ([a]Ecophysiology, Biochemistry and Toxicology Group, University of Antwerp, Groenenborgerlaan 171, B-2020 Antwerp, Belgium). **Heavy metal accumulation in *Littoraria scabra* along polluted and pristine mangrove areas of Tanzania. Environmental Pollution, Vol. 152(3) (2008) : 636-643**

The periwinkle *Littoraria scabra* was collected at polluted and pristine mangrove sites along the Tanzanian coastline, including Msimbazi, Mbweni (i.e. Dar es Salaam) and Kisakasaka, Nyamanzi and Maruhubi (i.e. Zanzibar). Periwinkles were morphologically characterized, sexed and their heavy metal content was determined using ICP-MS. Analysis revealed that *L. scabra* from polluted areas contained higher soft tissue heavy metal levels, were significantly smaller and weighed less compared to their conspecifics from the unpolluted mangroves. The current morphological observations may be explained in terms of growth and/or mortality rate differences between the polluted and non-polluted sites. Although a variety of stressors may account for these adverse morphological patterns, our data suggest a close relationship with the soft tissue heavy metal content. Compared to soft tissue heavy metal levels that were measured

in *L. scabra* along the same area in 1998, most metals, except for arsenic, chromium and iron have decreased dramatically.

Anthropogenic activities result in heavy metal accumulation and adverse morphological effects in the mangrove gastropod *Littoraria scabra*.

Keywords: Dar es Salaam; Heavy metals; *Littoraria scabra*; Mangrove; Zanzibar

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The biosorption of metal ions (Cr^{+3}, $Cr_2O_7^{-2}$, Cu^{+2}, and Ni^{+2}) on two algal blooms (designated HD-103 and HD-104) collected locally was investigated as a function of the initial metal ion concentration. The main constituent of HD-103 is *Cladophora* sp., while *Spirulina* sp. is present significantly in the bloom HD-104. Algal biomass HD-103 exhibited the highest Cu^{+2} uptake capacity (819 mg/g). This bloom adsorbed Ni^{+2} (504 mg/g), Cr^{+3} (347 mg/g), and $Cr_2O_7^{-2}$ (168 mg/g). Maximum of Ni^{+2} (1108 mg/g) is taken by HD-104. This species takes up 306, 202, and 576 mg/g Cr^{+3}, $Cr_2O_7^{-2}$, and Cu^{+2}, respectively. Equilibrium data fit very well to both the Langmuir and the Freundlich isotherm models. The sorption process followed the Freundlich model better. Pseudo-first-order kinetic model could describe the kinetic data. Infrared (IR) spectroscopic data were employed to identify the site(s) of bonding. It was found that phosphate and peptide moieties participate in the metal uptake by bloom HD-103. In the case of bloom HD-104, carboxylate and phosphate are responsible for the metal uptake. The role of protein in metal uptake by HD-103 was investigated using polyacrylamide gel electrophoresis.

Bioremediation

Adenipekun, Clementina Oyinkansola. (Department of Botany and Microbiology, University of Ibadan, Ibadan, Nigeria. E-mail: oyinpek@yahoo.com. Tel: 08033683516, 08055265186. Fax: 234- 02-8103043). Bioremediation of engine-oil polluted soil by *Pleurotus tuber-regium* Singer, a Nigerian white-rot fungus. African Journal of Biotechnology, Vol. 7 (1) (2008): 055-058

White-rot fungi have been used in various parts of the world for bioremediation of polluted sites. *Pleurotus tuber-regium* was noted to have the ability to increase nutrient contents in soils polluted with 1 - 40% engine-oil concentration after six months of incubation. *P. tuber-regium* increased organic matter, carbon and available potassium 5.19%, 2.99% and 0.97 meq/100 g respectively compared to 4.41%, 2.56% carbon and 0.66 meq/100 g, respectively in the control. However, higher values of 0.32% nitrogen, 11.42 ppm phosphorus and pH 6.94 were obtained in

the control compared to 0.16% nitrogen, 9.32 ppm phosphorus and pH 5.93 in soils incubated with the fungus. The fungus brought about an increase in copper content in engine oil polluted soils at 10% concentration followed by a decrease at 20 and 40% concentrations. Bioaccumulation of zinc and nickel was recorded at 20% engine-oil concentrations.

Keywords: Bioremediation, engine-oil polluted soil, nutrient contents, heavy metals, white-rot fungi.

T E. Ogbulie[1]*, J. N Ogbulie [2] and I Umezuruike[3]. ([1]Department of Biotechnology, Federal University of Technology, Imo State, Nigeria, [2]Department of Industrial Microbiology, Federal University of Technology, Imo State, Nigeria, [3]Quality Control Department, Unilever Nigerian Plc, Lagos State, Nigeria. *Corresponding author. E-mail: Ogbulie_toochi@yahoo.com. Tel: 08035472379, 08058796087). **Biodegradation of detergents by aquatic bacterial flora from Otamiri River, Nigeria. African Journal of Biotechnology Vol. 7 (6) (2008): 824**

The utilization of Omo®, Jet® and Persil® detergents by aquatic bacteria isolates from Otamiri River at Nekede in Owerri North, Imo State, Nigeria was investigated. Identification tests for bacteria isolates from Otamiri River revealed them to belong to the genera *Bacillus, Micrococcus, Escherichia, Enterobacter, Klebsiella, Psendomonas, Actinomyces, Corynebacterium, Serratia* and *Staphylococcus*. Detergent utilization studies revealed total heterotrophic count of 3.38, 3.40, 3.36 and 5.35 log cfu/ml and 2.08, 2.20, 1.95 and 3.48 log cfu/ml obtained at 0 and 48 h for Omo®, Jet®, Persil® and control experiment, respectively. At 96 and 144 h, 2.37, 2.35, 2.25 and 2.47 log cfu/ml and 2.39, 2.37, 2.35, and 2.46 log cfu/m were obtained. While counts of 1.70, 2.37, 1.38 and 2.4 log cfu/ml were obtained at 192 h for Omo®, Jet®, Persil® and the control experiment, respectively. Of the nine bacterial isolates obtained from the river water, only *Pseudomonas, Bacillus, Actinomyces, Corynebacterium* and *Staphylococcus* were found to survive in the detergent water and possibly utilize the test detergents. Isolate specific detergent utilization test revealed these isolates to be capable of utilizing the test detergents in single and combined forms with *Pseudomonas* showing the highest ability while the least was observed for *Staphylococcus*. Statistical analysis revealed significant changes in optical density of detergent broth challenged with the test organisms, with the organism showing more ability to utilize, Omo® and Jet® than Persil® detergents. The result obtained, however, reveals the ability of natural aquatic bacterial Isolates to degrade detergents in aquatic ecosystem.

Key words: Aquatic bacterial flora, detergents, biodegradation, Otamiri River, Nigeria.

Hazrat Ali* and Shah Khalid Muhammad. (Department of Biotechnology, University of Malakand, Chakdara, Pakistan. *Corresponding author. E-mail: hazratali80@yahoo.com, Tel: 92-945-764131 Ext. 3027). **Biodecolorization of acid violet 19 by *Alternaria solani*. African Journal of Biotechnology Vol. 7 (6) (2008): 831–833**

Microorganisms are the nature's tools for cleaning the environment. Bioremediation using bacteria, fungi and algae is becoming an attractive option for the treatment of industrial effluents containing a wide spectrum of pollutants including dyes and heavy metal ions. In the current research work, the potential of a deuteromycete fungus, *Alternaria solani* for the removal of a dye, Acid Violet 19 from aqueous solution was studied. The fungus showed promising potential for the decolorization of the dye (88.6%) at a dye concentration of 30 mg/L within a relatively

short period of time (four days). But with increase in the contact time, the % decolorization decreased showing that some of the adsorbed dye was desorbed especially in case of higher dye concentrations. The desorption of the dye from the fungal cells at long contact time and higher dye concentrations was considered to be due to higher molecular mass, structural complexity and the presence of inhibitory groups, SO_3Na in the dye.

Keywords: Decolorization, Acid Violet 19, *Alternaria solani*, biosorption, desorption.

S. M. I. Sajidu[1]*, I. Persson[2], W. R. L. Masamba[1, 3] and E. M. T. Henry[4]. ([1]Chemistry Department, University of Malawi, P.O Box 280, Zomba, Malawi, [2]Department of Chemistry, Swedish University of Agricultural Sciences, Box 7015, 75007 Uppsala, Sweden, [3]Harry Oppenheimer Okavango Research Centre, University of Botswana, P/Bag 285, Maun, Botswana, [4]Deceased. *Corresponding author. E-mail: sajidu@chanco.unima.mw. or ssajidu@yahoo.co.uk. Tel: +265 1 524 222. Fax: +265 1 524 046). **Mechanisms for biosorption of chromium (III), copper (II) and mercury (II) using water extracts of *Moringa oleifera* seed powder. African Journal of Biotechnology Vol. 7 (6) (2008): 800–804**

In continuation of our work on heavy metal remediation using *Moringa* seed powder, this study examines the mechanisms of metal sorption on water extracts of *Moringa oleifera* (MO) seed powder using extended X-ray absorption fine structure (EXAFS). Chromium(III) is hydrolysed to form a mixture of $[Cr_3(OH)_4(H_2O)_{10}]^{5+}$ and $[Cr(OH_x)_2<(OH)_2>]_n^{n\cdot(2x-3)+}$ complexes, x = 1 or 2. The chromium(III) complexes are octahedral with mean Cr-O bond distance of 1.97(2) Å. Copper (II) forms complexes with ligands with oxygen and/or nitrogen donor atoms, most likely amino and carboxylate groups. Copper(II) retain the typical Jahn-Teller distortion with Cu-O/N bond distances of 1.97(2) and 2.21(4) Å. Furthermore, a Cu···C distance at 2.96 Å, and a corresponding Cu-O-C 3-leg scattering path at 3.10 Å are observed as well, strongly supporting that a large fraction of carboxylate groups are bound to the copper(II) ion on the equatorial plane. Mercury (II) forms mainly linear complexes with nitrogen donor ligands, d(Hg-N) = 2.15(2) Å, most probably from amino groups in amino acids or proteins. This shows that the softer metal ions, copper(II) and mercury(II), form complexes with oxygen and/or nitrogen donor ligands in the MO extracts, while the harder and more highly charged chromium(III) ion becomes hydrolysed. The study therefore suggests that the successful biosorption of heavy metals by *Moringa*, a potential heavy metal removing agent, is attributable to its oxygen and nitrogen donating carboxylate and amino groups.

Keywords: Chromium, Copper, Mercury, *Moringa oleifera*, EXAFS.

Eleni Manousaki[a], Jana Kadukova[b], Nikolaos Papadantonakis[c] and Nicolas Kalogerakis[a]. ([a]Department of Environmental Engineering, Technical University of Crete, Polytechneioupolis, 73100 Chania, Greece, [b]Department of Non-Ferrous Metals and Waste Treatment, Technical University of Kosice, Letna 9, 04011 Kosice, Slovakia, [c]Department of Sustainable Agriculture, Mediterranean Agronomic Institute of Chania, Alsyllio Agrokepiou, P.O. Box 85, 73100 Chania, Greece). **Phytoextraction and phytoexcretion of Cd by the leaves of *Tamarix smyrnensis* growing on contaminated non-saline and saline soils. Environmental Research, Vol 106(3) (2008): 326-332**

Phytoremediation and more specifically phytoextraction, is an alternative restoration strategy for the clean up of heavy metal contaminated soils. Phytoextraction can only be successful if

suitable plant species colonize the contaminated area, extract the toxic substances and accumulate them in their above ground tissues.

In this study, the salt cedar *Tamarix smyrnensis* that is a widespread salt-tolerant plant in the Mediterranean region has been investigated. A pot experiment is conducted with *T. smyrnensis* grown in polluted soil with 16 ppm of cadmium and at three different salt concentrations (0.0, 0.5, 3.0% NaCl) for a 10-week period. It took place in an open-air area with natural light, at ambient temperature and humidity in an effort to keep the plants under conditions as similar as possible to those in the field. However, care was taken not to let them be rained on. Temperature ranged from 19 to 50 °C with 33 and 21 °C being the average day and night temperature, respectively. Humidity ranged from 28% to 87% with a 13–14 h photoperiod. The specific aims of this work are to investigate the accumulation of cadmium via root uptake at different saline conditions and cadmium excretion through salt glands on the surface of the leaves as a probable detoxification mechanism of the plant. Furthermore, measurements of chlorophyll content, biomass, and shoot length are used to evaluate the potential of the plant for the removal of cadmium from contaminated saline and non-saline soils.

The experimental data suggest that increased soil salinity results in an increase of the cadmium uptake by *T. smyrnensis*. Analysis of white salt crystals taken from glandular tissue confirmed the fact that this plant excretes cadmium through its salt glands on the surface of the leaves as a possible detoxification mechanism in order to resist metal toxicity. Excreted cadmium is again released into the environment and it is redeposited on the top soil. Furthermore, increased salinity results in an increased excretion of the metal on *Tamarix* leaf surface. The presence of metals usually affects negatively the plant health, but *T. smyrnensis* developed no visible signs of metal toxicity, only salt toxicity symptoms were observed. Cadmium usually decreases the chlorophyll content in plants; however, the amount of photosynthetic pigments of *T. smyrnensis* was found not to be affected. All the above points to the potential of *T. smyrnensis* for use in phytoremediation with the metal secretion from the leaves being a unique advantage that may change current phytoextraction practices.

Keywords: *Tamarix smyrnensis*; Cadmium; Phytoextraction; Phytoexcretion; Metal excretion; Salinity

Ozgür Dogan Uluozlu[a], Ahmet Sari[a], Mustafa Tuzen[a] and Mustafa Soylak[b.] ([a]Department of Chemistry, Gaziosmanpasa University, 60250 Tokat, Turkey, [b]Department of Chemistry, Erciyes University, 38039 Kayseri, Turkey). **Biosorption of Pb(II) and Cr(III) from aqueous solution by lichen (*Parmelina tiliaceae*) biomass. Bioresource Technology, Vol 99 (8) (2008): 2972-2980**

The biosorption characteristics of Pb(II) and Cr(III) ions from aqueous solution using the lichen (*Parmelina tiliaceae*) biomass were investigated. Optimum biosorption conditions were determined as a function of pH, biomass dosage, contact time, and temperature. Langmuir, Freundlich and Dubinin–Radushkevich (D–R) models were applied to describe the biosorption isotherm of the metal ions by *P. tiliaceae* biomass. Langmuir model fitted the equilibrium data better than the Freundlich isotherm. The monolayer biosorption capacity of *P. tiliaceae* biomass for Pb(II) and Cr(III) ions was found to be 75.8 mg/g and 52.1 mg/g, respectively. From the D–R isotherm model, the mean free energy was calculated as 12.7 kJ/mol for Pb(II) biosorption and 10.5 kJ/mol for Cr(III) biosorption, indicating that the biosorption of both metal ions was taken

place by chemical ion-exchange. The calculated thermodynamic parameters ($\Delta G°$, $\Delta H°$ and $\Delta S°$) showed that the biosorption of Pb(II) and Cr(III) ions onto *P. tiliaceae* biomass was feasible, spontaneous and exothermic under examined conditions. Experimental data were also tested in terms of biosorption kinetics using pseudo-first-order and pseudo-second-order kinetic models. The results showed that the biosorption processes of both metal ions followed well pseudo-second-order kinetics.

Keywords: *Parmelina tiliaceae*; Lead(II); Chromium(III); Biosorption; Kinetics

Tamer Akar[a], A. Safa Ozcan[b], Sibel Tunali[a] and Adnan Ozcan[b]. ([a]Department of Chemistry, Faculty of Arts and Science, Eskişehir Osmangazi University, 26480 Eskişehir, Turkey, [b]Department of Chemistry, Faculty of Science, Anadolu University, 26470 Eskişehir, Turkey). **Biosorption of a textile dye (Acid Blue 40) by cone biomass of *Thuja orientalis*: Estimation of equilibrium, thermodynamic and kinetic parameters. Bioresource Technology, Vol 99 (8) (2008): 3057-3065**

Biosorption of Acid Blue 40 (AB40) onto cone biomass of *Thuja orientalis* was studied with variation in the parameters of pH, contact time, biosorbent and dye concentration and temperature to estimate the equilibrium, thermodynamic and kinetic parameters. The AB40 biosorption was fast and the equilibrium was attained within 50 min. Equilibrium data fitted well to the Langmuir isotherm model in the studied concentration range of AB40 and at various temperatures. Maximum biosorption capacity (q_{max}) for AB40 was 2.05×10^{-4} mol g^{-1} or 97.06 mg g^{-1} at 20 °C. The changes of Gibbs free energy, enthalpy and entropy of biosorption were also evaluated for the biosorption of AB40 onto *T. orientalis*. The results indicate that the biosorption was spontaneous and exothermic. Kinetics of biosorption of AB40 was analyzed and rate constants were also derived and the results show that the pseudo-second-order kinetic model agrees very well with the experimental data.

Keywords: *Thuja orientalis*; Biosorption; AB40; Isotherms; Kinetics

M.G.A. Vieira[a], R.M. Oisiovici[a], M.L. Gimenes[b] and M.G.C. Silva[a,]. ([a]UNICAMP, State University of Campinas, Chemical Engineering (FEQ), C. P. 6066 – Barão Geraldo-Campinas, São Paulo, CEP 13083-970, Brazil, [b]UEM, State University of Maringá, Chemical Engineering Department (DEQ), Bloco D90, Av. Colombo 5790, CEP 87020-900, Maringá – PR, Brazil). **Biosorption of chromium(VI) using a *Sargassum* sp. packed-bed column. Bioresource Technology. Vol 99(8) (2008): 3094-3099**

Chromium(VI) is present in several industrial wastewaters and it can cause health and environmental hazards above certain concentrations. Equilibrium studies have shown the feasibility of using *Sargassum* sp. algae for chromium removal from aqueous solutions by biosorption. However, for the design and operation of chromium biosorption processes, dynamic flow studies are required. The objective of the study was to examine chromium(VI) removal from an aqueous solution using a packed-bed column with *Sargassum* sp. algae as a biosorbent. The dynamic behavior of the biosorption column was investigated through experiments and the influence of operating conditions, such as initial chromium concentration, flow rate and amount of biosorbent, on the column removal capacity have been analyzed using the factorial design methodology. The capacity of removal obtained at optimum conditions was 19.06 mg of metal/g biosorbent.

Keywords: Biosorption; Chromium; Wastewater; Packed-bed columns

V. Padmavathy [a]. ([a]e-Lab Analytical, Inc., 10450 Stancliff Road, Suite 210, Houston, TX 77099, USA). Biosorption of nickel(II) ions by baker's yeast: Kinetic, thermodynamic and desorption studies. Bioresource Technology, Vol 99(8) (2008): 3100-3109

In this study, the biosorption of nickel(II) ion on deactivated protonated yeast was investigated as a function of temperature at different initial metal ion concentrations. The effect of temperature on the sorption was more significant at lower nickel(II) ion concentrations compared to higher concentrations. The protonated yeast biomass exhibited the highest nickel(II) ion uptake capacity at 27 °C at an initial nickel(II) ion concentration of 400 mg/l and an initial pH of 6.75. The biosorption capacity decreased from 9.8 to 9.3 mg/g at an initial nickel(II) ion concentration of 400 mg/l, while at a lower initial concentration of 100 mg/l, it decreased from 8.2 to 4.9 mg/g, as the temperature was increased from 27 °C to 60 °C. The equilibrium data fit better to the Freundlich and Redlich–Peterson isotherm models compared to the Langmuir model in the concentration range studied (10–400 mg/l). Kinetic models applied to the sorption data at different temperatures showed that nickel(II) ion uptake process followed the pseudo-second order rate model and the adsorption rate constants decreased with increasing temperature. The activation energy of biosorption (E_a) was determined to be −13.3 kJ/mol using the pseudo-second order rate constants. The results indicated that the biosorption of nickel(II) ion on to baker's yeast was spontaneous and exothermic in nature. Desorption studies revealed that the protonated yeast biomass can be regenerated using 0.1N HCl and reused.

Keywords: Activation energy; Biosorption; Baker's yeast; Desorption; Nickel(II) ion; Thermodynamic parameters

C. Namasivayam [a,] and M.V. Sureshkumar[a]. ([a]Environmental Chemistry Division, Department of Environmental Sciences, Bharathiar University, Coimbatore 641046, India). Removal of chromium(VI) from water and wastewater using surfactant modified coconut coir pith as a biosorbent. Bioresource Technology, Vol 99(7) (2008): 2218-2225

Coconut coir pith, an agricultural solid waste was used as biosorbent for the removal of chromium(VI) after modification with a cationic surfactant, hexadecyltrimethylammonium bromide. Optimum pH for Cr(VI) adsorption was found to be 2.0. Reduction of Cr(VI) to Cr(III) occurred to a slight extent during the removal. Langmuir, Freundlich and Dubinin Radushkevich (D–R) isotherms were used to model the adsorption equilibrium data and the system followed all the three isotherms. The adsorption capacity of the biosorbent was found to be 76.3 mg g^{-1}, which is higher or comparable to the adsorption capacity of various adsorbents reported in literature. Kinetic studies showed that the adsorption obeyed second order and Elovich model. Thermodynamic parameters such as ΔG^0, ΔH^0 and ΔS^0 were evaluated, indicating that the overall adsorption process was endothermic and spontaneous. Effects of foreign anions were also examined. The adsorbent was also tested for the removal of Cr(VI) from electroplating effluent.

Keywords: Coir pith; Chromium(VI); Biosorption; Kinetics; Isotherms

Rani Devi[a], Esayas Alemayehu[a], Vijender Singh[b], Ashok Kumar[c] and Embialle Mengistie[a]. ([a]Department of Environmental Science and Technology, Jimma University, P.O. Box 378, Ethiopia, [b]District Science Specialist, Hisar, Haryana, India, [c]District Food and Supplies Officer, Sirsa, Haryana, India) Removal of fluoride, arsenic and coliform bacteria by

modified homemade filter media from drinking water. Bioresource Technology, Vol 99(7) (2008): 2269-2274

An attempt was made to investigate the removal of fluoride, arsenic and coliform bacteria from drinking water using modified homemade filter media. Batch mode experimental study was conducted to test the efficiency of modified homemade filter for reduction of impurities under the operating condition of treatment time. The physico-chemical and biological analysis of water samples had been done before and after the treatment with filter media, using standard methods. Optimum operating treatment time was determined for maximum removal of these impurities by running the experiment for 2, 4, 6, 8, 10 and 12 h, respectively. The maximum reduction of fluoride, arsenic and coliform bacteria in percentage was 85.60%, 93.07% and 100% and their residual values were 0.72 mg/l, 0.009 mg/l and 0 coliform cells/100 ml, respectively after a treatment time of 10 h. These residual values were under the permissible limits prescribed by WHO. Hence this could be a cheap, easy and an efficient technique for removal of fluoride, arsenic and coliform bacteria from drinking water.

Keywords: Arsenic; Coliform bacteria; Drinking water; Fluoride; Homemade filter media; Modified homemade filter media

Serkan Eker[a] and Fikret Kargi[a]. ([a]Department of Environmental Engineering, Dokuz Eylul University, Buca, Izmir, Turkey). **Biological treatment of 2,4-dichlorophenol containing synthetic wastewater using a rotating brush biofilm reactor. Bioresource Technology,** Vol 99(7) (2008): 2319-2325

A newly developed rotating brush biofilm reactor was used for DCP, COD and toxicity removal from 2,4-dichlorophenol (DCP) containing synthetic wastewater at different feed COD, TCP concentrations and *A*/*Q* (biofilm surface area/feed flow rate) ratios. A Box–Wilson statistical experiment design was used by considering the feed DCP (50–500 mg l^{-1}), COD (2000–6000 mg l^{-1}) and *A*/*Q* ratio (73–293 m^2 d m^{-3}) as the independent variables while percent DCP, COD, and toxicity removals were the objective functions. The experimental data were correlated by a quadratic response function and the coefficients were determined by regression analysis. Percent DCP, COD and toxicity removals calculated from the response functions were in good agreement with the experimental data. DCP, COD and toxicity removals increased with increasing *A*/*Q* ratio and decreasing feed DCP concentrations. The optimum *A*/*Q* ratio resulting in the highest COD (90%), DCP (100%) and toxicity (100%) removals with the highest feed COD (6000 mg l^{-1}) and DCP (500 mg l^{-1}) contents was nearly 210 m^2 d m^{-3}.

Keywords: Biological treatment; Rotating brush biofilm reactor (RBBR); Toxicity removal; 2,4-Dichlorophenol (DCP)

Sevilay Cengiz[a] and Levent Cavas [a]. ([a]Dokuz Eylul University, Faculty of Arts and Sciences, Department of Chemistry, Biochemistry Division, Tinaztepe Campus, Izmir, Turkey). **Removal of methylene blue by invasive marine seaweed: *Caulerpa racemosa* var. *cylindracea*. Bioresource Technology, Vol 99(7) (2008): 2357-2363**

Caulerpa racemosa var. *cylindracea* is one of the well-known invasive species in the Mediterranean Sea. In the present study, dried biomass of *C. racemosa* var. *cylindracea* was shown to have adsorption capacity for methylene blue. The adsorption reached equilibrium at 90 min for all studied concentrations (5–100 mg/L). The pseudo-second-order model is well in

line with our experimental results. There was a sharp increase in the adsorbed dye amount per adsorbent amount from 3.3 to 16.7 g/L, then a slight increase up to 66.7 g/L was observed. Langmuir and Freundlich's models were applied to the data related to adsorption isotherm. According to Langmuir's model data, the observed maximum adsorption capacity (q_m) was 5.23 mg/g at 18 °C. The enthalpy of adsorption was found to be 33 kJ/mol, which indicated a chemical adsorption between dye molecules and *C. racemosa* var. *cylindracea* functional groups.

Keywords: Biosorption; *Caulerpa racemosa* var. *cylindracea*; Dye removal; Methylene blue; Waste waters

Mustafa Tuzen[a], Kadriye Ozlem Saygi[a], Canan Usta[b] and Mustafa Soylak[c]. ([a]Gaziosmanpasa University, Faculty of Science and Arts, Chemistry Department, 60250 Tokat, Turkey, [b]Gaziosmanpasa University, Faculty of Science and Arts, Biology Department, 60250 Tokat, Turkey, [c]Erciyes University, Faculty of Science and Arts, Chemistry Department, 38039 Kayseri, Turkey) ***Pseudomonas aeruginosa* immobilized multiwalled carbon nanotubes as biosorbent for heavy metal ions. Bioresource Technology, Vol 99(6) (2008): 1563-1570**

Pseudomonas aeruginosa immobilized multiwalled carbon nanotubes has been used as biosorbent for the solid phase extraction of some heavy metal ions in environmental samples. Cobalt(II), cadmium(II), lead(II), manganese(II), chromium(III) and nickel(II) ions have been selected as analytes for the presented study, due to their important negative and positive roles in human life. In order to investigate quantitative biosorption conditions of the analytes, the influences of pH of the aqueous solution, eluent type, eluent vol , samples vol , etc. were examined. The effects of alkaline, earth alkaline and some transitions metals on the biosorption of analyte ions on *P. aeruginosa* immobilized multiwalled carbon nanotubes were also investigated. The presented biosorption procedure was applied to the determination of analytes in tomato leaves, bovine liver, boiled wheat, canned fish, black tea, lichen and natural water samples.

Keywords: *Pseudomonas aeruginosa*; Multiwalled carbon nanotubes; Biosorption; Preconcentration; Trace metal

D. Pokhrel[a] and T. Viraraghavan[a]. ([a]Faculty of Engineering, University of Regina, 3737 Wascana Parkway, Regina, SK, Canada S4S 0A2). **Arsenic removal in an iron oxide-coated fungal biomass column: Analysis of breakthrough curves. Bioresource Technology, Vol 99(6) (2008). 2067-2071**

Column studies were conducted, using iron oxide-coated *Aspergillus niger* biomass, to examine the removal of arsenic [As(III) and As(V)] from an aqueous solution. The Thomas and Yan models were examined to predict the breakthrough curves. The Yan Model described the data better (based on the R^2 values) when compared with the Thomas Model. The adsorption capacity of the iron oxide-coated biomass estimated by the Thomas Model {1070 μg/g for As(V) and 700 μg/g for As(III)} was comparable to the calculated value of its adsorption capacity {1080 μg/g for As(V) and 880 μg/g for As(III)}.

Keywords: Arsenic removal; Fungal biomass; Column study; Iron oxide-coated biomass

L. Jiménez[a], E. Ramos[b], M.J. De la Torre[b], I. Pérez[b] and J.L. Ferrer[a]. ([a]Departamento de Ingeniería Química, Campus de Rabanales, Edificio C-3, Universidad de Córdoba, 14071-Córdoba, Spain, [b]Departamento de Ciencias Ambientales, Carretera de Utrera, Universidad Pablo de Olavide, Sevilla, Spain). **Bleaching of soda pulp of fibres of *Musa textilis nee* (abaca) with peracetic acid. Bioresource Technology, Vol 99(5) (2008): 1474-1480**

In this work, we studied the influence of operational variables in the bleaching of soda pulp of *Musa textilis nee* (abaca) [viz. temperature (55–85 °C), bleaching time (30–150 min) and peracetic acid concentration oven dry pulp (0.5–4.5%)] on the kappa number and viscosity of the bleached pulp, as well as on the breaking length, burst index and brightness of paper sheets made from it.

For this purpose, we used a central composite factorial design in order to identify the optimum operating conditions. In this way equations relating the dependent variables to the operational variables of the bleaching process were derived. These equations reproduce the dependent variables with errors less than 12% for all, except the viscosity which was predicted with errors less than 18%.

Obtaining bleached pulp with the highest possible viscosity (1519 ml/g), and paper sheets with the maximum possible breaking length (6547 m) and burst index (5.00 kN/g), entails using a temperature of 55 °C, a peracetic acid concentration of 4.5% and a bleaching time of 150 min. This provides a brightness of 79.90%, which is only 6.53% lower than the maximum possible value (85.48%).

Keywords: *Musa textilis nee*; Abaca; Bleaching; Soda pulp; Strength properties

F.J. Álvarez-Hornos[a], C. Gabaldón[a], V. Martínez-Soria[a], M. Martín[b], P. Marzal[a] and J.M. Penya-roja[a]. ([a]Department of Chemical Engineering, University of Valencia, Dr. Moliner, 50, 46100 Burjassot, Spain, [b]Department of Hydraulic and Environmental Engineering, Polytechnic University of Valencia, Camino de Vera s/n, 46022 Valencia, Spain). **Biofiltration of ethylbenzene vapours: Influence of the packing material. Bioresource Technology, Vol 99(2) (2008): 269-276**

In order to investigate suitable packing materials, a soil amendment composed of granular high mineralized peat (35% organic content) locally available has been evaluated as carrier material for biofiltration of volatile organic compounds in air by comparison with a fibrous peat (95% organic content). Both supports were tested to eliminate ethylbenzene from air streams in laboratory-scale reactors inoculated with a two-month conditioned culture. In pseudo-steady state operation, experiments at various ethylbenzene inlet loads (ILs) were carried out. Maximum elimination capacity of about 120 g m^{-3} h^{-1} for an IL of 135 g m^{-3} h^{-1} was obtained for the fibrous peat. The soil amendment reactor achieved a maximum elimination capacity of about 45 g m^{-3} h^{-1} for an inlet load of 55 g m^{-3} h^{-1}. Ottengraf–van den Oever model was applied to the prediction of the performance of both biofilters. The influence of gas flow rate was also studied: the fibrous peat reactor kept near complete removal efficiency for empty bed residence times greater than 1 min. For the soil amendment reactor, an empty bed residence time greater than 2 min was needed to achieve adequate removal efficiency. Concentration profiles along the biofilter were also compared: elimination occurred in the whole fibrous peat biofilter, while in the soil amendment reactor the biodegradation only occurred in the first 65% part of the biofilter.

Results indicated that soil amendment material, previously selected to increase the organic content, would have potential application as biofilter carrier to treat moderate VOC inlet loads.

Keywords: Air control pollution; Biofiltration; Ethylbenzene; Volatile organic compounds

Lei Yang[a] and J. Paul Chen[a, b]. ([a]Department of Chemical and Biomolecular Engineering, National University of Singapore, 10 Kent Ridge Crescent, Singapore 119260, Singapore, [b]Division of Environmental Science and Engineering, National University of Singapore, 10 Kent Ridge Crescent, Singapore 119260, Singapore). **Biosorption of hexavalent chromium onto raw and chemically modified *Sargassum* sp. Bioresource Technology, Vol 99(2) (2008): 297-307**

Hexavalent chromium biosorption by raw algae is always accompanied with significantly high organic leaching. In this study, hydrochloric acid, sodium hydroxide, calcium chloride, formaldehyde, and glutaraldehyde were used for modification of raw *Sargassum* sp. seaweed (RSW), in order that the modified seaweed (MSW) has a lower organic leaching while the metal biosorption capacity is comparable to the RSW. The result shows that the chemical modification by 0.2% formaldehyde achieves such goals. The biosorption of both RSW and MSW is highly pH dependent. At the optimal pH of 2.0, the maximum biosorption capacities of MSW and RSW are 1.123 and 0.601 mmol g^{-1}, respectively. The surface treatment improves the reduction capacity of the biosorbents. The instrumental analysis demonstrates that the Cr(VI) biosorption is controlled by redox, ion exchange and coordination reactions, of which alcohol, carboxyl, amino and sulphonic groups play important roles. The complete uptake of hexavalent chromium is achieved in 20 h. The chemical reduction for Cr(VI) to Cr(III) is pH dependent and controls the overall chromium removal kinetics.

Keywords: Biosorption; Hexavalent chromium; *Sargassum* sp.; Organic leaching; Modification

A.L. John Peter[a] and T. Viraraghavan[a]. ([a]Faculty of Engineering, University of Regina, Regina, Saskatchewan, Canada S4S 0A2). **Removal of thallium from aqueous solutions by modified *Aspergillus niger* biomass. Bioresource Technology, Vol 99(3) (2008): 618-625**

The present study involves an investigation of various treated fungal biomasses of *Aspergillus niger* for the removal of thallium from aqueous solutions. Batch pH and kinetic studies were carried out to examine the effects of pH and contact time on the adsorption process. Among various pH values studied, the optimum pH was found to be between 4 and 5. The equilibrium time for Tl adsorption was found to be 6 h and the rate of Tl adsorption was rapid in the initial hours. Both Lagergren's pseudo first-order model and Ho's pseudo second-order model well described the reaction kinetics. Batch adsorption experiments conducted at room temperature (22 ± 1 °C) showed that the adsorption pattern followed the Freundlich isotherm model. Column studies using iron oxide-coated immobilized fungal biomass showed lower adsorption capacities compared to batch studies.

Keywords: Thallium; Adsorption; *A. niger*; Kinetics; Isotherms

Thomas L. Eberhardt[a] and Soo-Hong Min[b]. ([a]USDA Forest Service, Southern Research Station, 2500 Shreveport Highway, Pineville, LA 71360, USA, [b]Samsung Corporation, Technology Division, 270-1, Seohyun-Dong, Bundang-Gu, Sungnam-Si, Gyonggi-Do 463-824, Republic of Korea). **Biosorbents prepared from wood particles treated with anionic**

polymer and iron salt: Effect of particle size on phosphate adsorption. Bioresource Technology, Vol 99(3) (2008): 626-630

Biomass-based adsorbents have been widely studied as a cost-effective and environmentally-benign means to remove pollutants and nutrients from water. A two-stage treatment of aspen wood particles with solutions of carboxymethyl cellulose (CMC) and ferrous chloride afforded a biosorbent that was effective in removing phosphate from test solutions. FTIR spectroscopy of the biosorbent samples showed a decrease in the intensity of the carboxylate signal coinciding with a decrease in particle size. Elemental analysis results showed the iron content of both the biosorbent samples, and wood particles treated with ferrous chloride alone, to also decrease with particle size. The relationship between iron content and particle size for the biosorbent samples appeared to be a function of both the amount of CMC–Fe complex and the efficiency of removing free iron ions after treating. Sorption testing results showed a strong linear correlation between the phosphorous uptake capacities and the iron contents of the samples adjusted for losses of iron during testing. As anticipated, pretreating with the anionic polymer provided additional sites to complex iron and thereby imparted a greater phosphorous uptake capacity. Although the larger wood particles provided a greater amount of iron for phosphate removal, smaller wood particles may be preferred since they afforded the lowest release of iron relative to the amount of phosphate removed.

Keywords: Adsorption; Biomass; Biosorbent; Carboxymethyl cellulose; Phosphate

Karine Jézéquel[a] and Thierry Lebeau[a]. ([a]Laboratoire Gestion des Risques et Environnement, Université de Haute-Alsace, Antenne de Colmar, BP 50568, 68 008 Colmar Cedex, France). Soil bioaugmentation by free and immobilized bacteria to reduce potentially phytoavailable cadmium. Bioresource Technology, Vol 99(4) (2008): 690-698

Soil bioaugmentation was performed in soil pots to reduce the cadmium potentially available for plants. A *Bacillus* sp. (isolate ZAN-044) and a *Streptomyces* sp. (isolate R25) were compared, just as the inoculation technique, i.e., inoculum size, free or immobilized cells. After 3 weeks of a batch incubation, the potentially phytoavailable Cd was reduced, at the maximum, to a factor 14.1 and 4.3 with *Bacillus* sp. ZAN-044 and *Streptomyces* sp. R25, respectively. The two bacteria survived and colonized the soil. The immobilization technique did not improve the cell survival in the bioaugmented soil. The potentially phytoavailable Cd was positively (r^2 = +0.73) or negatively correlated (r^2 = −0.78) to the cell concentration in the sterilized soil bioaugmented with *Bacillus* sp. ZAN-044 or *Streptomyces* sp. R25, respectively. The major effect upon the phytoavailable Cd was the microorganism used and, to a lesser extent, the inoculum size and the culture technique.

Keywords: Soil bioremediation; Cadmium; *Bacillus* sp.; *Streptomyces* sp.; Cell immobilization

Bao-E. Wang[a, b], Yong-You Hu[a], Lei Xie[a] and Kang Peng[a]. ([a]School of Environmental Science and Technology, South China University of Technology, Guangzhou 510640, China, [b]Department of Environmental Science and Technology, Zhongkai University of Agriculture and Technology, Guangzhou 510225, China). Biosorption behavior of azo dye by inactive CMC immobilized *Aspergillus fumigatus* beads. Bioresource Technology, Vol 99(4) (2008): 794-800

The biosorption equilibria and kinetics of an azo dye (reactive brilliant red K-2BP) were examined in this study using inactive carboxylmethylcellulose (CMC) immobilized *Aspergillus fumigatus* beads as the biosorbent. It was found that the biosorption capacity was at maximum when dye solution pH was about 2.0, that the sorption was spontaneous and endothermic with insignificant entropy changes, and that the Freundlich isotherm model fitted well to the biosorption equilibrium data. The biosorption rates were found to be consistent with a pseudo-second-order model. An intraparticle diffusion-based Weber–Morris model was applied to evaluate rate-limiting steps of the biosorption processes. The results suggested that the diffusion controlled the overall biosorption process, but the boundary layer diffusion of dye molecules could not be neglected. External mass transfer coefficients ($\beta_I S$) obtained by both Mathews and Weber model and Frusawa and Smith model were consistent.

Keywords: Biosorption; Inactive immobilized beads; Isotherm; Mass transfer; Pseudo-second-order kinetics; Thermodynamics

Sandra Lameiras[a], Cristina Quintelas [a,] and Teresa Tavares[a]. ([a]IBB-Institute for Biotechnology and Bioengineering, Centre for Biological Engineering, University of Minho, 4710-057 Braga, Portugal). **Biosorption of Cr (VI) using a bacterial biofilm supported on granular activated carbon and on zeolite. Bioresource Technology, Vol 99(4) (2008): 801-806**

Two mini-columns partially filled with granular activated carbon (GAC) and/or a natural zeolite, covered by a bacterial biofilm of *Arthrobacter viscosus*, were used in a continuous flow system to remove Cr (VI) from solutions with initial concentration of 70 mg/l and a working pH ranging between 4.5 and 5.5. Three different set-up's were used: two columns in series filled GAC covered with a biofilm, two columns in series filled with zeolite covered with a biofilm and a column filled with GAC followed by another column filled with zeolite, both supports covered with biofilm. Comparatively, the biosorption system supported on GAC reaches similar removal values, 19%, as the one supported on the zeolite, 18%, but when these two beds are used in combination better performances are reached, i.e. 42% removal. The maximum uptake values ranged from 0.57 $mg_{Cr}/g_{Support}$ to 3.58 $mg_{Cr}/g_{Support}$. The interactions between metal ions and functional groups on the cell wall surface of the biomass were confirmed by FTIR. GAC was regenerated with steam draughting and reused twice. The first regeneration caused a decrease in the removal capacity of 38% and the second regeneration caused a total decrease in the removal capacity of 76%.

Keywords: Activated carbon; Biofilm; Biosorption; Chromium (VI); Zeolite

Xue-Fei Sun[a], Shu-Guang Wang[a], Xian-Wei Liu[a], Wen-Xin Gong[a], Nan Bao[a], Bao-Yu Gao[a] and Hua-Yong Zhang[b]. ([a]School of Environmental Science and Engineering, Shandong University, Jinan 250100, China, [b]Energy and Environmental Research Center, North China Electric Power University, Beijing 102206, China). **Biosorption of Malachite Green from aqueous solutions onto aerobic granules: Kinetic and equilibrium studies. Bioresource Technology, Vol 99(9) (2008): 3475-3483**

Batch experiments were conducted to study the biosorption characteristics of a cationic dye, Malachite Green (MG), onto aerobic granules. Effects of pH, aerobic granule dosage, contact time and solution temperature on MG biosorption by aerobic granules were evaluated. Simultaneity the thermodynamic analysis was also performed. The results showed that alkaline

pH was favorable for the biosorption of MG and chemisorption seemed to play a major role in the biosorption process. Kinetic studies indicate that MG biosorption on aerobic granules in the system follows the pseudo-second order kinetics. The equilibrium time was 60 min for both 50 and 60 mg/L and 120 min for both 70 and 80 mg/L MG concentrations, respectively. Moreover, the experimental equilibrium data have been analyzed using the linearized forms of Langmuir, Freundlich, and Redlich–Peterson isotherms and the Langmuir isotherm was found to provide the best theoretical correlation of the experimental data for the biosorption of MG. The monolayer biosorption (saturation) capacities were determined to be 56.8 mg of MG per gram of aerobic granules at 30 °C. Thermodynamic analysis show that biosorption follows an endothermic path of the positive value of ΔH° and spontaneous with negative value of ΔG°.

Keywords: Aerobic granule; Malachite Green; Biosorption; Equilibrium isotherm; Kinetic study

M. Eiroa[a], A. Vilar[a], C. Kennes[a] and M.C. Veiga [a]. ([a]Chemical Engineering Laboratory, Faculty of Sciences, University of A Coruña, Alejandro de la Sota 1, 15008-A Coruña, Spain). Effect of phenol on the biological treatment of wastewaters from a resin producing industry. Bioresource Technology, Vol 99(9) (2008): 3507-3512

The effect of phenol on the biological treatment of wastewaters from a resin producing industry was analyzed in a pre-denitrification system. First, the effect of phenol overloads on the removal of organic matter and nitrogen compounds was studied. During the overloads (from 250 to 4000 mg/L), phenol was detected in the effluent of the anoxic reactor but the system recovered fast after stopping the overloads. The total organic carbon (TOC) removal remained unchanged during phenol addition (91.9% at 0.20 kg TOC/m^3 d), except for the highest overload. With regard to total Kjeldahl nitrogen (TKN), its mean removal (87.9% at 0.08 kg TKN/m^3 d) was not affected by the phenol overloads. Afterwards, the effect of different phenol concentrations on the biological treatment of these wastewaters was analyzed. Phenol concentrations from 250 to 4000 mg/L were added to the feed. Phenol was completely removed despite the presence of other carbon sources in the wastewater. In spite of the presence of phenol, a TOC removal around 91.3% was achieved at an average organic loading rate of 0.11 kg TOC/m^3 d. The mean applied nitrogen loading rates were 0.05 and 0.08 kg TKN/m^3 d, obtaining TKN removals around 85.8% and 87.1%, respectively. Therefore, the biological treatment of wastewaters from a resin producing industry in a pre-denitrification system was not affected by the presence of phenol.

Keywords: Phenol; Industrial wastewaters; Biological treatment

Hyeun-Jong Bae[a], Hyun Joo Kim[a] and Yoon Soo Kim[a]. ([a]Department of Forest Products and Technology, BK21 Program, Chonnam National University, Gwangju 500-757, Republic of Korea). Production of a recombinant xylanase in plants and its potential for pulp biobleaching applications. Bioresource Technology, Vol 99(9) (2008): 3513-3519

The purpose of this study was to produce recombinant xylanase in transgenic plants and to test its potential application for pulp bleaching. The *xynII* xylanase gene from *Trichoderma reesei* was inserted into the *Arabidopsis* genome. Many transgenic plants produced biologically active XYNII and accumulated in leaves at level of 1.4–3.2% of total soluble proteins. The bleaching ability of XYNII on Kraft pulp was demonstrated by a reduction in the kappa number and the residual lignin contents. The bleaching efficiency of transgenic plant produced XYNII was similar to commercial xylanase on unbleached Kraft pulp. The effect of xylanase treatment on

Kraft pulp was also investigated by SEM. Clear physical change on the pulp fiber surface was observed and was related to the amount xylan removed and microfibrils were visible on the fiber surface. This report demonstrates the potential application of plant produced recombinant xylanase for pulp and paper bleaching.

Keywords: Biobleaching; Plant expression; Transgenic plant; Xylanase

Valeria Prigione[a], Giovanna Cristina Varese [a], Leonardo Casieri[a] and Valeria Filipello Marchisio[a]. ([a]Università degli Studi di Torino, Dipartimento di Biologia Vegetale, Viale Mattioli 25, 10125 Torino, Italy). **Biosorption of simulated dyed effluents by inactivated fungal biomasses. Bioresource Technology, Vol 99(9) (2008): 3559-3567**

Treatment of dyed effluents presents several problems mainly due to the toxicity and recalcitrance of dyestuffs. Innovative technologies, such as biosorption, are needed as alternatives to conventional methods to find inexpensive ways of removing dyes from large vol s of effluents. Inactivated biomasses do not require a continuous supply of nutrients and are not sensitive to the toxicity of dyes or toxic wastes. They can also be regenerated and reused in many cycles and are both safe and environment-friendly. The sorption capacities (SC) of autoclaved biomasses of three Mucorales fungi (*Cunninghamella elegans*, *Rhizomucor pusillus* and *Rhizopus stolonifer*), cultured on two different media, were evaluated against simulated effluents containing concentrations of 1000 and 5000 ppm of a single dye and a mix of 10 industrial textile dyes in batch experiments. SC values of up to 532.8 mg of dye g^{-1} dry weight of biomass were coupled with high effluent decolourisation percentages (up to 100%). These biomasses may thus prove to be extremely powerful candidates for dye biosorption from industrial wastewaters. Even better results were obtained when a column system with the immobilised and inactivated biomass of one fungus was employed.

Keywords: Biosorption; *Cunninghamella elegans*; *Rhizomucor pusillus*; *Rhizopus stolonifer*; Synthetic dyes

Ruoyu D. Chen[1], Michael J. Semmens[1] and Timothy M. LaPara[1]. ([1]Department of Civil Engineering, University of Minnesota, 122 Civil Engineering, 500 Pillsbury Drive SE, Minneapolis, MN 55455-0116, USA). **Biological treatment of a synthetic space mission wastewater using a membrane-aerated, membrane-coupled bioreactor (M2BR). Journal of Industrial Microbiology and Biotechnology, Vol 35(6) (2008): 465-473**

This paper describes the membrane-aerated, membrane-coupled bioreactor (M2BR), which was developed for wastewater treatment during long-term space missions because it achieves aeration and biomass separation using components that are compatible with microgravity conditions. In the experiments described herein, the M2BR was used to treat a synthetic wastewater formulated by NASA to simulate the wastewater typically collected during space missions. The M2BR was able to achieve more than 90% removal of both chemical oxygen demand (COD) and total nitrogen when it was fed a modified NASA wastewater that had a 4:1 COD to nitrogen ratio. When the full-strength synthetic wastewater was fed to the M2BR (COD:N = 1), however, the nitrogenous pollutant removal efficiency was adversely affected because of either insufficient oxygen transfer to support nitrification (an air-fed M2BR) or insufficient electron donor to support denitrification (an oxygen-fed M2BR). In conclusion, the M2BR provides considerable promise for wastewater treatment during long-term space missions,

although additional research is needed to identify the best approach to treat the space mission wastewater, which poses a unique challenge because of its low COD:N ratio.

Keywords M2BR - MABR - Membrane filtration - Microgravity - Space travel - Wastewater treatment

Apostolos Giannis[a], Evangelos Gidarakos [a,] and Antigoni Skouta[a]. ([a]Laboratory of Toxic and Hazardous Waste Management, Department of Environmental Engineering, Technical University of Crete, Politechnioupolis, Chania 73100, Greece). Transport of cadmium and assessment of phytotoxicity after electrokinetic remediation. Journal of Environmental Management. Vol 86(3) (2008): 535-544

The use of ethylene diamine tetraacetic acid (EDTA) on the electrokinetic removal of cadmium-contaminated soil was evaluated. A total of four different tests were conducted using EDTA as a washing solution as well as a purging solution at the electrode compartments. The efficiency of electrokinetic extraction was significantly influenced by the pH of the soil medium. The results show that EDTA was effective in desorbing cadmium at a high pH, with Cd–EDTA^{-} anion complexes migrating toward the anode. At low pH values near the anode area, cadmium existed as Cd^{2+}, migrating toward the cathode. Such contradicting directions of cadmium have resulted in its detrimental removal from the soil cell. However, accumulation of cadmium near the cathode was observed at the end of the tests due to the dominating low pH in the soil cell. The phytotoxicity after the electrokinetic process was investigated using *Sorghum saccharatum*, *Lepidium sativum* and *Sinapis alba* plants. The germination index was a major endpoint estimated by measuring seed germination and shoot elongation. The results obtained show that the phytotoxicity was increased after electrokinetic extraction. Despite, the extensive cadmium removal from two-thirds of the cell, the low pH of the soil was the principal parameter exhibiting the phytotoxicity.

Keywords: Cadmium; EDTA; Electrokinetic remediation; Phytotoxicity; Germination index

Mazhar Abbas[1], Raziya Nadeem[1], Muhammad Nadeem Zafar[1, 3] and Mamoona Arshad[2]. ([1]Department of Chemistry, University of Agriculture, Faisalabad, 38040, Pakistan, [2]Bioprocess Technology Division, National Institute for Biotechnology and Genetic Engineering (NIBGE), Faisalabad, 577, Pakistan, [3]*Present address:* Department of Analytical Chemistry, Lund University, P.O. Box 124, SE-221 00 Lund, Sweden). Biosorption of Chromium (III) and Chromium (VI) by Untreated and Pretreated *Cassia fistula* Biomass from Aqueous Solutions. Water, Air, & Soil Pollution, Vol 191(1-4) (2008): 139-148

The present study explained the effect of pretreatments on the biosorption of Cr (III) and Cr (VI) by *Cassia fistula* biomass from aqueous solutions. For this purpose *Cassia fistula* biomass was pretreated physically by heating, autoclaving, boiling and chemically with sodium hydroxide, formaldehyde, gluteraldehyde, acetic acid, hydrogen peroxide, commercial laundry detergent, orthophosphoric, sulphuric acid, nitric acid, and hydrochloric acid. The adsorption capacity of biomass for Cr (III) and Cr (VI) was found to be significantly improved by the treatments of gluteraldehyde (95.41 and 96.21 mg/g) and benzene (85.71 and 90.81 mg/g) respectively. The adsorption capacity was found to depend on pH, initial metal concentration, dose, size, kinetics, and temperature. Maximum adsorption of both the Cr (III) and Cr (VI) was observed at pH 5 and 2. When Freundlich and Langmuir isotherms were tested, the latter had a better fit with the

experimental data. The kinetic studies showed that the sorption rates could be described better by a second order expression than by a more commonly applied Lagergren equation.

Keywords *Cassia fistula* - Sorption - Langmuir - Freundlich - Chromium - Pretreatments

Ruo-fei Jin[1], Ji-ti Zhou[1], Ai-li Zhang[1] and Jing Wang[1]. ([1]School of Environmental and Biological Science and Technology, Dalian University of Technology, Dalian, 116023, P.R. China). **Bioaugmentation of the decolorization rate of acid red GR by genetically engineered microorganism *Escherichia coli* JM109 (pGEX-AZR). World Journal of Microbiology and Biotechnology, Vol 24(1) (2008): 23-29**

The study showed that the genetically engineered microorganism (GEM) bioaugment successfully the dye wastewater biotreatment systems to enhance acid red GR (ARGR) removal. *Escherichia coli* JM109 (pGEX-AZR) was the GEM with higher azoreductase activity. The kinetics of the ARGR decolorization by the *E. coli* JM109 (pGEX-AZR) agreed with Andrews model. The kinetic parameters, $r_{dye,max}$, K_s and K_i, were found to be 42.45 mg g^{-1} h^{-1}, 584.93 mg L^{-1} and 556.89 mg L^{-1}, respectively. The *E. coli* JM109 (pGEX-AZR) was tested in anaerobic sequencing batch reactors (AnSBR) in order to enhance the ARGR decolorization. The decolorization rate of ARGR was affected by the amount of *E. coli* JM109 (pGEX-AZR) inoculation and the best amount of inoculation was 10%. The continuous operations of the four bioreactors with different *E. coli* JM109 (pGEX-AZR) immobilization supports showed that the *E. coli* JM109 (pGEX-AZR) could bioaugment decolorization in AnSBRs with suspended and immobilized on macroporous foam carriers. For 42 days continuous operation in the AnSBRs, both the tolerance to ARGR concentration shock and the decolorization rate in these two bioaugmented AnSBRs are higher than those of the other two systems, control system and bioaugmented AnSBRs system with the sodium-alginate immobilized cells, the decolorization rate reached 90%. Changes in microbial community were detected by ribosomal intergenic spacer analysis (RISA) and amplified ribosomal DNA restriction analysis (ARDRA), which revealed that the introduced *E. coli* JM109 (pGEX-AZR) was persistent in the augmented systems and maintained higher metabolic activity.

Keywords: Acid red GR - Bioaugmentation - Decolorization kinetics - *Escherichia coli* JM109 (pGEX-AZR) - Genetically engineered microorganism

Pushpa Singh[1], Archna Suman[1], Priyanka Tiwari[1], Namita Arya[1], Asha Gaur[1] and A. K. Shrivastava[1]. ([1]Indian Institute of Sugarcane Research, P.O. Dilkusha, Rae-Barely Road, Lucknow, 226 002, UP, India). **Biological pretreatment of sugarcane trash for its conversion to fermentable sugars. World Journal of Microbiology and Biotechnology, Vol 24(5) (2008): 667-673**

Pretreatment of lignocellulosic biomasses, the first step in their conversion to utilizable molecules requires very high energy (steam and electricity), corrosion resistant high-pressure reactors and high temperatures. These severe conditions not only add to the cost component of the entire process but also lead to the loss of sugars to the side reactions. Microbial pretreatments have been reported to be associated with reducing the cost factors as well as the severities of the reactions. Eight bioagents, including fungi and bacteria, were screened for their pretreatment effects on sugarcane trash. They narrowed down the C:N ratio of trash from 108:1 to a varying range of approximately 42:1 to 60:1.The maximum drop in C:N ratio of 61% was observed using *Aspergillus terreus* followed by *Cellulomonas uda* (52%) and *Trichoderma reesei* and

Zymomonas mobilis (49%). The bioagents helped in degradation of sugarcane trash by production of cellulases, the maximum being produced by *A. terreus*, (12 fold) followed by *C. uda* (10 fold), *Cellulomonas cartae* (9 fold) and *Bacillus macerans* (8 fold). The microbial pretreatment of trash rendered the easy accessibility of sugars for enzymatic hydrolysis, which can be directed for production of alcohol.

Keywords Microbial pretreatment - Sugarcane trash - Delignification - Cellulose degradation - C:N ratio

Yi-Ling Lai [1], Gurusamy Annadurai [1], Fu-Chang Huang [2], Jiunn-Fwu Lee [1 *]. ([1]Graduate Institute of Environmental Engineering, National Central University, Chung-Li 320, Taiwan, ROC, [2]Department of Civil and Environmental Engineering, Nanya Institute of Technology, Chung-Li 320, Taiwan, ROC email: Jiunn-Fwu Lee jflee@ncuen.ncu.edu.tw. [*]Correspondence to Jiunn-Fwu Lee, Graduate Institute of Environmental Engineering, National Central University, Chung-Li 320, Taiwan, ROC). **Biosorption of heavy metals from aqueous solution using modified activated carbon: comparison of linear and nonlinear methods. Journal of Chemical Technology & Biotechnology, Vol 83(6) (2008); 788 - 798**

BACKGROUND: Biosorption of heavy metals from aqueous solution by modified activated carbon with *Phanerochaete chrysosporium* immobilised in Ca-alginate beads was investigated using a batch system and comparison of linear and nonlinear methods.

RESULTS: The amount of Cu(II), Zn(II) and Pb(II) ion sorption by the beads was as follows: activated carbon with *P. chrysosporium* immobilised in Ca-alginate beads (ACFCA) (193.4, 181.8, 136.6 mg g^{-1}) > activated carbon immobilised in Ca-alginate beads (ACCA) (174.8, 162.0, 130.7 mg g^{-1}) > *P. chrysosporium* (F) (148.8, 125.6, 120.4 mg g^{-1}) > activated carbon (AC) (138.8, 112.3, 109.3 mg g^{-1}) > plain Ca-alginate beads (PCA) (125.4, 105.2, 98.2 mg g^{-1}). The widely used Langmuir and Freundlich isotherm models were utilised to describe the biosorption equilibrium process.

CONCLUSION: The results of this study suggest that the immobilisation of modified activated carbon with *P. chrysosporium* in Ca-alginate beads is suitable for a batch system. The isotherm parameters were estimated using linear and nonlinear regression analyses. The surface charge density of the biosorbents varied with the pH of the medium; the maximum biosorption of heavy metal ions on the biosorbents was obtained when the pH was between 5.6 and 7.4.

Keywords: biosorption • activated carbon • heavy metal • *Phanerochaete chrysosporium*

Sudhir Dahiya[a], R.M. Tripathi[b] and A.G. Hegde[a]. ([a]Environmental Studies Section, Health Physics Division, Bhabha Atomic Research Centre (BARC), Trombay, Mumbai 400085, India, [b]Environmental Assessment Division, Bhabha Atomic Research Centre (BARC), India). **Biosorption of heavy metals and radionuclide from aqueous solutions by pre-treated arca shell biomass. Journal of Hazardous Materials, Vol 150(2) (2008): 376-386**

In this study biosorption potential of pre-treated arca shell biomass for lead, copper, nickel, cobalt and cesium was explored from the artificially prepared solution containing known amount of metals. The effects of pH, initial concentration, biosorbent dosage and contact time were studied in batch experiments. Effects of common ions like sodium, potassium, calcium and

magnesium on the sorption capacity of pre-treated arca biomasses were also studied. To analyse the homogeneity of the biomaterial, experiments were performed for eight lots arca shell biomass for all the studies elements and it was observed that relative standard deviation in uptake capacity was within 10% for all elements. At equilibrium, the maximum total uptake by shell biomaterial was 18.33 ± 0.44, 17.64 ± 0.31, 9.86 ± 0.17, 3.93 ± 0.11 and 7.82 ± 0.36 mg/g for lead, copper, nickel, cesium and cobalt, respectively, under the optimised condition of pH, initial concentration, biosorbent dose and contact time. Effect of all the common ions jointly up to concentration of 50 ppm was negligible for all the elements but at higher levels the cations affects the uptake capacity. Sorption isotherms were studied to explain the removal mechanism of both elements by fitting isotherms data into Lagergren, Freundlich and Langmuir equations. Halls separation factor estimated under optimised condition also favours the sorption potential of these elements using arca shell biomass. Arca shell biomass can be effectively and efficiently employed for removal of studied elements after optimisation of parameters.

Keywords: Copper; Lead; Nickel; Cesium; Cobalt; Lagergren; Langmuir; Freundlich isotherm

N.K. Srivastava [a,] and C.B. Majumder[a]. ([a]Department of Chemical Engineering, Indian Institute of Technology Roorkee, Roorkee 247667, Uttarakhand, India). **Novel biofiltration methods for the treatment of heavy metals from industrial wastewater. Journal of Hazardous Materials, Vol 151(1) (2008): 1-8**

Most heavy metals are well-known toxic and carcinogenic agents and when discharged into the wastewater represent a serious threat to the human population and the fauna and flora of the receiving water bodies. In the present review paper, the sources have discussed the industrial source of heavy metals contamination in water, their toxic effects on the fauna and flora and the regulatory threshold limits of these heavy metals. The various parameters of the biofiltration processes, their mechanism for heavy metals removal along with the kinetics of biofilters and its modeling aspects have been discussed. The comparison of various physico-chemical treatment and the advantages of biofiltration over other conventional processes for treatment of heavy metals contaminated wastewater have also been discussed. The applications of genetic engineering in the modification of the microorganisms for increasing the efficiency of the biofiltration process for heavy metals removal have been critically analyzed. The results show that the efficiency of the process can be increased three to six folds with the application of recombinant microbial treatment.

Keywords: Heavy metals; Biofiltration; Biosorption; Modeling; Genetic engineering

Liang-Ming Whang[a, b], Pao-Wen G. Liu[c], Chih-Chung Ma[a] and Sheng-Shung Cheng[a, b]. ([a]Department of Environmental Engineering, National Cheng Kung University, No. 1, University Road, Tainan 701, Taiwan, ROC, [b]Sustainable Environment Research Center (SERC), National Cheng Kung University, No. 1, University Road, Tainan 701, Taiwan, ROC, [c]Department of Safety Health and Environmental Engineering, Chung Hwa University of Medical Technology, No. 89, Wenhua 1st Street, Rende Shiang, Tainan County 71703, Taiwan, ROC). **Application of biosurfactants, rhamnolipid, and surfactin, for enhanced biodegradation of diesel-contaminated water and soil. Journal of Hazardous Materials, Vol 151(1) (2008): 155-163**

This study investigated potential application of two biosurfactants, surfactin (SF) and rhamnolipid (RL), for enhanced biodegradation of diesel-contaminated water and soil with a

series of bench-scale experiments. The rhamnolipid used in this study, a commonly isolated glycolipid biosurfactant, was produced by *Pseudomonas aeruginosa* J4, while the surfactin, a lipoprotein type biosurfactant, was produced by *Bacillus subtilis* ATCC 21332. Both biosurfactants were able to reduce surface tension to less than 30 dynes/cm from 72 dynes/cm with critical micelle concentration (CMC) values of 45 and 50 mg/L for surfactin and rhamnolipid, respectively. In addition, the results of diesel dissolution experiments also demonstrated their ability in increasing diesel solubility with increased biosurfactant addition. In diesel/water batch experiments, an addition of 40 mg/L of surfactin significantly enhanced biomass growth (2500 mg VSS/L) as well as increased diesel biodegradation percentage (94%), compared to batch experiments with no surfactin addition (1000 mg VSS/L and 40% biodegradation percentage). Addition of surfactin more than 40 mg/L, however, decreased both biomass growth and diesel biodegradation efficiency, with a worse diesel biodegradation percentage (0%) at 400 mg/L of SF addition. Similar trends were also observed for both specific rate constants of biomass growth and diesel degradation, as surfactin addition increased from 0 to 400 mg/L. Addition of rhamnolipid to diesel/water systems from 0 to 80 mg/L substantially increased biomass growth and diesel biodegradation percentage from 1000 to 2500 mg VSS/L and 40 to 100%, respectively. Rhamnolipid addition at a concentration of 160 mg/L provided similar results to those of an 80 mg/L addition. Finally, potential application of surfactin and rhamnolipid in stimulating indigenous microorganisms for enhanced bioremediation of diesel-contaminated soil was also examined. The results confirmed their enhancing capability on both efficiency and rate of diesel biodegradation in diesel/soil systems.

Keywords: Biosurfactant; Surfactin; Rhamnolipid; Diesel; Bioremediation

S. Comte[a], G. Guibaud [a,] and M. Baudu[a]. ([a]Laboratoire des Sciences de l'Eau et de l'Environnement, Université de Limoges, Faculté des Sciences et Techniques, 123 Avenue A. Thomas, 87060 Limoges Cedex, France). **Biosorption properties of extracellular polymeric substances (EPS) towards Cd, Cu and Pb for different pH values. Journal of Hazardous Materials, Vol 151(1) (2008): 185-193**

The aim of this study was to assess the influence of pH on the metal biosorption of extracellular polymeric substances (EPS) extracted from two different activated sludges called A and B. The composition and physico-chemical characteristics of EPS were determined. The biosorption capacities of the EPS were examined at pH 4, 6, 7 and 8 successively with three metals Cu, Pb and Cd using differential pulse polarography (DPP) as an investigation tool and Ruzic's model was used to produce polarographic titration curves. Two apparent pK_a were obtained, the first were 6.6 (EPS A) and 5.7 (EPS B), attributed to carboxylic and phosphoric groups whereas the second was 8.7 for EPS A and 9.4 for B and these were attributed to phenolic and amino functional groups. Whatever the EPS and the metal considered, the conditional binding constant did not show significant differences in the strength of complex formed between the EPS and metals. But for all metals, the number of EPS binding sites was significantly lowered by a decrease in the pH of the medium. At pH 4, the metal biosorption capacity of EPS is very low. At pH 6, the number of EPS binding sites increased in the following order: Pb > Cu > Cd whereas at pH 7 and 8, this order changed and was: Cu > Pb $\gg$ Cd. Simulations of the speciation states of Cu, Pb and Cd at the different pH values in ultra-pure water (25 °C, ionic strength 0.045 M) were performed with MINEQL 4.5 software and indicated the presence of hydroxylated forms and sometimes solid forms for Pb and Cu. But the polarographic titration curves revealed precipitation of Cu only at the end of the experiments at pH 8.

Keywords: Activated sludge; Biosorption; EPS; Heavy metals; pH

Alex Godoy-Faúndez[a], Blanca Antizar-Ladislao[b], Lorenzo Reyes-Bozo[a], Andrés Camaño[c] and César Sáez-Navarrete[a]. ([a]Department of Chemical Engineering and Bioprocesses, Pontifica Universidad Católica de Chile, Chile, [b]Department of Water and Environment Science and Technology, University of Bulevar Ronda Rufino Peón, 39316 Torrelavega, Cantabria, Spain, [c]Minera Escondida Ltd., Chile). **Bioremediation of contaminated mixtures of desert mining soil and sawdust with fuel oil by aerated in-vessel composting in the Atacama Region (Chile). Journal of Hazardous Materials, Vol 151(2-3) (2008): 649-657**

Since early 1900s, with the beginning of mining operations and especially in the last decade, small, although repetitive spills of fuel oil had occurred frequently in the Chilean mining desert industry during reparation and maintenance of machinery, as well as casual accidents. Normally, soils and sawdust had been used as cheap readily available sorbent materials of spills of fuel oil, consisting of complex mixtures of aliphatic and aromatic hydrocarbons. Chilean legislation considers these fuel oil contaminated mixtures of soil and sawdust as hazardous wastes, and thus they must be contained. It remains unknown whether it would be feasible to clean-up Chilean desert soils with high salinity and metal content, historically polluted with different commercial fuel oil, and contained during years. Thus, this study evaluated the feasibility of aerated in-vessel composting at a laboratory scale as a bioremediation technology to clean-up contaminated desert mining soils (fuel concentration > 50,000 mg kg^{-1}) and sawdust (fuel concentration > 225,000 mg kg^{-1}) in the Atacama Region. The composting reactors were operated using five soil to sawdust ratios (S:SD, 1:0, 3:1, 1:1, 1:3, 0:1, on a dry weight basis) under mesophilic temperatures (30–40 °C), constant moisture content (MC, 50%) and continuous aeration (16 l min^{-1}) during 56 days. Fuel oil concentration and physico-chemical changes in the composting reactors were monitored following standard procedures. The highest (59%) and the lowest (35%) contaminant removals were observed in the contaminated sawdust and contaminated soil reactors after 56 days of treatment, respectively. The S:SD ratio, time of treatment and interaction between both factors had a significant effect ($p < 0.050$) on the contaminant removal. The results of this research indicate that bioremediation of an aged contaminated mixture of desert mining soil and sawdust with fuel oil is feasible. This study recommends a S:SD ratio 1:3 and a correct nutrient balance in order to achieve a maximum overall hydrocarbon removal of fuel oil in the weathered and aged contaminated wastes.

Keywords: Bioremediation; Composting; Fuel oil; Mining desert soil; Atacama

Elisa Ferrarese [a], Gianni Andreottola[a] and Irina Aura Oprea[a]. ([a]Department of Civil and Environmental Engineering, University of Trento, Italy). **Remediation of PAH-contaminated sediments by chemical oxidation. Journal of Hazardous Materials, Vol 152(1) (2008): 128-139**

The aim of this experimental investigation was to assess the feasibility of using chemical oxidation to degrade sorbed polycyclic aromatic hydrocarbons (PAHs) in case of old date sediment contamination. For this purpose several bench scale laboratory tests were performed, with the following liquid reactants: hydrogen peroxide, modified Fenton's reagent, activated sodium persulfate, potassium permanganate, as well as a combination of potassium permanganate and hydrogen peroxide, and a combination of activated sodium persulfate and hydrogen peroxide. The main target of the study was to find out what liquid oxidant was more

effective in reducing the pollutant content and to assess the optimal reactant doses. The initial total PAH concentration in sediment samples was about 2800 mg/kg$_{SS}$ (light PAHs about 1600 mg/kg$_{SS}$, heavy PAHs about 1200 mg/kg$_{SS}$) and a 95% degradation was required to meet the remediation goals. Based on the results of this study, chemical oxidation proved to be an effective remediation technology, amenably applicable for the ex situ remediation of the sediments of concern. Different reactants resulted however in different removal efficiencies. The best remediation performances were achieved with the use of modified Fenton's reagent, hydrogen peroxide and potassium permanganate, with oxidant dosages about 100 mmols per 30 g sediment sample. In all these cases the residual heavy PAH concentration in the treated samples was below 100 mg/kg$_{SS}$. The optimal oxidant dosages determined in this study were quite high, as sorbed PAH mineralization requires very vigorous oxidation conditions, especially for soils and sediments with high organic matter content. The results indicated that the optimal oxidant dose must be carefully determined under site-specific conditions. In fact, if the oxidation conditions are not strong enough, the reactants cannot be able to attack the most recalcitrant compounds, while also too high oxidant doses can result in a decrease in the oxidation efficiency, thus failing in meeting the remediation goals.

Keywords: Sediments; Remediation; Polycyclic aromatic hydrocarbons; Chemical oxidation

Ching Yuan[a,] and Tzu-Shing Chiang[a]. ([a]Department of Civil and Environmental Engineering, National University of Kaohsiung, No. 700, Kaohsiung University Road, Nan-Tzu District, Kaohsiung City 811, Taiwan). **Enhancement of electrokinetic remediation of arsenic spiked soil by chemical reagents. Journal of Hazardous Materials, Vol 152(1) (2008): 309-315**

An enhanced electrokinetic remediation process for removal of arsenic, presented as As(V) form, from spiked soil has been investigated with groundwater (GW) and chemical reagents of cetylpyridinium chloride (CPC, a cationic surfactant), ethylenediaminetetraacetic acid (EDTA) and citric acid (CA) under potential gradient of 2.0–3.3 V/cm for 5 days treatment. The removal efficiency of As(V) in EK-EDTA system was better than that in other two EK systems. As potential gradient increased from 2.0 V/cm to 3.0 V/cm, the removal efficiency of As(V) was increased from 35.4% to 44.8% in EK-EDTA system. It showed that the arsenic removal could be enhanced by selecting suitable chemical reagent and increasing potential gradient. The intensive of electroosmotic flow towards the cathode caused a significant retardation of electromigration of arsenic towards the anode. The quantity of As(V) collected in anode reservoir was 1.4–2.5 times greater than that in cathode reservoir for all EK systems. It implied that As(V) removal was directly related to the electromigration rather than electroosmosis mechanism in EK systems. A further investigation need to be conducted to achieve higher removal efficiency of As(V).

Keywords: Arsenic; Electrokinetic process; Processing fluid; Potential gradient; Soil remediation

P. King[a], K. Anuradha[a], S. Beena Lahari[a], Y. Prasanna Kumar[b] and V.S.R.K. Prasad[a]. ([a]Environmental Pollution Control Engineering Laboratory, Department of Chemical Engineering, A.U. College of Engineering, Andhra University, Visakhapatnam 530003, India, [b]Department of Chemical Engineering, GMR Institute of Technology, GMR Nagar, Rajam 532127, India). **Biosorption of zinc from aqueous solution using *Azadirachta indica***

bark: Equilibrium and kinetic studies. Journal of Hazardous Materials, (Vol 152(1) (2008): 24-329

The removal of zinc ions from aqueous solutions on the biomass of *Azadirachta indica* bark has been studied by using batch adsorption technique. The biosorption studies were determined as a function of contact time, pH, initial metal ion concentration, average biosorbent size and biosorbent dosage. The equilibrium metal uptake was increased and percentage biosorption was decreased with an increase in the initial concentration and particle size of biosorbent. The maximum zinc biosorption occurred at pH 6 and percentage biosorption increases with increase in the biosorbent dosage. Experimental data obtained were tested with the adsorption models like Langmuir, Freundlich and Redlich–Peterson isotherms. Biosorption isothermal data were well interpreted by Langmuir model with maximum biosorption capacity of 33.49 mg/g of zinc ions on *A. indica* bark biomass and kinetic data were properly fitted with the pseudo-second-order kinetic model.

Keywords: *Azadirachta indica* bark; Biosorption; Isotherms; Kinetic studies

V.K. Gupta [a] and A. Rastogi[a]. ([a]Department of Chemistry, Indian Institute of Technology Roorkee, Roorkee 247667, India). Biosorption of lead from aqueous solutions by green algae *Spirogyra* species: Kinetics and equilibrium studies. Journal of Hazardous Materials, Vol 152(1) (2008): 407-414

Biosorption is the effective method for the removal of heavy metal ions from wastewaters. Results are presented showing the sorption of Pb(II) from solutions by biomass of commonly available, filamentous green algae *Spirogyra* sp. Batch experiments were conducted to determine the biosorption properties of the biomass and it was observed that the maximum adsorption capacity of Pb(II) ion was around 140 mg metal/g of biomass at pH 5.0 in 100 min with 200 mg/L of initial concentration. Temperature change in the range 20–40 °C affected the adsorption capacity and the nature of the reaction was found to be endothermic in nature. Uptake kinetics follows the pseudo-second-order model and equilibrium is well described by Langmuir isotherm. Isotherms have been used to determine thermodynamic parameters of the process, viz., free energy change, enthalpy change and entropy change. Various properties of the algae, as adsorbent, explored in the characterization part were chemical composition of the adsorbent, thermal analysis by TGA, surface area calculation by BET method, surface morphology with scanning electron microscope images and surface functionality by FTIR. FTIR analysis of algal biomass revealed the presence of amino, carboxyl, hydroxyl and carbonyl groups, which are responsible for biosorption of metal ions. The results indicated that the biomass of *Spirogyra* sp. is an efficient biosorbent for the removal of Pb(II) from aqueous solutions.

Keywords: Biosorption; Kinetics; *Spirogyra* sp.; Langmuir model; Thermodynamic parameters; Characterization

Giuseppe Mascolo [a], Ruggero Ciannarella[a], Lydia Balest[a] and Antonio Lopez[a]. ([a]Istituto di Ricerca Sulle Acque, Consiglio Nazionale delle Ricerche, Via F. De Blasio, 5, 70123 Bari, Italy). Effectiveness of UV-based advanced oxidation processes for the remediation of hydrocarbon pollution in the groundwater: A laboratory investigation. Journal of Hazardous Materials, Vol 152(3) (2008): 1138-1145

The effectiveness of advanced oxidation processes in a batch and a flow reactor was investigated for the remediation of hydrocarbon pollution in the groundwater underlying a petrochemical industrial site. The main organic contaminants present in the groundwater were MTBE, benzene, alkyl-benzenes and alkyl-naphthalenes. Experimental results with a batch reactor showed that for all the organic contaminants the removal efficiency order is $UV/TiO_2 \approx UV/H_2O_2 > UV$ (medium-pressure) in a synthetic aqueous solution, compared to $UV/H_2O_2 > UV$ (medium-pressure) $> UV/TiO_2$ for the real polluted groundwater. The much lower performance of UV/TiO_2 with respect to UV/H_2O_2 was inferred to the matrix of the groundwater, i.e. the salt content, as well as the organic and particulate matter. In fact, it is likely that the salts and dissolved organic matter quench the superoxide anion $O_2^{\cdot -}$ and hydroxyl radicals just formed at the surface of the TiO_2 catalyst. MTBE was the hardest compound to remove with each of the investigated treatments. UV and UV/TiO_2 treatments were not able to reach a residual concentration of 10 μg/L (set by Italian legislation) even after 180 min. As for the UV/H_2O_2 process, only the MTBE degradation rate resulted affected by the initial H_2O_2 concentration, while for other compounds a complete removal was obtained within 20 min even with the lowest H_2O_2 concentration used (0.13 g/L). Only after 120 min of treatment, with an initial H_2O_2 concentration of 0.13 g/L, did the residual MTBE concentration fall below the above reported maximum admissible concentration. Instead, by using an initial concentration of 2 g/L a residual concentration lower than 5 μg/L was obtained after just 30 min of reaction. The UV/H_2O_2 process was also investigated with a flow reactor. Results showed that it was more efficient than the batch reactor for removing MTBE, in terms of reaction time and initial H_2O_2 concentration required. This is consistent with the higher power of the UV lamp and with the different geometry of the flow reactor, which has a much shorter optical path than the batch reactor. By-product characterisation was also performed showing that *t*-butyl-formate and low molecular weight organic acids are formed as intermediate and final by-products, respectively. Finally, a preliminary evaluation of the operational cost of the UV/H_2O_2 process showed a value of 1.7 €/m^3 under the optimised condition.

Keywords: Advanced oxidation processes; Groundwater; Petrochemical industry; MTBE; BTEX; UV; TiO_2

Durali Mendil[a], Mustafa Tuzen[a] and Mustafa Soylak[b.] ([a]Gaziosmanpasa University, Faculty of Science and Arts, Chemistry Department, 60250 Tokat, Turkey, [b]Erciyes University, Faculty of Science and Arts, Chemistry Department, 38039 Kayseri, Turkey). **A biosorption system for metal ions on *Penicillium italicum*– loaded on Sepabeads SP 70 prior to flame atomic absorption spectrometric determinations. Journal of Hazardous Materials, Vol 152(3) (2008): 171-1178**

A solid phase extraction (SPE) preconcentration system, coupled to a flame atomic absorption spectrometer (FAAS), was developed for the determination of copper(II), cadmium(II), lead(II), manganese(II), iron(III), nickel(II) and cobalt(II) ions at the μg L^{-1} levels on *Penicillium italicum* – loaded on Sepabeads SP 70. The analytes were adsorbed on biosorbent at the pH range of 8.5–9.5. The adsorbed metals were eluted with 1 mol L^{-1} HCl. The influences of the various analytical parameters including pH of the aqueous solutions, sample vol , flow rates were investigated for the retentions of the analyte ions. The recovery values are ranged from 95–102%. The influences of alkaline, earth alkaline and some transition metal ions were also discussed. Under the optimized conditions, the detection limits (3 s, n = 21) for analytes were in the range of 0.41 μg L^{-1} (cadmium) and 1.60 μg L^{-1} (iron). The standard reference materials (IAEA 336 Lichen, NIST SRM 1573a Tomato leaves) were analyzed to verify the proposed

method. The method was successfully applied for the determinations of analytes in natural water, cultivated mushroom, lichen (*Bryum capilare Hedw*), moss (*Homalothecium sericeum*) and refined table salt samples.

Keywords: *Penicillium italicum*; Sepabeads SP 70; Biosorption; Trace metal; Atomic absorption spectrometry

Erkan Sahinkaya[1, a], Nigmet Uzal[a], Ulku Yetis[a] and Filiz B. Dilek [a.] ([a]Middle East Technical University, Department of Environmental Engineering, 06531 Ankara, Turkey). Biological treatment and nanofiltration of denim textile wastewater for reuse. Journal of Hazardous Materials, Vol 153(3) (2008): 1142-1148

This study aims at coupling of activated sludge treatment with nanofiltration to improve denim textile wastewater quality to reuse criteria. In the activated sludge reactor, the COD removal efficiency was quite high as it was 91 ± 2% and 84 ± 4% on the basis of total and soluble feed COD, respectively. The color removal efficiency was 75 ± 10%, and around 50–70% of removed color was adsorbed on biomass or precipitated within the reactor. The high conductivity of the wastewater, as high as 8 mS/cm, did not adversely affect system performance. Although biological treatment is quite efficient, the wastewater does not meet the reuse criteria. Hence, further treatment to improve treated water quality was investigated using nanofiltration. Dead-end microfiltration (MF) with 5 μm pore size was applied to remove coarse particles before nanofiltration. The color rejection of nanofiltration was almost complete and permeate color was always lower than 10 Pt–Co. Similarly, quite high rejections were observed for COD (80–100%). Permeate conductivity was between 1.98 and 2.67 mS/cm (65% conductivity rejection). Wastewater fluxes were between 31 and 37 $L/m^2/h$ at 5.07 bars corresponding to around 45% flux declines compared to clean water fluxes. In conclusion, for denim textile wastewaters nanofiltration after biological treatment can be applied to meet reuse criteria.

Keywords: Textile wastewater; Water reuse; Activated sludge; Nanofiltration

Kishore K. Krishnani[a], Xiaoguang Meng[b], C. Christodoulatos[b] and Veera M. Boddu[c]. ([a]Central Institute of Brackishwater Aquaculture, 75 Santhome High Road, R.A. Puram, Chennai 600028, India, [b]Center for Environmental Systems, Stevens Institute of Technology, Hoboken, NJ 07030, USA, [c]US Army Construction Engineering Research Laboratories, Champaign, IL 61826-9905, USA). Biosorption mechanism of nine different heavy metals onto biomatrix from rice husk. Journal of Hazardous Materials, Vol 153(3) (2008): 1222-1234

A biomatrix was prepared from rice husk, a lignocellulosic waste from agro-industry, for the removal of several heavy metals as a function of pH and metal concentrations in single and mixed solutions. The biomatrix was characterized using scanning electron microscope and Fourier transform infrared spectroscopy, which indicated the presence of several functional groups for binding metal ions. Different experimental approaches were applied to show mechanistic aspects, especially the role of calcium and magnesium present in the biomatrix in ion exchange mechanism. The ultimate maximum adsorption capacity obtained from the Langmuir isotherm increases in the order (mmol/g): Ni (0.094), Zn (0.124), Cd (0.149), Mn (0.151), Co (0.162), Cu (0.172), Hg (0.18) and Pb (0.28). The sorption of Cr(III) onto biomatrix at pH 2 was 1.0 mmol/g. Speciation of chromium, cadmium and mercury loaded on the

biomatrix was determined by X-ray photoelectron spectroscopy. The biomatrix has adsorption capacity comparable or greater to other reported sorbents.

Keywords: Biomatrix; Heavy metals; Removal mechanism

D. Prasanna[a], S. Venkata Mohan [a], B. Purushotham Reddy[a] and P.N. Sarma[a]. ([a]Bioengineering and Environmental Centre, Indian Institute of Chemical Technology, Hyderabad 500007, India). **Bioremediation of anthracene contaminated soil in bio-slurry phase reactor operated in periodic discontinuous batch mode. Journal of Hazardous Materials, Vol 153(1-2) (2008): 244-251**

Bioremediation of soil-bound anthracene was studied in a series of bio-slurry phase reactors operated in periodic discontinuous/sequencing batch mode under anoxic–aerobic–anoxic microenvironment using native soil microflora. Five reactors were operated for a total cycle period of 144 h (6 days) at soil loading rate of 16.66 kg soil/m^3/day at 30 ± 2 °C temperature. The performance of the bioreactors was studied at various substrate loading rates (vol tric substrate loading rate (SLR), 0.1, 0.2 and 0.3 g anthracene/kg soil/day) with and without bioaugmentation (domestic sewage inoculum; 2×10^6 CFU/g of soil). Control reactor (without microflora) showed negligible degradation of anthracene due to the absence of biological activity. The performance of the bio-slurry system with respect to anthracene degradation was found to depend on both substrate loading rate and bioaugmentation. Application of bioaugmentation showed positive influence on the rate of degradation of anthracene. Anthracene degradation data was analysed using different kinetic models to understand the mechanism of bioremediation process in the bio-slurry phase system. Variation in pH/oxidation–reduction potential (ORP), soil microflora and oxygen consumption rate correlated well with the substrate degradation pattern observed during soil slurry phase anthracene degradation.

Keywords: Polycyclic aromatic hydrocarbons (PAHs); Anthracene; Bio-slurry phase reactor; Periodic discontinuous batch process; Bioaugmentation

Veera Virtanen[1, 2], Antti Nyyssölä[1], Antti Vuolanto[1, 3], Matti Leisola[1] and Pekka Seiskari[4]. ([1]Laboratory of Bioprocess Engineering, Helsinki University of Technology, P.O. Box 6100, 02015 Espoo, Finland, [2]*Present address:* Oy Keskuslaboratorio – Centrallaboratorium Ab, P.O. Box 70, 02151 Espoo, Finland, [3]*Present address:* Mobidiag Ltd, Haartmaninkatu 8/Biomedicum, 00290 Helsinki, Finland, [4]Verdera Oy, PL 5, 02271 Espoo, Finland). **Bioreactor for solid-state cultivation of *Phlebiopsis gigantea* Biotechnology Letters, Vol. 30 (2) (2008): pp. 253 - 258.**

Phlebiopsis gigantea fungus used in biological control of root rot is currently cultivated commercially in disposable, sterilizable plastic bags. A novel packed bed bioreactor was designed for cultivating *P. gigantea* and compared to the plastic bag method and to a tray bioreactor. The spore viability of 5.4×10^6 c.f.u./g obtained with the packed bed bioreactor was of the same order of magnitude as the viabilities obtained with the other cultivation methods. Furthermore, the packed bed bioreactor was less time and space consuming and easier to operate than the tray bioreactor.

Keywords: Biofungicides - Packed bed bioreactor - *Phlebiopsis gigantea* - Solid-state cultivation - Tray bioreactor

Velmurugan Ganesan[1]. ([1]Department of Biochemistry, School of Biological Sciences, Madurai Kamaraj University, Madurai, 625 021, India). Rhizoremediation of Cadmium Soil Using a Cadmium-Resistant Plant Growth-Promoting Rhizopseudomonad. Current Microbiology, Vol 56(4) (2008): 403-407

Three pseudomonad strains (MKRh1, MKRh3, and MKRh4) isolated from rhizospheres showed a high growth potential in the presence of cadmium, with a minimal inhibitory concentration of 7 mM for cadmium chloride ($CdCl_2$). Among them, isolate MKRh3 was specifically chosen as the most favorable cadmium-resistant plant growth-promoting rhizobacterium based on its higher 1-aminocyclopropane carboxylic acid deaminase activity, siderophore production, phosphate solubilization, and auxin synthesis and the in vivo growth increment of black gram plants. 16S ribosomal RNA gene sequencing identified MKRh3 as *Pseudomonas aeruginosa*. The effect of cadmium on black gram plants was studied in soil amended with a gradient of $CdCl_2$ concentration and the toxicity was evident from stunted growth, poor rooting, and cadmium accumulation. Application of isolate MKRh3 by seed coating overcomes the cadmium toxicity; plants showed lessened cadmium accumulation, extensive rooting, and enhanced plant growth. Further research and development of this promising innate strategy for scale-up to higher-efficiency and large-scale application will be a potent tool to prevent accumulation of cadmium in plants, thereby ensuring food security for humans.

Christopher J. McNamara[a, b, c], Christos C. Anastasiou[c, 1], Vincent O'Flaherty[d] and Ralph Mitchell[b]. ([a]Exposure, Epidemiology and Risk Program, Department of Environmental Health, Harvard School of Public Health, Boston, MA 02215, USA, [b]Laboratory of Applied Microbiology, Harvard School of Engineering and Applied Sciences, Cambridge, MA 02138, USA, [c]Cyprus International Institute for the Environment and Public Health in association with Harvard School of Public Health, Nicosia, Cyprus, [d]Microbial Ecology Laboratory, Department of Microbiology and Environmental Change Institute, National University of Ireland, Galway, Ireland). Bioremediation of olive mill wastewater. International Biodeterioration & Biodegradation, Vol 61(2) (2008): 127-134

The vast majority of olive oil production (>98%) occurs in the Mediterranean region, utilizing a tremendous vol of water (10–30 million m^3) in an area of the world in which water resources are limited. Treatment and reuse of olive mill wastewater (OMWW) presents significant challenges both due to the nature of olive oil production (seasonal and small scale) and due to the characteristics of the wastewater (high chemical oxygen demand (COD), high phenolic content, and dark color). A number of different microorganisms (Archaea, Bacteria and fungi) and processes (aerobic or anaerobic bioreactors, composting) have been tested to treat OMWW. Aerobic bacteria have been tested primarily as an approach for removal of phytotoxic compounds from OMWW, although some studies have also focused on reduction of COD. Fungi on the other hand, have proven effective at reducing COD and toxicity. Anaerobic consortia can effectively reduce COD, but are sensitive to phenolics in OMWW. Biological processes provide some of the most viable options for the treatment of OMWW. Effective application of these techniques, yielding significant reductions in COD, phenolics, and color, will allow safe and economical disposal of OMWW.

Keywords: Olive mill wastewater; Bioremediation; Phytotoxicity; Phenolics; COD

M.E. Mancera-López[a], F. Esparza-García[a], B. Chávez-Gómez[b], R. Rodríguez-Vázquez[a], G. Saucedo-Castañeda[c] and J. Barrera-Cortés[a]. ([a]CINVESTAV-IPN, Depto. Biotecnología y Bioingeniería, Av. IPN #2508 Col. San Pedro Zacatenco, C.P. 07360, México D.F., Mexico, [b]Instituto Mexicano del Petróleo, Depto Biotecnología, Eje Central Lázaro Cárdenas 152, Col. San Bartolo Atepehuacan, C.P. 07730, México D.F., Mexico, [c]UAM-Iztapalapa, Av. San Rafael Atlixco No 186, Col. Vicentina C.P. 09340, Iztapalapa, México D.F., Mexico). **Bioremediation of an aged hydrocarbon-contaminated soil by a combined system of biostimulation–bioaugmentation with filamentous fungi** **International Biodeterioration & Biodegradation, Vol 61(2) (2008): 151-160**

This paper presents a study of the effect of a combined biostimulation–bioaugmentation treatment applied to a silty-loam soil polluted with 60,600 mg kg^{-1} of a complex mixture of total petroleum hydrocarbons (TPH), which comprises 40% aliphatic hydrocarbons (AH) and 21% polycyclic aromatic hydrocarbons (PAH). The bioaugmentation was performed with *Rhizopus* sp., *Penicillium funiculosum* and *Aspergillus sydowii* strains isolated from two aged soils contaminated with 60,600 and 500,000 mg of TPH per kilogram of dried soil. The native fungi were able to grow in a complex solid mixture of hydrocarbons of high molecular weight, after previous acclimatization in liquid culture. The three fungi mentioned above were able to remove, respectively, 36%, 30% and 17% more PAH in comparison with biostimulation alone. In the bioaugmented systems with *Rhizopus* sp. and *A. sydowii*, a positive correlation of respirometric activity (CO_2 production) with hydrocarbon removal was obtained (R^2=0.75; $p(F)$=0.001 and R^2=0.78; $p(F)$=0.001, respectively); in contrast, *P. funiculosum* did not show any correlation. An interesting finding from this work is that two of these species of fungi had not previously been reported as being PAH-degrading.

Keywords: Bioaugmentation; Bioremediation; Hydrocarbons; Hydrocarbon-degrading fungi

C.S. Benimeli[a], M.S. Fuentes[a], C.M. Abate[a, b, c] and M.J. Amoroso[a, c]. ([a]Planta Piloto de Procesos Industriales y Microbiológicos (PROIMI), CONICET, Av. Belgrano y Pasaje Caseros, 4000 Tucumán, Argentina, [b]Facultad de Ciencias Naturales e Instituto Miguel Lillo, Universidad Nacional de Tucumán, 4000 Tucumán, Argentina, [c]Facultad de Bioquímica, Química y Farmacia, Universidad Nacional de Tucumán, 4000 Tucumán, Argentina). **Bioremediation of lindane-contaminated soil by *Streptomyces* sp. M7 and its effects on *Zea mays* growth** **International Biodeterioration & Biodegradation, Vol 61(3) (2008): 233-239**

The objective of the present study was to study the lindane bioremediation abilities of *Streptomyces* sp. M7 in soil samples and to know the pesticide effects on maize plants seeded in lindane-contaminated soil previously inoculated with *Streptomyces* sp. M7.

When different initial pesticide concentrations (100, 150, 200, and 300 μg kg^{-1}) were added to sterile soil, the microbial growth observed was similar to the control without lindane. A decrease of the residual lindane concentration was detected in soils samples in relation to the abiotic controls (29.1%, 78.03%, 38.81%, and 14.42%, respectively). The optimum *Streptomyces* sp M7 inoculum was selected in sterile soil spiked with lindane 100 μg kg^{-1}soil; it was 2 g kg^{-1} soil for obtaining the most efficient bioremediation process (56% removal).

Lindane concentrations of 100, 200, and 400 μg kg^{-1} soil did not affect the germination and vigor index of maize plants seeded in contaminated soils without *Streptomyces* sp. M7. When

this microorganism was inoculated at the same conditions a better vigor index was observed and 68% of lindane removal.

These results confirm the lindane-contaminated soil bioremediation potential of *Streptomyces* sp. M7.

Keywords: *Streptomyces*; Lindane; Organochlorine pesticides; Bioremediation; Soil; Vigor index

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Lithium recovery from aqueous solutions was studied by trapping lithium ions using a gel of aluminum hydroxide freshly prepared in situ under the reaction of a strong base. A 2^{4-1} fractional factorial design and central composite design were employed for experimental design and analysis of the results. The combined effect of molar ratio Al/Li, pH and stirring time on lithium trapping at 25 °C was investigated and optimized using response surface methodology (RSM). The optimum values of these factors were found to be 4.7, 7.2 and 3 h respectively. In this case the lithium trapping percent is $\sim$95%. The obtained model is highly significant ($F_{obs} > F_{tabulate}$ and low p-value) with a correlation coefficient of 96.64%. On the other hand, linear, quadratic and interaction terms in this model have the largest statistical effect on the response (confidence level = 99.9%).

Keywords: Lithium recovery; Highly concentrated solutions; RSM

Şenol Sert[a], Ceren Kütahyali[1, a], Süleyman İnan[a], Zeynep Talip[a], Berkan Çetinkaya[a] and Meral Eral[a]. ([a]Ege University Institute of Nuclear Sciences, 35100 Bornova-Izmir, Turkey). Biosorption of lanthanum and cerium from aqueous solutions by *Platanus orientalis* leaf powder. Hydrometallurgy, Vol 90(1) (2008): 13-18

The biosorption of lanthanum and cerium by leaves powder of *Platanus orientalis* was separately determined at varying experimental conditions using a batch technique. The effects of initial pH, contact time, initial metal ion concentration and temperature were investigated. The Langmuir and Freundlich isotherms were applied to represent the adsorption process. Langmuir isotherm fits the experimental data quite well. The Langmuir monolayer capacity of the sorbent is 28.65mg g^{-1} and 32.05mg g^{-1} for La and Ce(III), respectively. Thermodynamic parameters such as standard enthalpy (ΔH°), entropy (ΔS°) and free energy (ΔG°) were calculated from the slope and intercept of the plots of $\ln K_d$ versus $1/T$. The results indicated that sorption was endothermic and spontaneous in nature. The work reveals that powdered leaf of *Platanus orientalis* is a good choice as a biosorbent for the recovery of lanthanum and cerium from aqueous solution.

Keywords: Biosorption; Lanthanum; Cerium; Rare earth elements; *Platanus orientalis*

F. Bakhtiari[a], M. Zivdar[a], H. Atashi[a] and S.A. Seyed Bagheri[b]. ([a]Department of Chemical Engineering, Faculty of Engineering, Sistan and Baluchestan University, Zahedan, 98164, Iran, [b]Hydrometallurgy Research Unit, R & D Center, Sarcheshmeh Copper Complex, Rafsanjan, Iran). Bioleaching of copper from smelter dust in a series of airlift bioreactors. Hydrometallurgy, Vol 90(1) (2008): 40-45

Bioleaching of copper from the flue dust of the Sarcheshmeh copper smelter has been investigated. A series of continuous tests were carried out in two-stages of airlift bioreactors inoculated with the acidophilic, iron and sulfur oxidizing bacteria, initially derived from acid mine drainage. The effects of different parameters such as pulp density, retention time and temperature on the mesophile bioleach performance of the copper sulfide rich dust were evaluated after pre-leaching with dilute acid. Pulp densities of 2% and 4% gave the same oxidation–reduction potential in both reactors. However, increasing the average pulp density to 7% generated an unstable oxidation–reduction potential in the first bioreactor at 34 °C. Overall copper extractions calculated for 2%, 4% and 7% pulp densities were 90%, 89% and 86% with mean retention times of 2.7, 4 and 5 days, respectively. The process is net acid consuming and has the potential for further development and feasibility studies.

Keywords: Bioleaching; Copper flue dust; Continuous; Airlift bioreactors

H.R. Watling[a]. ([a]Parker Centre for Integrated Hydrometallurgy Solutions, CSIRO Minerals, PO Box 7229, Karawara, Western Australia 6152). The bioleaching of nickel-copper sulfides. Hydrometallurgy, Vol 91(1-4) (2008): 70-88

Demand for nickel, largely driven by the Chinese stainless steel market, currently exceeds production, causing an unprecedented rise in the price of nickel and renewed interest in bioleaching technology for the processing of low grade nickel sulfide ores and concentrates. Although nickel inhibits bacterial physiological functions such as iron- and sulfur-oxidation, some bacteria adapt readily to high concentrations. In pilot-scale continuous reactors, mixed microbial populations grew actively over many months in the presence of up to 400 mM nickel (23 g/L). The results of bench-scale test work have been sufficiently encouraging to prompt pilot- and demonstration-scale trials in heaps and agitated tanks in Australia, China, Finland and South Africa in recent years. The first commercial implementation of nickel sulfide heap leaching is likely to be the operation at Talvivaara, Finland.

Keywords: Bioleaching; Pentlandite; Heap leaching; Continuous reactor leaching

Biotransformation

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Environmental Science and Engineering, Hunan University, Changsha, Hunan 410082, China. ' College of Environmental Science and Engineering, Hunan University, Changsha, Hunan 410082, China). Biotransformation of rice straw by Phanerachaete chrysosporium and the related ligninolytic enzymes. International Journal of Biotechnology, Vol. 10(1) (2008): 86 - 92

Biotransformation of lignin is related to the biomass utilisation of agricultural wastes. Ligninolytic enzyme from Phanerochaete chrysosporium plays an important role in biodegrading lignin and is specially concerned by researchers. The aim of the study is to optimise the conditions for producing ligninolytic enzymes in solid-state fermentation, and to biotransform the rice straw for the biomass utilisation. The effects of five factors on enzyme activity in state-solid medium were studied using orthogonal experiments, which were expected to offer reference for condition design of enzyme production in solid-state fermentation. The results indicated that the optimal condition for enzyme production by P. chrysosporium during solid-state fermentation could be realised when fungi were domesticated for 8 days, 0.8% fungi suspension (weight ratio) inoculated, temperature kept at 37°C, water content of the solid substrate maintained by 85% and 0.3% Tween80 added, respectively. Also, it was found that the temperature and water content were the foremost influencing factors for the ligninolytic enzyme production of P. chrysosporium during solid-state fermentation. The lignocellulose of rice straw was reduced significantly. The structures of the untreated straw and the straw degraded under the optimal fermentation condition were analysed through ultraviolet spectroscopy and infrared spectroscopy. It could be observed that long-bond and difficult-to-biodegrade hydrocarbons of giant molecule were degraded into short-bond hydrocarbons of small molecule, which could be easily biodegraded.

Keywords: degradation; rice straw; Phanerochaete chrysosporium; ligninolytic enzymes; lignin biotransformation; agricultural wastes; fermentation; biomass.

Tianli Tian[1], Qiling Sun[1], Jing Shen[1], Tao Zhang[2], Pei Gao[1] and Qun Sun[1]. ([1]College of Life Sciences, Key Laboratory of Bio-resources and Eco-environment of Ministry of Education, Sichuan University, 29# Wangjianglu Street, Chengdu, Sichuan, 610064, China, [2]College of Life Science & Biotechnology, Shanghai Jiao Tong University F0408004, Shangha, 200240, P.R. China). Microbial transformation of polydatin and emodin-8-β-D - glucoside of *Polygonum cuspidatum* Sieb. et Zucc into resveratrol and emodin respectively by *Rhizopus microsporus*. World Journal of Microbiology and Biotechnology, Vol. 24(6) (2008) : 861-866

Rhizopus microsporus isolated by our laboratory was able to transform polydatin into resveratrol and emodin-8-β-D-glucoside into emodin, respectively, through the fermentation of *Polygonum cuspidatum* Sieb. et Zucc. The fermentation products were separated and purified by H1020 resin and silica gel column chromatography. Thin layer chromatography (TLC) and high performance liquid chromatography (HPLC) were used to identify the products and evaluate the transformation efficiency. A variety of parameters of submerged state fermentation, including the growth characteristics, the change of β-glucosidase activity and the amount of polydatin, resveratrol, emodin-8-β-D-glucoside, emodin, and the dissolved oxygen, were monitored simultaneously. The amount of resveratrol yielded increased dramatically from 0.04 g/l at the beginning to the maximum value of 0.34 g/l at 36 h of fermentation, and emodin was from

0.4 g/l to 0.65 g/l at 80 h. The transformation rate of glycosides reached 98% and the purity of both resveratrol and emodin was 95%.

Keywords: Emodin - Emodin-8-β-D-glucoside - Polydatin - *Polygonum cuspidatum* Sieb. et Zucc - Resveratrol - *Rhizopus microsporus*

In-Ae Chang1, Jae-Han Bae1, Min-Jung Suh1, In-Hwan Kim2, Ching T. Hou[3] and Hak-Ryul Kim[1]. ([1]Department of Animal Science and Biotechnology, Kyungpook National University, Daegu, South Korea, 702-701, [2]Department of Food and Nutrition, College of Health Science, Korea University, Seoul, South Korea, [3]Microbial Genomic and Bioprocessing Research Unit, National Center for Agricultural Utilization Research, ARS, USDA, Peoria, IL, USA). **Environmental optimization for bioconversion of triolein into 7,10-dihydroxy-8(*E*)-octadecenoic acid by *Pseudomonas aeruginosa* PR3. Applied Microbiology and Biotechnology, Vol. 78(4) (2008) : 581-586**

Hydroxy fatty acids (HFAs), originally found in small amount mainly from plant systems, are well known to have special properties such as higher viscosity and reactivity compared with other normal fatty acids. Recently, various microbial strains were tested to produce HFAs from different unsaturated fatty acids. Among those microbial strains tested, *Pseudomonas aeruginosa* PR3 are well known to utilize various unsaturated fatty acids to produce mono-, di-, and tri-HFAs. Previously, we reported that strain PR3 could utilize triolein as a substrate for the production of 7,10-dihydroxy-8(*E*)-octadecenoic acid (DOD) via the induction of lipase activity (Chang et al., *Appl Microbiol Biotechnol*, 74:301–306, *2007*). In this study, we focused on the development of the optimal environmental conditions for DOD production from triolein by PR3. Optimal initial medium pH and incubation temperature were pH 8.0 and 25°C, respectively. Magnesium ion was essentially required for DOD production. Optimal inoculum size, time for substrate addition, and substrate concentration were 1%, 12 to 24 h, and 300 mg, respectively.

Keywords: *Pseudomonas aeruginosa* - Hydroxy fatty acid - Triolein - Optimization - Bioconversion

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Cement–asbestos is the main asbestos containing material still found in most of the European countries such as Italy. Man- and weathering-induced degradation of the cement–asbestos slates makes them a source of dispersion of asbestos fibres and represents a priority cause of concern. This concern is the main prompt for the actual policy of abatement and disposal of asbestos containing materials in controlled wastes. An alternative solution to the disposal in dumping sites is the direct temperature-induced transformation of the cement–asbestos slates into non-hazardous mineral phases. This patented process avoids the stage of mechanical milling of the material before the treatment, which improves the reactivity of the materials but may be critical for the dispersion of asbestos fibres in working and life environment. For the first time, this

paper reports the description of the reaction path taking place during the firing of cement–asbestos slates up to the complete transformation temperature, 1200 °C. The reaction sequence was investigated using different experimental techniques such as optical and electron microscopy, *in situ* and *ex situ* quali-quantitative X-ray powder diffraction. The understanding of the complex reaction path is of basic importance for the optimization of industrial heating processes leading to a safe recycling of the transformed product.

For the recycling of asbestos containing materials, the Italian laws require that the product of the crystal chemical transformation of asbestos containing materials must be entirely asbestos-free, and should not contain more than 0.1 wt% fraction of the carcinogenic substances such as cristobalite. Moreover, if fibrous phases other than asbestos (with length to diameter ratio >3) are found, they must have a geometrical diameter larger than 3 μm. We have demonstrated that using an interplay of different experimental techniques, it is possible to safely verify the complete transformation of asbestos minerals in this temperature-induced process.

The product of transformation of cement–asbestos (CATP) has a phase composition similar to that of a natural or a low temperature clinker with the exception of having a larger content of aluminium, iron and magnesium. This product can be safely recycled for the production of stoneware tile mixtures. The addition of 3–5 mass% of CATP does not bear significant variations to the standard parameters of white porcelain tile mixtures.

Keywords: Asbestos; Thermal treatment; SEM; Rietveld method; Stoneware tile

Dong-Sung Kim[1, 2], Sung-Kyoon Kim[1], Yong-Bok Choi[1], Ik-Hyeon Kwon[1] and Kwan-Hwa Park[3]. ([1]R&D Business Labs, Hyosung Corporation, Anyang-Si, Gyeonggi-Do, 431-080, Korea, [2]Department of Food Science and Biotechnology, Seoul National University, Seoul, 151-921, Korea, [3]Department of Food Science and Biotechnology, Center for Agricultural Biomaterials, Seoul National University, Seoul, 151-921, Korea). **A novel biotransformation of 2-formyl-6-naphthoic acid to 2,6-naphthalene dicarboxylic acid by *Pseudomonas* sp. for the purification of crude 2,6-naphthalene dicarboxylic acid. Biotechnology Letters, Vol. 30(2) (2008): 329-333**

Crude 2,6-naphthalene dicarboxylic acid was purified by *Pseudomonas* sp. HN-72 which biotransformed the major impurity of 2-formyl-6-naphthoic acid into 2,6-naphthalene dicarboxylic acid. The biotransformation yield reached 100% when the reaction was performed at 40°C for 1 h, in 200 ml KH_2PO_4/KOH buffer (50 mM, pH 8.0), with 0.2% (w/v) crude 2,6-naphthalene dicarboxylic acid and 2.5 mg dry cell wt/ml.

Keywords: Biotransformation - Crude 2,6-naphthalene dicarboxylic acid - 6-Formyl-2-naphthoic acid - *Pseudomonas* sp. - Purification

Biomarker

Sergio Montes[a], Horacio Riojas-Rodríguez[b], Eva Sabido-Pedraza[b] and Camilo Ríos[a,.] ([a]Departamento de Neuroquímica, Instituto Nacional de Neurología y Neurocirugía "Manuel Velasco Suárez", Insurgentes Sur 3877, La Fama, Tlalpan, Mexico city, México, [b]Centro de Investigación en Salud Poblacional, Instituto Nacional de Salud Pública, México). **Biomarkers of manganese exposure in a population living close to a mine and**

mineral processing plant in Mexico. Environmental Research, Vol. 106(1) (2008): Pages 89-95

Manganese (Mn) is considered an essential metal; nevertheless, excessive Mn exposure in humans is known to affect central nervous system. Mn access to its toxic target, the brain, is a complex phenomenon subject to physiological and physiopathological processes; in which, among others, the route of exposure plays an important role. Mn airborne exposure has gained interest both in occupational and environmental studies in order to understand the effects of low-level, long-term exposure. The objective of the present study was to describe the relationship between blood Mn and prolactin as marker of effect exposure, as well as other variables from subjects dwelling in a mining district in central Mexico environmentally exposed to the metal. This study was conducted on 230 volunteers; blood samples were obtained from cubital vein and hemoglobin, prolactin, lead (Pb), and Mn levels were measured. Non-parametrical Spearman's correlation showed statistical associations between blood and Mn levels and prolactin (ρ=0.197), hemoglobin (ρ=−0.213), age (ρ=−0.186), and blood lead (ρ=−0.167). Multiple regression analysis showed that blood Mn levels as an important factor to determine serum prolactin levels (β=0.111, p=0.029) in a model corrected by gender and age. Results suggest that assessment of Mn exposure by biomarkers on general population is complex due to the variability and characteristics of the metal; however, specific subpopulations such as iron-deficient individuals are suspected to accumulate Mn in blood and thus they may be susceptible to the neurotoxic effects of Mn.

Keywords: Manganese; Population; Biomarkers; Prolactin; Hemoglobin

Biofertilizer

Chen KS, Lin YS, Yang SS. (Institute of Microbiology and Biochemistry, National Taiwan University, Taipei, Taiwan). Application of thermotolerant microorganisms for biofertilizer preparation. J Microbiol Immunol Infect., Vol.40(6)(2007) : 462-73.

BACKGROUND AND PURPOSE: Intensive agriculture is practised in Taiwan, and compost application is very popular as a means of improving the soil physical properties and supplying plant nutrition. We tested the potential of inoculation with thermotolerant microorganisms to shorten the maturity and improve the quality of biofertilizer prepared by composting. METHODS: Thermotolerant microorganisms were isolated from compost and reinoculated for the preparation of biofertilizer. The physical, chemical and biological properties of the biofertilizer were determined during composting. The effects of biofertilizer application on the growth and yield of rape were also studied. RESULTS: Among 3823 colonies of thermotolerant microorganisms, Streptomyces thermonitrificans NTU-88, Streptococcus sp. NTU-130 and Aspergillus fumigatus NTU-132 exhibited high growth rates and cellulolytic and proteolytic activities. When a mixture of rice straw and swine manure were inoculated with these isolates and composted for 61 days, substrate temperature increased initially and then decreased gradually during composting. Substrate pH increased from 7.3 to 8.5. Microbial inoculation enhanced the rate of maturity, and increased the content of ash and total and immobilized nitrogen, improved the germination rate of alfalfa seed, and decreased the content of total organic carbon and the carbon/nitrogen ratio. Biofertilizer application increased the growth and yield of rape. CONCLUSIONS: Inoculation of thermotolerant and thermophilic microorganisms

to agricultural waste for biofertilizer preparation enhances the rate of maturity and improves the quality of the resulting biofertilizer. Inoculation of appropriate microorganisms in biofertilizer preparation might be usefully applied to agricultural situations.

Juwarkar AA, **Jambhulkar HP**. **(Environmental Biotechnology Division, National Environmental Engineering Research Institute (NEERI), Nehru Marg, Nagpur 440020, India. aa_juwarkar@neeri.res.in). Restoration of fly ash dump through biological interventions. Environ Monit Assess, Vol. 139(1-3)(2008):355-65.**

Field experiment on 10 ha area of fly ash dump was conducted to restore and revegetate it using biological interventions, which involves use of organic amendment, selection of suitable plant species along with specialized nitrogen fixing strains of biofertilizer. The results of the study indicated that amendment with farm yard manure at 50 t/ha improved the physical properties of fly ash such as maximum water holding capacity from 40.0 to 62.42% while porosity improved from 56.78 to 58.45%. The nitrogen content was increased by 4.5 times due to addition of nitrogen fixing strains of Bradyrhizobium and Azotobacter species, while phosphate content was increased by 10.0 times due to addition of VAM, which helps in phosphate immobilization. Due to biofertilizer inoculation different microbial groups such as Rhizobium, Azotobacter and VAM spores, which were practically absent in fly ash improved to 7.1 x 10(7), 9.2 x 10(7) CFU/g and 35 VAM spores/10 g of fly ash, respectively. Inoculation of biofertilizer and application of FYM helped in reducing the toxicity of heavy metals such as cadmium, copper, nickel and lead which were reduced by 25, 46, 48 and 47%, respectively, due to the increased organic matter content in the fly ash which complexes the heavy metals thereby decreasing the toxicity of metals. Amendment of fly ash with FYM and biofertilizer helped in profuse root development showing 15 times higher growth in Dendrocalamus strictus plant as compared to the control. Thus amendment and biofertilizer application provided better supportive material for anchorage and growth of the plant.

Tripathi RD, **Dwivedi S**, **Shukla MK**, **Mishra S**, **Srivastava S**, **Singh R**, **Rai UN**, **Gupta DK. (Ecotoxicology and Bioremediation Group, National Botanical Research Institute, Rana Pratap Marg, Lucknow 226 001, India. tripathi_rd@rediffmail.com). Role of blue green algae biofertilizer in ameliorating the nitrogen demand and fly-ash stress to the growth and yield of rice (Oryza sativa L.) plants. Chemosphere, Vol. 70(10) (2008):1919-29**

Rice is a major food crop throughout the world; however, accumulation of toxic metals and metalloids in grains in contaminated environments is a matter of growing concern. Field experiments were conducted to analyze the growth performance, elemental composition (Fe, Si, Zn, Mn, Cu, Ni, Cd and As) and yield of the rice plants (Oryza sativa L. cv. Saryu-52) grown under different doses of fly-ash (FA; applied @ 10 and 100 tha(-1) denoted as FA(10) and FA(100), respectively) mixed with garden soil (GS) in combination with nitrogen fertilizer (NF; applied @ 90 and 120 kg ha(-1) denoted as NF(90) and NF(120), respectively) and blue green algae biofertilizer (BGA; applied @ 12.5 kg ha(-1) denoted as BGA(12.5)). Significant enhancement of growth was observed in the plants growing on amended soils as compared to GS and best response was obtained in amendment of FA(10)+NF(90)+BGA(12.5). Accumulation of Si, Fe, Zn and Mn was higher than Cu, Cd, Ni and As. Arsenic accumulation was detected only in FA(100) and its amendments. Inoculation of BGA(12.5) caused slight reduction in Cd, Ni and As content of plants as compared to NF(120) amendment. The high levels of stress inducible non-protein thiols (NP-SH) and cysteine in FA(100) were decreased by application of NF and

BGA indicating stress amelioration. Study suggests integrated use of FA, BGA and NF for improved growth, yield and mineral composition of the rice plants besides reducing the high demand of nitrogen fertilizers.

Parrado J, **Bautista J**, **Romero EJ**, **García-Martínez AM**, **Friaza V**, **Tejada M**. **(Departamento de Bioquímica, Bromatología y Toxicología, Facultad de Farmacia, Universidad de Sevilla, C/ Profesor García González sn, 41012 Sevilla, Spain. parrado@us.es <parrado@us.es). Production of a carob enzymatic extract: potential use as a biofertilizer. Bioresource Technology, Vol. 99(7)☹2008): 2312-8**

In this paper, we describe a biological process that converts carob germ (CG), a proteinic vegetable by-product, into a water-soluble enzymatic hydrolyzate extract (CGHE). The chemical and physical properties are also described. The conversion is done using a proteolytic enzyme mixture. The main component of CGHE extracted by the enzymatic process is protein (68%), in the form of peptides and free amino acids, having a high content of glutamine and arginine, and a minor component of phytohormones, which are also extracted and solubilized from the CG. We have also compared its potential fertilizer/biostimulant capacity on growth, flowering, and fruiting of tomato plants (Licopericon pimpinellifolium cv. Momotaro) with that of an animal enzymatic protein hydrolyzate. CGHE had a significantly beneficial impact, most notably regarding the greater plant height, number of flowers per plant, and number of fruits per plant. This could be due primarily to its phytohormonal action.

Chen Z, **Ma S**, **Liu LL**. **(Chemistry and Life Sciences College, Tianjin Normal University, Tianjin 300074, PR China; Department of Material Processing and Control Engineering, BeiHang University (BUAA), Beijing 100083, PR China).Studies on phosphorus solubilizing activity of a strain of phosphobacteria isolated from chestnut type soil in China. Bioresource Technology, 2008**

A phosphorus solubilizing bacterium, designated phosphobacterium 9320-SD, was isolated from field soil in Tianjin, China. Cells of the phosphobacterium 9320-SD were gram-positive, rod shaped, and produced spores. When 9320-SD was inoculated into MPMLM, amended with powdered (insoluble) mineral phosphate as the single P source, and incubated at 30 degrees C, the release of soluble phosphorus increased with increasing amounts of added phosphates over the range of 0.12-4% (w/v). The maximal available phosphorus reached 12.01mmol P/L after 7days incubation. Furthermore, there was a direct positive correlation (r=0.9330) between the level of soluble phosphorus release and the concentration of viable bacteria. SEM study of the phosphate powder retrieved from the phosphobacterium 9320-SD cultured medium revealed the actual dissolution of phosphate from the mineral surface. Phosphobacterium 9320-SD had significant effect ($p<0.05$) on winter wheat total P and plant biomass under both pot and field conditions, although no obvious difference in plant height was found compared to the control. Taken together, these results demonstrate that phosphobacterium 9320-SD has the ability to convert non-available forms of phosphorus into plant-available forms, and therefore holds great potential for development as a biofertilizer to enhance soil fertility and promote plant growth.

Biocomposting

Surindra Suthar[a], Sushma Singh[b] and Sachin Dhawan[c]. ([a]Environmental Biology Lab, P.G. Department of Zoology, S.G.N. Khalsa (PG) College, Sri Ganganagar 335001, India, [b]Department of Chemistry, N.M. (PG) College, Hanumangarh 335 513, India, [c]Department of Botany, S.G.N. Khalsa (PG) College, Sri Ganganagar 335001, India). **Earthworms as bioindicator of metals (Zn, Fe, Mn, Cu, Pb and Cd) in soils: Is metal bioaccumulation affected by their ecological category? Ecological Engineering, Vol. 32(2) (2008): 99-107**

The importance of earthworms in metal pollution monitoring is widely recognized in terrestrial ecosystems. Metal bioaccumulation by soil-dwelling earthworms can be used as an ecological indicator of metal availability in soils. In this study, we quantify the level of DTPA extractable metals in casts and tissues of earthworms (endogeic: *Metaphire posthuma* (Vaillant) and anecic: *Lampito mauritii* Kinberg) and ingesting soils, collected form cultivated land, urban garden and sewage soils. Soil and worm casts collected from sewage and cultivated land showed the greater metal concentrations. The concentration of Zn, Fe, Pb and Mn in earthworm casts was in the order: sewage soil > cultivated land > urban garden, while for Cu and Cd the order was cultivated land > sewage soil > urban garden. Data suggested that the level of DTPA extractable metals was higher than that of surrounding soils. We got close relationships between metal concentration in worm tissues and surrounding soils: Zn (r^2 = 0.94 and 0.89, $P < 0.01$ for both), Fe (r^2 = 0.95 and 0.97, $P < 0.01$ for both), Cu (r^2 = 0.93 and 0.96, $P < 0.01$), Pb (0.63, $P < 0.01$ and 0.57, $P > 0.05$), and Cd (r^2 = 0.15, $P > 0.01$ and 0.75, $P < 0.01$), respectively, for *M. posthuma* and *L. mauritii.* The study clearly indicates that earthworms have efficient potentials for bioaccumulation of metals in their tissues which can be used as an ecological indicator of soil contaminations. A species-specific metal accumulation pattern was observed in studied earthworms. Comparatively, endogeic showed the higher metal contents in their tissues than anecic (*t*-test: $P < 0.05$); collected form different habitats studied. Data suggested that species-specific feeding behaviour, earthworm niche structure, ecological category of inhabiting earthworm and even horizontal distribution of contaminants in soil layers are some major determinant for metal accumulation patterns in soil dwelling earthworms. The difference in burrowing patterns can influence the patterns of metal bioaccumulations between endogeic and anecic, although other factors are also contributory. Further more detailed study is still required to elaborate the proposed hypothesis.

Keywords: Agro-ecosystem; Anecic; Earthworm; Epigeic; *Lampito mauritii*; *Metaphire posthuma*; Metal-bioavailability; Soil pollution; Worm casts

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Municipal solid waste (MSW) compost is increasingly used in agriculture as a soil conditioner but also as a fertilizer. Proponents of this practice consider it an important recycling tool since MSW would otherwise be landfilled and critics are concerned with its often elevated metal concentrations. Large amounts of MSW compost are frequently used in agriculture to meet crop N requirements and for the addition of organic matter. The main concern is loading the soil with

metals that can result in increased metal content of crops. Furthermore, in some cases, metals and excess nutrients can move through the soil profile into groundwater. Municipal solid waste compost has also been reported to have high salt concentrations, which can inhibit plant growth and negatively affect soil structure. A review of relevant agricultural studies is presented as well as recommendations for improving MSW compost quality. Its safe use in agriculture can be ensured with source separation (or triage of MSW to be composted) as well as the development and implementation of comprehensive industry standards.

Keywords: Compost; Metal contamination; Municipal solid waste; Organic waste recycling

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The present investigation of preparing vermicompost from different organic wastes (leaf litters, tea wastes, vegetable wastes and fruit wastes) using Eudrilus eugeniae has shown evidence for positive participation of earthworm in biocomposting. [The vermibeds were prepared with cow dung (CD) and organic wastes in the ratio of 1:1 and 1:2 with appropriate control. The vermicompost were analyzed for pH, EC, Organic carbon (OC), N.P, K and C/N ratio. When compared with tea, vegetable and fruit wastes vermicompost, the leaf litters vermicompost showed higher N, P and K. The OC and C/N ratio decreased significantly during maturation of the compost in 1:1 and 1:2 ratios. The pot culture studies on the germination, growth and yield performance of Vigna radiata (L) CO 6 with vermicompost were significant.

Keywords: Biocomposting, Eudrilus eugeniae, Vigna radiata, Ficus indica

Biopesticides

Yan Ma[a, b, 1], Zhi-zhou Chang[b], Jiang-tao Zhao[c] and Ming-guo Zhou[a]. ([a]College of Plant Protection, Nanjing Agricultural University, Nanjing 210095, China, [b]Institute of Agricultural Resources and Environments, Jiangsu Academy of Agricultural Sciences, Nanjing 210014, China, [c]Science and Technology Division, Jiangsu Academy of Agricultural Sciences, Nanjing 210014, China). Antifungal activity of *Penicillium striatisporum* Pst10 and its biocontrol effect on Phytophthora root rot of chilli pepper. Biological Control, Vol. 44(1) (2008): 24-31

Penicillium striatisporum Pst10 was isolated from the rhizosphere of chilli peppers. In dual culture agar plate assays, this isolate showed very high antagonistic effects on mycelium growth of *Phytophthora* spp., *Cladosporium cucumerium*, and *Sclerotinia sclerotiorum*. In *in vitro* assays, the toxicity of sterilized liquid culture filtrates (SLCF) of Pst10 grown in potato-dextrose broth (PDB) was tested against *Phytophthora capsici* mycelium growth and sporangia/spore formation or germination. The SLCF completely inhibited mycelium growth and even at a 100-fold dilution led to abnormal mycelium. A 20-fold dilution of SLCF inhibited formation and germination of sporangia and spores. Three antifungal substances were separated by thin-layer chromatography (TLC) from organic solvent extracts of liquid culture filtrate of Pst10. Composted pig manure slightly increased the colonization of the chilli rhizosphere by Pst10. In

pot tests, the incidence of Phytophthora root rot of chilli was significantly reduced when artificially infested soil was treated with conidia and SLCF of Pst10.

Keywords: *Penicillium striatisporum*; *Phytophthora capsici*; Antagonistic mechanism; Biocontrol

M.T. Mmbaga[a], R.J. Sauvé[b,] and F.A. Mrema[a]. ([a]Tennessee State University, Institute of Agricultural and Environmental Research, Otis Floyd Research Center, 472 Cadillac Lane, McMinnville, TN 37110, USA, [b]Tennessee State University, Institute of Agricultural and Environmental Identification of microorganisms for biological control of powdery mildew in *Cornus florida.* Biological Control, Vol. 44(1) (2008): 67-72

Although early signs of powdery mildew on flowering dogwood in Tennessee woodlands appear at about the same time as in commercial nurseries, they do not progress further. The objective of this study was to isolate potential biological agents on flowering dogwoods (*Cornus florida* L.) leaves in the forest setting of two state parks that contribute to the low incidence of powdery mildew in that setting, and to assess their role in disease suppression. Microorganisms isolated from leaves of native forest understory trees were evaluated on susceptible seedlings inoculated with powdery mildew conidia. Of 157 isolates, 25 reduced disease severity, and 14 were highly effective as biological control agents in greenhouse seedling trials. The highly effective isolates were identified as *Acremonium* spp., *Ampelomyces* spp., *Penicillium* spp., *Cladosporium* spp., *Trichoderma* spp., *Bacillus* spp., *Pseudomonas* spp., *Bradyrhizobium* spp., *Brachybacterium* spp., *Curtobacterium* spp., *Cryptocoocus* spp., *Rhodosporidium* spp., and two unidentified yeasts. The most effective isolates reduced the incidence of infected leaves from 75–100% to less than 10%.

Keywords: *Oidium* spp.; *Erysiphe* (Sect. *Microsphaera*) *pulchra*; Biological control agents

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Five pre-selected bacterial isolates and four plant extracts (canola, rapeseed, seaweed, and Canada milkvetch) were tested, under both growth room and field conditions during two growing seasons at two locations, for their ability to protect two potato cultivars (Russet Burbank, moderately susceptible and Kennebec, highly susceptible) against *Verticillium dahliae*. In growth room trials, *Pseudomonas fluorescens* Biotype F isolate DF37 significantly reduced the incidence, severity, and vascular discoloration of *Verticillium* wilt in both cultivars Kennebec and Russet Burbank over two seasons. *Bacillus pumulis* isolate M1 reduced wilt parameters only on cultivar Kennebec. Among the plant extracts tested, Canada milkvetch extract (MVE) was the most effective in reducing the wilt (55–84% reduction relative to the control). MVE reduced disease regardless of the method of application (incorporation into soil *versus* seed coating). In the first year of field testing, bacterial treatment DF37 and plant extract MVE were effective in reducing *Verticillium* wilt on Russet Burbank and Kennebec, respectively. Reductions in percent infection and vascular discoloration were estimated at 26% and 67% relative to the non-treated control for DF37 and 45% and 55% for MVE, respectively. In the second year of field trials,

bacterial isolates DF37 and M1, and plant extract MVE reduced all wilt parameters by percentages ranging from 19% to 31% and increased yield (18%) on cultivar Kennebec. Bacterial isolate DF37 also reduced wilt (29–43%) and increased yield (24%) on cultivar Russet Burbank.

Keywords: *Verticillium dahliae* Kleb.; *Solanum tuberosum* L.; *Verticillium* wilt; Biocontrol; Bacteria; Plant extract; Growth room conditions; Field trials; Soil borne diseases

Farooq A. Shah[a], M. Gaffney[a, b], M.A. Ansari[a], M. Prasad[c] and T.M. Butt[a]. ([a]Department of Biological Sciences, Swansea University, Singleton Park, Swansea SA2 8PP, UK, [b]Horticultural Development Unit, Teagasc Research Centre, Kinsealy, Co. Dublin, Ireland, [c]Bord Na Mona Horticulture Division, Research Centre, Main Street, Newbridge, Co. Kildare, Ireland). **Neem seed cake enhances the efficacy of the insect pathogenic fungus *Metarhizium anisopliae* for the control of black vine weevil, *Otiorhynuchs sulcatus* (Coleoptera: Curculionidae) Biological Control, Vol. 44(1) (2008): 111-115**

Neem seed cake enhanced the efficacy of the insect pathogenic fungus *Metarhizium anisopliae* for control of black vine weevil (BVW), *Otiorhynuchs sulcatus* (Coleoptera: Curculionidae) larvae in out door potted *Euonymus* plants. Both *M. anisopliae* and neem seed cake alone were effective against earlier instar larvae with the degree of control being dose dependant. Significantly higher conidial attachment was observed on larvae recovered from pots treated with combined application of *M. anisopliae* and neem seed cake (5 g/l of peat) suggesting that the neem seed cake increased larval movement and the subsequent acquisition of conidia. At higher concentration of neem seed cake (5 g/l), few BVW larvae survived whereas larvae recovered from neem treated pots (0.5 or 2.5 g/l) were less than half in body size and weight to that of untreated control suggesting that neem acts as growth regulator. Incorporation of neem seed cake or *M. anisopliae* in potting media did not influence adult BVW feeding or oviposition. Since neem seed cake products are considered safer than synthetic insecticides, the interactions we describe could easily be exploited to control insect pests in situations where no synthetic insecticides are permitted. Furthermore, enhanced efficacy of *M. anisopliae* at 100-fold lower doses (1×10^8 conidia/l of peat) in combination with neem seed cake would greatly benefit the grower by reducing the cost of the fungal BCA.

Keywords: *Metarhizium anisopliae*; Neem seed cake; Vine weevil; Conidial attachment; Antifeedant; Enhanced efficacy

Gerben J. Messelink[a], Roos van Maanen[b], Sebastiaan E.F. van Steenpaal[a] and Arne Janssen[b]. ([a]Wageningen UR Greenhouse Horticulture, P.O. Box 20, 2265 ZG Bleiswijk, The Netherlands, [b]IBED, Section Population Biology, University of Amsterdam, P.O. Box 94084, 1090 GB Amsterdam, The Netherlands). **Biological control of thrips and whiteflies by a shared predator: Two pests are better than one. Biological Control, Vol. 44(3) (2008): 372-379**

We studied the capacity of one species of predator to control two major pests of greenhouse crops, Western flower thrips (*Frankliniella occidentalis* (Pergande)) and the greenhouse whitefly (*Trialeurodes vaporariorum* (Westwood)). In such a one-predator–two-prey system, indirect interactions can occur between the two pest species, such as apparent competition and apparent mutualism. Whereas apparent competition is desired because it brings pest levels down, apparent mutualism is not, because it does the opposite. Because apparent competition and apparent

mutualism occurs at different time scales, it is important to investigate the effects of a shared natural enemy on biological control on a time scale relevant for crop growth. We evaluated the control efficacy of the predatory mites *Amblyseius swirskii* (Athias-Henriot) and *Euseius ovalis* (Evans) in cucumber crops in greenhouse compartments with only thrips, only whiteflies or both herbivorous insects together. Each of the two predators controlled thrips, but *A. swirskii* reduced thrips densities the most. There was no effect of the presence of whiteflies on thrips densities. Whitefly control by each of the two predators in absence of thrips was not sufficient, yet better with *E. ovalis*. However, whitefly densities in presence of thrips were reduced dramatically, especially by *A. swirskii*. The densities of predators were up to 15 times higher in presence of both pests than in the single-pest treatments. Laboratory experiments with *A. swirskii* suggest that this is due to a higher juvenile survival and developmental rate on a mixed diet. Hence, better control may be achieved not only because of apparent competition, but also through a positive effect of mixed diets on predator population growth. This latter phenomenon deserves more attention in experimental and theoretical work on biological control and apparent competition.

Keywords: Biological control; *Frankliniella occidentalis*; *Trialeurodes vaporariorum*; Phytoseiidae; *Amblyseius swirskii*; *Euseius ovalis*; Apparent competition; Mixed diet

Houping Liu[a] and Leah S. Bauer[a, b]. ([a]Department of Entomology, Michigan State University, East Lansing, MI 48824, USA, [b]USDA Forest Service, Northern Research Station, East Lansing, MI 48823, USA). **Microbial control of emerald ash borer, *Agrilus planipennis* (Coleoptera: Buprestidae) with *Beauveria bassiana* strain GHA: Greenhouse and field trials[☆]. Biological Control, Vol. 45(1) (2008): 124-132**

In 2003–2004, the lethal and sublethal effects of *Beauveria bassiana* strain GHA on emerald ash borer, *Agrilus planipennis* (Coleoptera: Buprestidae) adults and larvae were evaluated using topical spray and fungal band treatments in the greenhouse and field. *B. bassiana* strain GHA was moderately effective against *A. planipennis* adults in greenhouse studies. However, efficacy was improved in the field when *B. bassiana* was sprayed directly on trunk surfaces prior to adult emergence. In the greenhouse, adult infection rates ranged from 27.7% to 33.5% depending on the application rates that ranged from 25 to 75×10^{13} conidia/ha, whereas in the field, adult infection rates ranged from 58.5% and 83% at two application rates of 10 and 100×10^{13} conidia/ha. The sublethal effects of *B. bassiana* strain GHA was observed on *A. planipennis* adults and larvae surviving exposure to sprayed ash trunks. The adult longevity of females and males was significantly reduced by ca. 9 and 13 d, respectively; females also laid fewer eggs and larval development was prolonged. The use of *B. bassiana* strain GHA-fungal bands resulted in ca. 32% mortality of *A. planipennis* adults compared to ca. 1% for control adults. In addition, *B. bassiana* strain GHA trunk sprays in the fall resulted in ca. 8% mortality of *A. planipennis* under the bark of infested ash trees, compared to 1.6% mortality in the controls. Larval infection rate was positively correlated with larval density in the field. The development of *B. bassiana* strain GHA as a management tool for *A. planipennis* in North America was discussed.

Keywords: Emerald ash borer; *Agrilus planipennis*; *Beauveria bassiana* strain GHA; Lethal and sublethal effects; Greenhouse and field trials; Microbial control

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Kenya, [b]Department of Entomology, Washington State University, Prosser, WA 99350, USA, [c]Rothamsted Research, Harpenden, Hertfordshire AL5 2JQ, UK). **Chemical ecology and conservation biological control. Biological Control, Vol. 45(2) (2008). 210-224**

Elucidating the chemical ecology of natural enemies, herbivores and host plants is important in the development of effective and successful integrated pest management (IPM) strategies where abundance and distribution of natural enemies could be manipulated by semiochemicals for improved conservation biological control (CBC). In response to attack by herbivores, plants produce semiochemicals called Herbivore-Induced Plant Volatiles (HIPVs) which act to repel pests and attract their natural enemies. Damaged, and in some cases, intact plants may also produce volatile signals that warn other plants of impending attack. Some of these intact plants are used as intercrops in 'push–pull' strategies; cropping systems based on stimulo-deterrent principle, where the target crop is intercropped with herbivore repellent plants (push) while attractant plants (pull) are planted around this intercrop. The intercrop, in addition to repelling the herbivores, attracts and conserves natural enemies thereby ensuring continued suppression of the pests. This natural delivery of semiochemicals for CBC is currently being exploited by smallholder farmers in eastern Africa in the management of cereal stemborers in maize and sorghum. Synthetic HIPVs also have the potential to effectively recruit natural enemies, thereby improving CBC as has been demonstrated in a series of field experiments in vineyards and hop yards in the Pacific Northwest of the United States. Potentially, plants could be 'turned on' by synthetic HIPV signals, and therefore become sources of natural enemy-recruiting volatiles. With the rapid development of plant molecular biology, modification of secondary plant metabolism is also possible which could allow appropriate semiochemicals to be generated by plants at certain growth stages. By identifying the promoter sequences associated with external plant signals that induce biochemical pathways, plant defense genes could be 'switched on' prior to insect attack. We review recent research on 'push–pull' strategies and synthetic HIPVs in recruitment of beneficial arthropods and warding off pest attack.

Keywords: Chemical ecology; Semiochemicals; Herbivore-Induced Plant Volatiles; 'Push–pull' strategy; Natural enemies; Conservation biological control

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Improving the conditions for natural enemies through conservation biological control (CBC) in agricultural landscapes has the potential to be economically beneficial, but economic assessments of CBC programs are rarely conducted. In this paper, we discuss how to complete an economic assessment of CBC. We also ask what the research and development (R&D) requirements are for CBC and the likelihood of that R&D being funded. We examine the factors that may influence uptake of CBC amongst farmers and consider what policies or strategies might be introduced to increase the incentive to adopt CBC. Relative advantage of CBC over other production systems, trialability (ease of informal field experimentation and learning before adoption) of CBC and the social dynamics of CBC development and extension are key factors influencing adoption. The most important social factors are the social learning processes to support agroecological practices, and the configuration of economic incentives to reward farmers

for undertaking the transition to conservation biological control. By itself, neither social pressure to reduce insecticide use nor sophisticated scientific research guarantees expanded implementation of CBC.

Keywords: Cost benefit analysis; Ecological knowledge systems; Habitat management; Social learning

Guang-Hai Ji[a], Lan-Fang Wei[b], Yue-Qiu He[a], Ya-Peng Wu[a] and Xue-Hui Bai[a]. ([a]Key Laboratory of Agricultural Biodiversity for Plant Disease Management under the Ministry of Education, Yunnan Agricultural University, Kunming 650201, PR China, [b]Faculty of Resource and Environment, Yunnan Agricultural University, Kunming 650201, PR China). **Biological control of rice bacterial blight by *Lysobacter antibioticus* strain 13-1. Biological Control, Vol. 45(3) (2008): 288-296**

Bacterial leaf blight (BB) is a worldwide destructive rice disease caused by pathogen *Xanthomonas oryzae* pv. *oryzae* (*Xoo*). A novel strain of *Lysobacter antibioticus*, which was isolated from the rhizosphere of rice in Yunnan Province of China, can significantly inhibit the growth of various phytopathogenic bacteria and fungi, especially BB pathogen *Xoo*. In greenhouse experiments, whole bacterial broth culture (WBC) of strain 13-1 was more effective in reducing BB than other components of the culture, with disease suppression efficiency up to 69.7%. However, bacterial cells re-suspended in water, cell-free culture extracts, and heated cultures also significantly reduced BB severity. Suppression efficiencies ranged from 79.0% to 61.8% for undiluted to 100-fold dilution treatments and from 57.6% to 31.7% when the WBC of strain 13-1 (10^8 CFU/mL) was applied at 3 days and 7 days prior to pathogen inoculation, respectively. In three field trials, strain 13-1 reduced BB incidence by 73.5%, 78.3%, and 59.1%, respectively. Disease suppression by strain 13-1 varied significantly among different rice cultivars, although efficacy was not directly related to the susceptibility level of the cultivars. Efficacy of biocontrol was also affected by different pathogen isolates, with some isolates of *Xoo* being more sensitive to 13-1 suppression than others. These results suggest that antibiotics and density of colonization on leaves may be involved for biological control of rice BB by strain 13-1. To our knowledge, this is the first report of *L. antibioticus* being a potential biocontrol agent for rice bacterial blight.

Keywords: *Xanthomonas oryzae* pv. *oryzae*; Rice bacterial blight; *Lysobacter antibioticus*; Biocontrol

E. Gerber[a], H.L. Hinz[a] and B. Blossey[b]. ([a]CABI Europe—Switzerland, Rue des Grillons 1, CH-2800 Delémont, Switzerland, [b]Department of Natural Resources, 202 Fernow Hall, Cornell University, Ithaca, NY 14853, USA). **Pre-release impact assessment of two stem-boring weevils proposed as biological control agents for *Alliaria petiolata.* Biological Control, Vol. 45(3) (2008): 360-367**

Experimental studies can be useful tools to test plant responses to herbivory and to quantify the impact of potential biological control agents prior to their release. We evaluated the per-capita effect of *Ceutorhynchus alliariae* and *C. roberti*, two stem-boring weevils currently being investigated as potential biological control agents for garlic mustard, *Alliaria petiolata*, in North America. Weevils were released at three different densities in individual and mixed-species treatments onto potted plants of *A. petiolata*. Damage by *C. roberti* alone and by both weevils combined caused an increase in the numbers of inflorescences produced per plant. Although

plants could compensate for low levels of damage, moderate to high levels of damage by both *C. alliariae* and *C. roberti*, individually and in combination, caused a decrease in plant height and a reduction in seed output per plant. The damage inflicted by both weevil species is similar so the overall impact of both species combined can be predicted by summing the impact of each species alone. Provided they are sufficiently host specific, both weevils could be released as biocontrol agents. Because reduced seed production is necessary to suppress *A. petiolata* populations, both species have the potential to contribute to control of *A. petiolata* in North America.

Keywords: *Alliaria petiolata*; Biological control; Biological control efficacy; Impact study; Pre-release study; *Ceutorhynchus alliariae*; *Ceutorhynchus roberti*

L. Lassois[a], L. de Lapeyre de Bellaire[b] and M.H. Jijakli[a]. ([a]Gembloux Agricultural University, Plant Pathology Unit, Passage des Déportés 2, B-5030 Gembloux, Belgium, [b]CIRAD, UPR Systèmes bananes et ananas, Capesterre belle eau, Guadeloupe F-97130, France). **Biological control of crown rot of bananas with *Pichia anomala* strain K and *Candida oleophila* strain O. Biological Control, Vol. 45(3) (2008): 410-418**

The antagonistic activity of two yeast strains (*Pichia anomala* (E.C. Hansen) Kurtzman, strain K and *Candida oleophila* Montrocher, strain O) against the parasitic complex responsible for banana crown rot was evaluated. The strains were applied at three different concentrations (10^6, 10^7, 10^8 cfu/ml) and their efficacy tested *in vivo* on three separate fungi (*Colletotrichum musae* (Berk. & Curt.) Arx, *Fusarium moniliforme* Sheldon, and *Cephalosporium* sp.) and on a parasitic complex formed by association of these three fungi. At the concentrations used *C. musae* appeared to be the most pathogenic. The complex showed intermediate aggressiveness between *C. musae* and both other fungi.

Statistically significant antagonistic effects were observed on *C. musae*, *F. moniliforme*, and the fungal complex. The highest protection level (54.4%) was observed with strain O added at 10^8 cfu/ml on crowns previously inoculated with the fungal complex. The level was lower when the fungi were inoculated separately.

Furthermore, the antagonistic effect was strongly reinforced when strain O at 10^8 cfu/ml was applied 24 h before fungal complex inoculation (59.9%), as compared to its application 15 min (24.3%) or 3 h (27.3%) after fungal complex inoculation. Bananas showed increased susceptibility to the fungal complex from March to June, and this influenced the level of protection by yeast, which decreased over the same period. A strict negative correlation ($R^2 = 0.83$) was highlighted between susceptibility of banana to crown rot and protection provided by yeast.

Keywords: Banana; Biological control; *Candida oleophila*; *Cephalosporium* sp.; *Colletotrichum musae*; Crown rot; *Fusarium moniliforme*; Musa; *Pichia anomala*; Post-harvest

Biodegradation

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Two mixed bacterial cultures (C_{B-BT} and C_{I-AT}) degraded phenanthrene when it was: (i) in the presence of either hexadecane as a non aqueous phase liquid or a montmorillonite–Al(OH)x-humic acid complex as a model organo-mineral matrix; (ii) sorbed to the complex, either alone or in the presence of hexadecane. The cultures had different kinetic behaviours towards phenanthrene with or without hexadecane. The degradation of Phe alone as well as that of Phe in hexadecane ended in 8 and 15 days with C_{B-BT} and C_{I-AT} cultures, respectively. Hexadecane increased Phe bioavailability for C_{I-AT} bacteria which degraded Phe according to first-order kinetics. The same effect was observed for C_{B-BT} bacteria, but with an initial 2 days lag phase and in accordance with zero-order kinetics. The presence of hexadecane did not affect the degradation of phenanthrene sorbed and aged on the complex by C_{I-AT} culture. This capability was exhibited also after experimental aging of 30 days. The dynamics of the bacterial community composition was investigated through PCR-DGGE (denaturing gradient gel electrophoresis) of 16S rRNA gene fragments. Individual bands changed their intensity during the incubation time, implying that particular microbe's relative abundance changed according to the culture conditions. Isolation of phenanthrene and/or hexadecane degraders was in accord with cultivation-independent data. Growth-dependent changes in the cell surface hydrophobicity of the two cultures and of the isolates suggested that modulation of cell surface hydrophobicity probably played an important role for an efficient phenanthrene assimilation/uptake.

Keywords: Biodegradation - Phenanthrene - Organo-mineral matrix - NAPL

Vishakha Raina[1], Mrutyunjay Suar[1], Ajaib Singh[1], Om Prakash[1], Mandeep Dadhwal[1], Sanjay Kumar Gupta[1], Charu Dogra[1], Kirsten Lawlor[2], Sukanya Lal[1], Jan Roelof van der Meer[2, 4], Christof Holliger[3] and Rup Lal[1]. ([1]Department of Zoology, University of Delhi, Delhi, 110007, India, [2]Process of Environmental Microbiology and Molecular Ecotoxicology, Swiss Federal Institute for Environmental Science and Technology (Eawag), Dubendorf, 8600, Switzerland, [3]Laboratory of Environmental Biotechnology, EPFL, ENAC-ISTE, Lausanne, 1015, Switzerland, [4]Department of Fundamental Microbiology, University of Lausanne, Lausanne, 1015, Switzerland. Rup Lal, Email: **duzdel@vsnl.com).** **Enhanced biodegradation of hexachlorocyclohexane (HCH) in contaminated soils via inoculation with *Sphingobium indicum* B90A. Biodegradation, Vol. 19(1) (2008): 27-40**

Soil pollution with hexachlorocyclohexane (HCH) has caused serious environmental problems. Here we describe the targeted degradation of all HCH isomers by applying the aerobic bacterium *Sphingobium indicum* B90A. In particular, we examined possibilities for large-scale cultivation

of strain B90A, tested immobilization, storage and inoculation procedures, and determined the survival and HCH-degradation activity of inoculated cells in soil. Optimal growth of strain B90A was achieved in glucose-containing mineral medium and up to 65% culturability could be maintained after 60 days storage at 30°C by mixing cells with sterile dry corncob powder. B90A biomass produced in water supplemented with sugarcane molasses and immobilized on corncob powder retained 15–20% culturability after 30 days storage at 30°C, whereas full culturability was maintained when cells were stored frozen at −20°C. On the contrary, cells stored on corncob degraded γ-HCH faster than those that had been stored frozen, with between 15 and 85% of γ-HCH disappearance in microcosms within 20 h at 30°C. Soil microcosm tests at 25°C confirmed complete mineralization of [^{14}C]-γ-HCH by corncob-immobilized strain B90A. Experiments conducted in small pits and at an HCH-contaminated agricultural site resulted in between 85 and 95% HCH degradation by strain B90A applied via corncob, depending on the type of HCH isomer and even at residual HCH concentrations. Up to 20% of the inoculated B90A cells survived under field conditions after 8 days and could be traced among other soil microorganisms by a combination of natural antibiotic resistance properties, unique pigmentation and PCR amplification of the *linA* genes. Neither the addition of corncob nor of corncob immobilized B90A did measurably change the microbial community structure as determined by T-RFLP analysis. Overall, these results indicate that on-site aerobic bioremediation of HCH exploiting the biodegradation activity of *S. indicum* B90A cells stored on corncob powder is a promising technology.

Keywords: Bioaugmentation - HCH contaminated site - *Sphingobium indicum* B90A

Preeti N. Tallur[1], Veena B. Megadi[1] and Harichandra Z. Ninnekar[1.] ([1]Department of Biochemistry, Karnataka University, Dharwad, 580003, India). **Biodegradation of Cypermethrin by *Micrococcus* sp. strain CPN 1. Biodegradation, Vol 19 (1) (2007): 77-82**

A bacterium capable of utilizing pyrethroid pesticide cypermethrin as sole source of carbon was isolated from soil and identified as a *Micrococcus* sp. The organism also utilized fenvalerate, deltamethrin, perimethrin, 3-phenoxybenzoate, phenol, protocatechuate and catechol as growth substrates. The organism degraded cypermethrin by hydrolysis of ester linkage to yield 3-phenoxybenzoate, leading to loss of its insecticidal activity. 3-Phenoxybenzoate was further metabolized by diphenyl ether cleavage to yield protocatechuate and phenol as evidenced by isolation and identification of metabolites and enzyme activities in the cell-free extracts. Protocatechuate and phenol were oxidized by *ortho*-cleavage pathway. Thus, the organism was versatile in detoxification and complete mineralization of pyrethroid cypermethrin

Keywords: Biodegradation - Cypermethrin - *Micrococcus* sp. strain CPN 1 - 3-Phenoxybenzoate - Protocatechuate

Suneetha Parameswarappa[1], Chandrakant Karigar[1] and Manjunath Nagenahalli[1]. ([1]Bioremediation Laboratory, Biochemistry Division, Department of Chemistry, Central College Campus, Bangalore University, Bangalore, Karnataka, 560001, India). **Degradation of ethylbenzene by free and immobilized *Pseudomonas fluorescens*- CS2. Biodegradation, Vol 19 (1) (2008): 137-144**

Pseudomonas fluorescens-CS2 metabolized ethylbenzene as the sole source of carbon and energy. The involvement of catechol as the hydroxylated intermediate during the biodegradation of ethylbenzene was established by TLC, HPLC and enzyme analysis. The specific activity of

Catechol 2,3-dioxygenase in the cell free extracts of *P. fluorescens*-CS2 was determined to be 0.428 μmoles min^{-1} mg^{-1} protein. An aqueous-organic, Two-Phase Batch Culture System (TPBCS) was developed to overcome inhibition due to higher substrate concentrations. In TPBCS, *P. fluorescens*-CS2 demonstrated ethylbenzene utilization up to 50 mM without substrate inhibition on inclusion of *n*-decanol as the second phase. The rate of ethylbenzene metabolism in TPBCS was found enhance by fivefold in comparison with single phase system. Alternatively the alginate, agar and polyacrylamide matrix immobilized *P. fluorescens*-CS2 cells efficiently degraded ethylebenzene with enhanced efficiency compared to free cell cultures in single and two-phase systems. The cells entrapped in ployacrylamide and alginate were found to be stable and degradation efficient for a period of 42 days where as agar-entrapped *P. fluorescens* was stable and efficient a period of 36 days. This demonstrates that alginate and polyacrylamide matrices are more promising as compared to agar for cell immobilization.

Keywords: Ethylbenzene - *Pseudomonas fluorescens* - Biodegradation - TPBCS - catechol - Immobilization

Sybil E. Sharvelle[1] , Jay Garland[2] and M. K. Banks[1]. ([1]School of Civil Engineering, Purdue University, West Lafayette, IN, USA [2] Dynamac Corporation, Orlando, FL, USA). **Biodegradation of polyalcohol ethoxylate by a wastewater microbial consortium. Biodegradation, Vol19 (2) (2008): 215-221**

Polyalcohol ethoxylate (PAE), an anionic surfactant, is the primary component in most laundry and dish wash detergents and is therefore highly loaded in domestic wastewater. Its biodegradation results in the formation of several metabolites and the fate of these metabolites through wastewater treatment plants, graywater recycling processes, and in the environment must be clearly understood. Biodegradation pathways for PAE were investigated in this project with a municipal wastewater microbial consortium. A microtiter-based oxygen sensor system was utilized to determine the preferential use of potential biodegradation products. Results show that while polyethylene glycols (PEGs) were readily degraded by PAE acclimated microorganisms, most of the carboxylic acids tested were not degraded. Biodegradation of PEGs suggests that hydrophobe–hydrophile scission was the dominant pathway for PAE biodegradation in this wastewater community. Ethylene glycol (EG) and diethylene glycol (DEG) were not utilized by microbial populations capable of degrading higher molecular weight EGs. It is possible that EG and DEG may accumulate. The microtiter-based oxygen sensor system was successfully utilized to elucidate information on PAE biodegradation pathways and could be applied to study biodegradation pathways for other important contaminants.

Keywords: Biodegradation - Nonionic surfactant - Microorganisms - Wastewater - Metabolism - Pathway - Pollution - Trace contaminants - Water

Anuradha M. Desai[1, 2], Robin L. Autenrieth[1], Petros Dimitriou-Christidis[1, 3] and Thomas J. McDonald[4]. ([1]Department of Civil Engineering, Texas A&M University, College Station, TX 77843-3136, USA, [2]Department of Civil and Environmental Engineering, University of Houston, Houston, TX 77204-4003, USA, [3]Carollo Engineers, 376 E Warm Springs Road Suite 250, Las Vegas, NV 89119, USA, [4]Health Science Center, School of Rural Public Health, Texas A&M University, College Station, TX 77802-1266, USA). **Biodegradation kinetics of select polycyclic aromatic hydrocarbon (PAH) mixtures by *Sphingomonas paucimobilis* EPA505. Biodegradation, Vol 19(2), 2008 : 223-233**

Many contaminated sites commonly have complex mixtures of polycyclic aromatic hydrocarbons (PAHs) whose individual microbial biodegradation may be altered in mixtures. Biodegradation kinetics for fluorene, naphthalene, 1,5-dimethylnaphthalene and 1-methylfluorene were evaluated in sole substrate, binary and ternary systems using *Sphingomonas paucimobilis* EPA505. The first order rate constants for fluorene, naphthalene, 1,5-dimethylnaphthalene, and 1-methylfluorene were comparable; yet Monod parameters were significantly different for the tested PAHs. *S. paucimobilis* completely degraded all the components in binary and ternary mixtures; however, the initial degradation rates of individual components decreased in the presence of competitive PAHs. Results from the mixture experiments indicate competitive interactions, demonstrated mathematically. The generated model appropriately predicted the biodegradation kinetics in mixtures using parameter estimates from the sole substrate experiments, validating the hypothesis of a common rate-determining step. Biodegradation kinetics in mixtures were affected by the affinity coefficients of the co-occurring PAHs and mixture composition. Experiments with equal concentrations of substrates demonstrated the effect of concentration on competitive inhibition. Ternary experiments with naphthalene, 1,5-dimethylnaphthalene and 1-methylfluorene revealed delayed degradation, where depletion of naphthalene and 1,5-dimethylnapthalene occurred rapidly only after the complete removal of 1-methylfluorene. The substrate interactions observed in mixtures require a multisubstrate model to account for simultaneous degradation of substrates. PAH contaminated sites are far more complex than even ternary mixtures; however these studies clearly demonstrate the effect that interactions can have on individual chemical kinetics. Consequently, predicting natural or enhanced degradation of PAHs cannot be based on single compound kinetics as this assumption would likely overestimate the rate of disappearance.

Yucheng Wu[1, 2], Yongming Luo[1, 2], Dexun Zou[1], Jinzhi Ni[1], Wuxin Liu[1], Ying Teng[1] and Zhengao Li[1]. ([1] Soil and Environmental Bioremediation Research Center, State Key Laboratory of Soil and Sustainable Agriculture, Institute of Soil Science, Chinese Academy of Sciences, Nanjing, 210008, China, [2] Graduate School of the Chinese Academy of Sciences, Beijing, 100049, China). Bioremediation of polycyclic aromatic hydrocarbons contaminated soil with *Monilinia* sp.: degradation and microbial community analysis. Biodegradation, Vol 19(2) (2008): 247-257

Microcosms were set up with a PAHs-contaminated soil using biostimulation (addition of ground corn cob) and bioaugmentation (inoculated with *Monilinia* sp. W5-2). Degradation of polycyclic aromatic hydrocarbons and microbial community were examined at the end of incubation period. After 30 days, bioaugmented microcosms showed a 35 ± 0% decrease in total PAHs, while biostimulated and control microcosms showed 16 ± 9% and 3 ± 0% decrease in total PAHs, respectively. Bioaugmented microcosms also revealed 70 ± 8% and 72 ± 2% decreases in benzo[a]pyrene and anthracene, respectively, while the values for biostimulated and control microcosms were much lower. Detoxification of soils in bioaugmented microcosms was confirmed by genetic toxicity assay, suggesting important role of fungal remediation. Molecular fingerprint profiles and selective enumeration showed biostimulation with ground corn cob increased both number and abundance of indigenous aromatic hydrocarbons degraders and changed microbial community composition in soil, which is beneficial to natural attenuation of PAHs. At the same time, bioaugmentation with *Monilinia* strain W5-2 imposed negligible effect on indigenous microbial community. This study suggests that fungal remediation is promising in eliminating PAHs, especially the part of recalcitrant and highly toxic benzo[a]pyrene, in contaminated soil. It is also the first description of soil bioremediation with *Monilinia* sp.

Keywords: Bioaugmentation - Biostimulation - Fungal remediation - Microbial community - PAHs - Soil

Kimberly M. Reinauer[1], Yang Zhang[1], Xiaomin Yang[2] and Kevin T. Finneran[1]. ([1]Department of Civil and Environmental Engineering, University of Illinois-Urbana Champaign, NCEL 205 N. Mathews, Urbana, IL 61801, USA, [2] The Atlantic Richfield Company, Remediation Engineering and Technology, BP Business, Mail Code 2N, 28100 Torch Parkway, Warrenville, IL 60555, USA). **Aerobic biodegradation of *tert* -butyl alcohol (TBA) by psychro- and thermo-tolerant cultures derived from granular activated carbon (GAC). Biodegradation, Vol 19 (2) (2008): 259-268**

Tert-butyl alcohol (TBA) is a metabolite of methyl *tert*-butyl ether and is itself possibly a fuel oxygenate. The goals of this study were to enrich and characterize TBA-degrading micro-organism(s) from a granular activated carbon (GAC) unit currently treating TBA. The results reported herein describe the first aerobic, TBA-degrading cultures derived from GAC. Strains *KR1* and *YZ1* were enriched from a GAC sample in a bicarbonate-buffered freshwater medium. TBA was degraded to 10% of the initial concentration (2–5 mM) within 5 days after initial inoculation and was continuously degraded within 1 day of each re-amendment. Resting cell suspensions mineralized 70 and 60% of the TBA within 24 h for *KR1* and *YZ1*, respectively. Performance optimization with resting cells was conducted to investigate kinetics and the extent of TBA degradation as influenced by oxygen, pH and temperature. The most favorable temperature was 37°C; however, TBA was degraded from 4 to 60°C, indicating that the culture will sufficiently treat groundwater without heating. This is also the first report of psychrotolerant or thermotolerant TBA biodegradation. The pH range for TBA degradation ran from 5.0 to 9.0. Phylogenetic data using a partial 16S rRNA gene sequence (570 bases) suggest that the primary members of *KR1* and *YZ1* include uncharacterized organisms within the genera *Hydrogenophaga*, *Caulobacter*, and *Pannonibacter*.

Keywords: Biodegradation - Bio-GAC - Mixed microbial culture - Oxygenate - Psychrotolerant - Thermotolerant - *Tert*-butyl alcohol

Kumar. M.[b], Vidya Lakshmi C.[b]. and Khanna S.[a]. ([a]Department of Biotechnology and Bioinformatics, NIIT Institute of Information Technology, Balaji Estate, Kalkaji, New Delhi 110 019, India, [b]Department of Biotechnology and Environmental Sciences, Thapar Institute of Engineering and Technology, Patiala, 147 004 Punjab, India). **Biodegradation and bioremediation of endosulfan contaminated soil. Bioresource Technology, Vol 99(8), 2008: 3116-3122.**

Among the three mixed bacterial culture AE, BE, and CE, developed by enrichment technique with endosulfan as sole carbon source, consortium CE was found to be the most efficient with 72% and 87% degradation of *-endosulfan and β-endosulfan, respectively, in 20 days. In soil microcosm, consortium AE, BE and CE degraded *-endosulfan by 57%, 88% and 91%, respectively, whereas β-endosulfan was degraded by 4%, 60% and 67% after 30 days. *Ochrobacterum* sp., *Arthrobacter* sp., and *Burkholderia* sp., isolated and identified on the basis of 16s rDNA gene sequence, individually showed *in situ* biodegradation of *-endosulfan in contaminated soil microcosm by 61, 73, and 74, respectively, whereas degradation of β-endosulfan was 63, 75, and 62, respectively, after 6 weeks of incubation over the control which showed 26% and 23 % degradation of *-endosulfan and β-endosulfan, respectively. Population

survival of *Ochrobacterum* sp., *Arthrobacter* sp., and *Burkholderia* sp., by plate count on Luria Broth with carbenicillin showed 75–88% survival of these isolates as compared to 36–48% of survival obtained from PCR fingerprinting. *Arthrobacter* sp. oxidized endosulfan to endosulfan sulfate which was further metabolized but no known metabolite of endosulfan sulfate was detected.

Keywords: Endosulfan degradation; Soil microcosm; ERIC-PCR; Endosulfan sulfate; Bioaugmentation; DNA fingerprinting

Chakrabarti S.[a], Banerjee S.[b], Chaudhuri B[a], Bhattacharjee S [a], Dutta B. K [c]. ([a]Department of Chemical Engineering, Calcutta University, 92, Acharya P.C. Road, Kolkata 700 009, India, [b]Department of Polymer Science and Technology, Calcutta University, 92, Acharya P.C. Road, Kolkata 700 009, India, [c]Universiti Teknologi PETRONAS, Malaysia). **Application of biodegradable natural polymers for flocculated sedimentation of clay slurry. Bioresource Technology, Vol 99(8) (2008): 3313-3317.**

Tamarind seed kernel powder (TSKP) is a cheap starchy biodegradable material that has not been tested before for its flocculating properties. Sedimentation of clay slurry has been studied using this material. We have also done experiments with chemical grade starch and its blends with TSKP and compared their performance with that of potash alum for sedimentation of the clay slurry. The sedimentation phenomenon showed constant and falling rate zones. Sedimentation velocity, mass flux and concentration have been calculated at different time intervals for all the flocculants. Among the three types of natural flocculants, starch showed the highest rate constant in the constant rate zone and TSKP offers faster sedimentation in the falling rate zone. Thus TSKP, starch and their blends are potentially attractive environmentally benign flocculants. A qualitative explanation of the flocculating property of TSKP has been given.

Keywords: Tamarind seed kernel powder (TSKP); Clay slurry; Natural flocculants; Water clarification; Sedimentation rate

Paloma, P.[a], Ruiz, J[a], Lobo, M.C.[a], Martínez-Iñigo, M. J.[a]. ([a]Instituto Madrileño de Investigación y Desarrollo Rural, Agrario y Alimentario (IMIDRA), Finca El Encín, A-II Km 38,2, 28800 Madrid, Spain). **Degradation of oxadiazon in a bioreactor integrated in the water closed circuit of a plant nursery. Bioresource Technology, Vol 99 (7) (2007): 2177-2181.**

Hardy ornamental nursery stock (HONS) use fertigation as a rational supply of nutrients all along the growth cycle of plants. Nevertheless, that frequency of irrigation increases the risks of nutrient and herbicide leaching and subsequent contamination of the waste water. Therefore, systems of water treatment are required in plant nurseries. *Pseudomonas fluorescens* strain CG5 cells were immobilized on a ceramic support (sepiolite) contained in a 150 l-bioreactor for the biodegradation of the herbicide oxadiazon in the re-circulated leachates. Percolation and inundation operating processes were assayed in the bioreactor. The levels of oxadiazon in water samples were determined by solid phase extraction on C_{18} columns and gas chromatography with electron capture detection system. Fifty eight percolation cycles resulted in a significant reduction of oxadiazon up to just 5 $\mu g\ l^{-1}$ at the outlet. Similar herbicide elimination was achieved after two consecutive 68-h inundation periods. In addition, it was found that the nutrient content in the waste water at the bioreactor outlet was sufficient to support an adequate plant growth.

Keywords: Bioreactor; Plant nursery; Waste water; Oxadiazon; *Pseudomonas*

Roman H.[a,b], Madikane M. [a,b], Pletschke, B.I [b] and Rose P. D.[a]. ([a]Environmental Biotechnology Research Unit, Rhodes University, P.O. Box 94, Grahamstown 6140, South Africa, [b]Department of Biochemistry, Microbiology and Biotechnology, Rhodes University, P.O. Box 94, Grahamstown 6140, South Africa). **The degradation of lignocellulose in a chemically and biologically generated sulphidic environment. Bioresource Technology, Vol 99 (7) (2008): 2333-2339**

Acid mine drainage waters are characterised by a low pH, high concentrations of heavy metals, high levels of sulphate salts and low concentrations of organic material. The biological treatment of these waters has been a subject of increasing focus as an alternative to physico-chemical treatment. The utilisation of lignocellulose as a carbon source has been restricted by the amount of reducing equivalents available within the lignocellulose matrix. This present study demonstrated that lignocellulose could be utilised as a carbon source for sulphate reduction. It was shown that the initial reduction of sulphate observed using lignocellulose as a carbon source was due to the easily extractable components. This degradation resulted in the production of sulphide (~500 mg/l), which further aided in the degradation of lignin (observed as a release of aromatic compounds), allowing greater access to cellulose (and release of reducing sugars).

Keywords: Anaerobic; Aromatics; Lignin; Sulphate reducing; Sulphide

Shen, W. R.[a], Chen H.[b] and Pan S.[a]. ([a]Department of Environmental Engineering, Institute of Environment Resource, Zhejiang University, Hangzhou 310027, China). **Anaerobic biodegradation of 1,4-dioxane by sludge enriched with iron-reducing microorganisms. Bioresource Technology, Vol 99 (7) (2008): 2483-2487.**

The potential on anaerobic biodegradation of 1,4-dioxane was evaluated by use of enriched Fe(III)-reducing bacterium sludge from Hangzhou municipal wastewater treatment plant. The soluble Fe(III) supplied as Fe(III)-EDTA was more available for the Fe(III)-reducing bacterium in the sludge compared to insoluble Fe(III) oxide. The addition of humic acid (HA) further stimulated the anaerobic degradation of 1,4-dioxane accompanying with apparent reduction of Fe(III) which is believed that HA could stimulate the activity of Fe(III)-reducing bacterium by acting as an electron shuttle between Fe(III)-reducing bacterium and Fe(III), especially for insoluble Fe(III) oxides. After 40-day incubation, the concentration of 1,4-dioxane dropped up to 90% in treatment of Fe(III)-EDTA + HA. Further study proved that more than 50% of the carbon from 1,4-dioxane was converted to CO_2 and no organic products other than biomass accumulated in the growth medium. The results demonstrated that, under the appropriate conditions, 1,4-dioxane could be biodegraded while serving as a sole carbon substrate for the growth of Fe(III)-reducing bacterium. It might be possible to design strategies for anaerobic remediation of 1,4-dioxane in contaminated subsurface environments.

Keywords: 1,4-Dioxane; Fe(III)-reducing bacterium; Humic acid; Anaerobic biodegradation

Jacques R.J.S. [a], Okeke B.C. [b], Bento F. M. [c], Teixeira A. S. [d], Peralba M.C.R. [e] and Camargo F.A.O.[d.] ([a]Center of Rural Sciences, Federal University of Santa Maria/Federal University of Pampa, São Gabriel, RS, Brazil, [b]Department of Biology, Auburn University Montgomery, Montgomery, AL 36124, USA, [c]Department of Microbiology, Federal University of Rio Grande do Sul. Porto Alegre, RS, Brazil, [d]Department of Soil Science,

Federal University of Rio Grande do Sul. Porto Alegre, RS, Brazil, [c]Department of Inorganic Chemistry, Federal University of Rio Grande do Sul. Porto Alegre, RS, Brazil). Microbial consortium bioaugmentation of a polycyclic aromatic hydrocarbons contaminated soil. Bioresource Technology, Vol99(7), (2008):2637-2643

In this study we evaluated the capacity of a defined microbial consortium (five bacteria: *Mycobacterium fortuitum*, *Bacillus cereus*, *Microbacterium* sp., *Gordonia polyisoprenivorans*, *Microbacteriaceae* bacterium, Naphthalene-utilizing bacterium; and a fungus identified as *Fusarium oxysporum*) isolated from a PAHs contaminated landfarm site to degrade and mineralize different concentrations (0, 250, 500 and 1000 mg kg^{-1}) of anthracene, phenanthrene and pyrene in soil. PAHs degradation and mineralization was evaluated by gas chromatography and respirometry, respectively. The microbial consortium degraded on average, 99%, 99% and 96% of the different concentrations of anthracene, phenanthrene and pyrene in the soil, in 70 days, respectively. This consortium mineralized 78%, on average, of the different concentrations of the 3 PAHs in soil after 70 days. Contrarily, the autochthonous soil microbial population showed no substantial mineralization of the PAHs. Bacterial and fungal isolates from the consortium, when inoculated separately to the soil, were less effective in anthracene mineralization compared to the consortium. This signifies synergistic promotion of PAHs mineralization by mixtures of the monoculture isolates (the microbial consortium).

Keywords: Biostimulation; Mineralization; Anthracene; Phenanthrene; Pyrene

Santos. E. C.[a], Jacques, R.J.S.[a], Bento F. M.[a], Peralba M. C. R[b]., Selbach P.A[b]., Enilson L.S. Sá [a], and Camargo F. A.O[a]. ([a]Department of Soil Science, Faculty of Agronomy, Federal University of Rio Grande do Sul, 7712 Bento Gonçalves Ave, 91540-000 Porto Alegre, RS, Brazil, [b]Department of Inorganic Chemistry, Institute of Chemistry, Federal University of Rio Grande do Sul, 9500 Bento Gonçalves Ave, 91540-000 Porto Alegre, RS, Brazil). Anthracene biodegradation and surface activity by an iron-stimulated *Pseudomonas* sp. Bioresource Technology, Vol 99 (11) (2008): 2644-2649.

Iron may enhance polycyclic aromatic hydrocarbons (PAHs) degradation directly by increasing the activity of the enzymes involved in the aerobic biodegradation pathways for hydrocarbons, and indirectly by increasing the PAHs bioavailability due to the stimulation of biosurfactant production. In the present work, the PAH anthracene was used in order to study the effect of different forms and concentrations of iron on its biodegradation and surfactant production by *Pseudomonas* spp. isolates from a 14-years old petrochemical sludge landfarm site. Among the iron forms, iron nitrate was chosen based on its high solubility and effect on the increase in the growth of the isolate. Iron concentration of 0.1 mM was selected as the limit between deficiency and toxicity for isolates growth and anthracene degradation. After 48 days *Pseudomonas citronellolis* isolate 222A degraded 72% of anthracene related to iron stimulation and surface tension decrease, indicating surfactant production. *Pseudomonas aeruginosa* isolate 332C was iron-stimulated but did not reduce surface tension while *P. aeruginosa* isolate 312A exhibited a noniron and surfactant dependence to degrade 72% of anthracene. Isolate 222A showed a direct dependence on iron to stimulate surfactant activity, which probably increased anthracene bioavailability. To our knowledge, this is the first report about the iron effect on anthracene degradation and surfactant production by a *Pseudomonas* sp. Based on the iron requirement and surfactant activity, the *Pseudomonas* isolates may be useful for bioremediation of PAHs.

Keywords: Bioremediation; Biosurfactant; *P. aeruginosa*; *P. citronellolis*

Mahanty, B.[a], Pakshirajan, K. Venkata Dasu V. [a]. ([a]Department of Biotechnology, IIT Guwahati, Guwahati 781039, India). Biodegradation of pyrene by *Mycobacterium frederiksbergense* in a two-phase partitioning bioreactor system. Bioresource Technology Vol 99(7), (2008), 2694-2698

Biodegradation of pyrene by *Mycobacterium frederiksbergense* was studied in a two-phase partitioning bioreactor (TPPB) using silicone oil as non-aqueous phase liquid (NAPL). The TPPB achieved complete biodegradation of pyrene; and during the active degradation phase, utilization rates of 270, 230, 139, 82 mg l^{-1} d^{-1} for initial pyrene loading concentrations (in NAPL) of 1000, 600, 400 and 200 mg l^{-1}, respectively, were obtained. The degradation rates achieved using *M. frederiksbergense* in TPPB were much higher than the literature reported values for an *ex situ* PAH biodegradation system operated using single and pure microbial species. The degradation data was fitted to simple Monod, logistic, logarithmic, three-half-order kinetic models. Among these models, only exponential growth form of the three-half-order kinetic model provided the best fit to the entire degradation profiles with coefficient of determination (R^2) value >0.99. From the experimental findings, uptake of pyrene by the microorganism in TPPB was proposed to be a non-interfacial based mechanism.

Keywords: *Mycobacterium frederiksbergense*; Pyrene degradation; Two-phase partitioning bioreactor; Kinetics; Three-half-order kinetic model

Jawecki G. N [1], Hajnas A. [1] and Sawicki J. [1]. ([1]Department of Environmental Health Sciences, Medical University of Warsaw, Banacha 1, str. 02-097, Warsaw, Poland, Email: **grzenaja@wp.pl), Photodegradation and phototoxicity of thioridazine and chlorpromazine evaluated with chemical analysis and aquatic organisms. Ecotoxicology, Vol 17(1) (2008): 13-20**

The photochemical behaviour of chlorpromazine (CPZ) and thioridazine (THR) incubated under VIS light and a UV-A lamp was investigated with a high-performance liquid chromatography photodiode array detector (HPLC-PAD) and two bioassays. VIS light caused the decrease of CPZ and THR to 25% and 34% of the initial level, respectively, while UV-A degraded the drugs almost totally. CPZ and THR were very toxic to the protozoan *Spirostomum ambiguum* (Spirotox) and anostracan crustacean *Thamnocephalus platyurus* (Thamnotoxkit F^{TM}) with 24-h LC50 values of around 0.5 mg l^{-1}. In spite of the drastic decrease of the concentration of the drugs, the irradiated samples were toxic to the protozoan, especially when a sublethal end-point was taken into consideration. Contrary to the protozoan the crustacean was not sensitive to the products of photodegradation. Mass spectrometry analysis showed the presence of dimers and trimers of the CPZ and mono-, di-, and tri-oxygenated derivatives of THR. The presented data give a strong indication of the importance of the investigation of the environmental fate of drugs, especially those known to be phototoxic.

Keywords *Spirostomum ambiguum* - *Thamnocephalus platyurus* - UV-A - Photodegradation - Phototoxicity

Yamanaka H. , Moriyoshi K. , Ohmoto T. Ohe T. and Sakai K.. ([a]Department of Environmental Technology, Osaka Municipal Technical Research Institute, 1-6-50 Morinomiya, Joto-ku, Osaka 536-8553, Japan). Efficient Microbial Degradation of Bisphenol A in the Presence of Activated Carbon. Journal of Bioscience and Bioengineering, Vol 105(2), (2008):157-160

The biodegradation of bisphenol A (BPA) was carried out with *Sphingomonas* sp. strain BP-7 and *Sphingomonas yanoikuyae* BP-11R in the presence of activated carbon (AC). When AC was present, both BPA-degrading bacteria efficiently degraded 300 mg/*l* BPA without releasing 4-hydroxyacetophenone, the major intermediate produced in BPA degradation, into the medium. The biological regeneration of AC was possible using the BPA-degrading bacteria, suggesting that an efficient system for BPA removal can be constructed by introducing BPA-degrading bacteria into an AC treatment system.

Key words: bisphenol A; biodegradation; activated carbon; *Sphingomonas*; endocrine-disrupting chemical

Mudliar, S.N., Padoley K.V., Bhatt P., Sureshkumar, S.K. Lokhande M., Pandey R.A. and Vaidya A.N. (National Environmental Engineering Research Institute, Nehru Marg, Nagpur 440 020, India). Pyridine biodegradation in a novel rotating rope bioreactor. Bioresource Technology, Vol 99(5) (2008): 1044-1051

A novel immobilised bioreactor has been developed especially for the treatment of pollutants characterized by high volatility alongwith high water solubility and low microbial yields. The new bioreactor referred to as the rotating rope bioreactor (RRB) provides higher interfacial area (per unit reactor liquid volume) along with high oxygen mass transfer rate, greater microbial culture stability; and consequently higher substrate loadings and removal rates in comparison to other conventional rectors for the treatment of volatile compounds. Pyridine was used as a model compound to demonstrate the enhanced performance with RRB, when compared to that reported with other conventional bioreactors. The experimental results indicate that the novel RRB system is able to degrade pyridine with removal efficiency of more than 85% at higher pyridine concentration (up to 1000 mg/l) and loading [up to 400 $mg/m^2/h$ (66.86 $g/m^3/h$)], with a shorter hydraulic retention time (9–18 h). The reactor has been in operation for the past 15 months and no loss of activity has been observed.

Keywords: Pyridine; RRB; Biodegradation; Ammonia; Mass transfer

Jiménez L.[a], Ramos E.[b], De la Torre M.J.[b], Pérez I.[b] and. Ferrer J.L[b]. ([a]Departamento de Ingeniería Química, Campus de Rabanales, Edificio C-3, Universidad de Córdoba, 14071-Córdoba, Sapin, [b]Departamento de Ciencias Ambientales, Carretera de Utrera, Universidad Pablo de Olavide, Sevilla, Spain). Bleaching of soda pulp of fibres of *Musa textilis nee* (abaca) with peracetic acid. Bioresource Technology, Vol 99(5) (2008) :1474-1480

In this work, we studied the influence of operational variables in the bleaching of soda pulp of *Musa textilis nee* (abaca) [viz. temperature (55–85 °C), bleaching time (30–150 min) and peracetic acid concentration oven dry pulp (0.5–4.5%)] on the kappa number and viscosity of the bleached pulp, as well as on the breaking length, burst index and brightness of paper sheets made from it.

For this purpose, we used a central composite factorial design in order to identify the optimum operating conditions. In this way equations relating the dependent variables to the operational variables of the bleaching process were derived. These equations reproduce the dependent variables with errors less than 12% for all, except the viscosity which was predicted with errors less than 18%.

Obtaining bleached pulp with the highest possible viscosity (1519 ml/g), and paper sheets with the maximum possible breaking length (6547 m) and burst index (5.00 kN/g), entails using a temperature of 55 °C, a peracetic acid concentration of 4.5% and a bleaching time of 150 min. This provides a brightness of 79.90%, which is only 6.53% lower than the maximum possible value (85.48%).

Keywords: *Musa textilis nee*; Abaca; Bleaching; Soda pulp; Strength properties

Jonathan S.G.[a], Fasidi I.O.[b], Ajayi A.O. [b]and Adegeye O.[b]. ([a]Department of Botany and Microbiology, University of Ibadan, Ibadan, Nigeria, [b]Department of Forest Resources Management, University of Ibadan, Ibadan, Nigeria). **Biodegradation of Nigerian wood wastes by *Pleurotus tuber-regium* (Fries) Singer. Bioresource Technology, Vol 99(4) (2008):807-811**

Studies were carried out for 90 days on the degradation of wood wastes of four economically important Nigerian trees; *Terminalia superba, Mansonia altissima, Holoptelia grandis* and *Milicia excelsa* by white rot fungus, *Pleurotus tuber-regium* a Nigerian edible mushroom. The pH of the wastes dropped to 4.0/4.2, 90 days after incubation. On the contrary, amino nitrogen content of the wastes increased consistently during this period of solid-state fermentation. Lignin degradation also increased with the increase in incubation days. The greatest lignin reduction was observed in *H. grandis* followed by *T. superba, M. altissima* and *M. excelsa*.

Digestibility of spent substrates by ruminants increased during fermentation as follows: *M. excelsa* > *M. altissima* > *T. superba* > *H. grandis*. These results are discussed in relation to the use of fermented wood wastes as feeds for ruminants.

Keywords: *Pleurotus tuber-regium*; Biodegradation; Wood wastes; Digestibility; Fermentation

Chen H.[a], Zhang W.J.[b], Chen J. M.[b], Cai Y.B. [a] and Li W.[a]. ([a]Department of Environmental Engineering, Zhejiang University, Yuquan Campus, Hangzhou 310027, China , [b]College of Biological and Environmental Engineering, Zhejiang University of Technology, Hangzhou 310032, China). **Desulfurization of various organic sulfur compounds and the mixture of DBT + 4,6-DMDBT by *Mycobacterium* sp. ZD-19. Bioresource Technology, Vol 99(9) (2008): 3630-3634**

A new isolated dibenzothiophene (DBT) desulfurizing bacterium, identified as *Mycobacterium* sp. ZD-19 can utilize a wide range of organic sulfur compounds as a sole sulfur source. Thiophene (TH) or benzothiophene (BTH) was completely degraded by strain ZD-19 within 10 h or 42 h, and 100% DBT or 4,6-dimethyldibenzothiophene (4,6-DMDBT) was removed within 50 h or 56 h, respectively. Diphenylsulfide (DPS) possessed the lowest desulfurization efficiencies with 60% being transformed within 50 h and 80% at 90 h. The desulfurization activities of five substrates by resting cells are in order of TH > BTH > DPS > DBT > 4,6-DMDBT. In addition, when DBT and 4,6-DMDBT were mixed, they could be simultaneously desulfurized by strain ZD-19. However, DBT appeared to be attacked prior to 4,6-DMDBT. The desulfurization rate of DBT or 4,6-DMDBT in mixture is lower than they are desulfurized separately, indicating that the substrate competitive inhibition is existent when DBT and 4,6-DMDBT are mixed.

Keywords: Dibenzothiophene; Organic sulfur compounds; *Mycobacterium* sp.; Desulfurization

Chen C., Chen J., Ni W., Tian X. and Huang F. (School of Life Science, Nanjing University, Nanjing, JiangSu 210093, China). Biodegradation of Orange G by wood-rot fungi *Phanerochaete sordida* TXJ-1302A and *Tyromyces lauteus* TXJ-1302B. Bioresource Technology, Vol 99(9) (2008):3926-3929

Two strains isolated from the organic layers of forests on Zijin Mountain have indicated a strong capability of decolorization for Orange G on the solid plates. They were identified as *Phanerochaete sordida* and *Tyromyces lauteus* according to phenotypic and molecular techniques. Through this study, we try to find the suitable condition and cheapest way for decolorization by two strains. The result shows that malt extract and ammonium sulfate are the best N source for *P. sordida* and *T. lauteus*, respectively; 0.95 g per L glucose + 0.05 g per L ethonal are the best C source both for *P. sordida* and *T. lauteus*. Oxalate plays an important role as the organic acid chelator which can also enhance the decolorized capability of fungi.

Keywords: White-rot fungi; Brown-rot fungi; Glucose; Chelator; Ethanol

Sakai S., Inokuma K., Nakashimada Y., and Nishio N. (Department of Molecular Biotechnology, Graduate School of Advanced Sciences of Matter, Hiroshima University, Kagamiyama 1-3-1, Higashi-Hiroshima 739-8530, Japan E-mail: nnishio@hiroshima-u.ac.jp). Degradation of Glyoxylate and Glycolate with ATP Synthesis by a Thermophilic Anaerobic Bacterium, *Moorella* sp. Strain HUC22-1. Applied and Environmental Microbiology, Vol 74 (5) (2008):1447-1452.

The thermophilic homoacetogenic bacterium *Moorella* sp. strain HUC22-1 ferments glyoxylate to acetate roughly according to the reaction 2 glyoxylate $\rightarrow$ acetate + 2 CO_2. A batch culture with glyoxylate and yeast extract yielded 11.7 g per mol of cells per substrate, which was much higher than that obtained with H_2 plus CO_2. Crude extracts of glyoxylate-grown cells catalyzed the ADP- and NADP-dependent condensation of glyoxylate and acetyl coenzyme A (acetyl-CoA) to pyruvate and CO_2 and converted pyruvate to acetyl-CoA and CO_2, which are the key reactions of the malyl-CoA pathway. ATP generation was also detected during the key enzyme reactions of this pathway. Furthermore, this bacterium consumed L-malate, an intermediate in the malyl-CoA pathway, and produced acetate. These findings suggest that *Moorella* sp. strain HUC22-1 can generate ATP by substrate-level phosphorylation during glyoxylate catabolism through the malyl-CoA pathway.

May H. D.,[1] Miller G. S.,[1] Kjellerup B. V.,[2] and Sowers K. R. [2] (Department of Microbiology & Immunology, Marine Biomedicine & Environmental Science Center, Medical University of South Carolina, 173 Ashley Avenue, Charleston, South Carolina 29425,[1] Center for Marine Biotechnology, University of Maryland Biotechnology Institute, 701 E. Pratt Street, Baltimore, Maryland 21202[2] E-mail: mayh@musc.edu). Dehalorespiration with Polychlorinated Biphenyls by an Anaerobic Ultramicrobacterium. Applied and Environmental Microbiology, Vol. 74 (7) (2008): 2089-2094

Anaerobic microbial dechlorination is an important step in the detoxification and elimination of polychlorinated biphenyls (PCBs), but a microorganism capable of coupling its growth to PCB dechlorination has not been isolated. Here we describe the isolation from sediment of an ultramicrobacterium, strain DF-1, which is capable of dechlorinating PCBs containing double-flanked chlorines added as single congeners or as Aroclor 1260 in contaminated soil. The isolate requires *Desulfovibrio* spp. in coculture or cell extract for growth on hydrogen and PCB in

mineral medium. This is the first microorganism in pure culture demonstrated to grow by dehalorespiration with PCBs and the first isolate shown to dechlorinate weathered commercial mixtures of PCBs in historically contaminated sediments. The ability of this isolate to grow on PCBs in contaminated sediments represents a significant breakthrough for the development of in situ treatment strategies for this class of persistent organic pollutants.

Srinivasan, R., Rajeswari H., and Ajitkumar P. (Department of Microbiology and Cell Biology, Indian Institute of Science, Bangalore-560012, India). Analysis of degradation of bacterial cell division protein FtsZ by the ATP-dependent zinc-metalloprotease FtsH in vitro. Microbiological Research, Vol 163 (1) (2008): 21-30

The identity of protease(s), which would degrade bacterial cell division protein FtsZ in vivo, remains unknown. However, we had earlier demonstrated that *Escherichia coli* metalloprotease FtsH degrades *E. coli* cell division protein FtsZ in an ATP- and Zn^{2+}-dependent manner in vitro. In this study, we examined FtsH protease-mediated degradation of FtsZ in vitro in detail using seven different deletion mutants of FtsZ as the substrates, which lack different extents of specific regions at the N- or C-terminus. FtsH protease assay in vitro on these mutants revealed that FtsH could degrade all the seven deletion mutants irrespective of the deletions or the extent of deletions at the N- or C-terminus. These observations indicated that neither the N-terminus nor the C-terminus was required for the degradation of FtsZ, like already known in the case of the FtsH substrate σ^{32} protein. The recombinant clones expressing full-length FtsZ protein and FtsZ deletion mutant proteins would be useful in investigating the possibility of FtsZ as a potential in vivo substrate for FtsH in *ftsH*-null cells carrying *ftsH* suppressor function and ectopically expressed FtsH protease.

Keywords: FtsH protease; FtsZ protein; AAA family; Bacterial cell division

Kumar, R[1]. , Singh, S[1]. and Singh O. V. [2]. ([1]Radiation Biotechnology Unit, Division of Radiation Biology and Radiation Protection, Institute of Nuclear Medicine and Allied Sciences, New Delhi, 110054, India, [2] Department of Pediatrics, The Johns Hopkins University School of Medicine, Baltimore, MD 21287, USA). Bioconversion of lignocellulosic biomass: biochemical and molecular perspectives. Journal of Industrial Microbiology and Biotechnology, Vol 35(5) (2008): 377-391

In view of rising prices of crude oil due to increasing fuel demands, the need for alternative sources of bioenergy is expected to increase sharply in the coming years. Among potential alternative bioenergy resources, lignocellulosics have been identified as the prime source of biofuels and other value-added products. Lignocelluloses as agricultural, industrial and forest residuals account for the majority of the total biomass present in the world. To initiate the production of industrially important products from cellulosic biomass, bioconversion of the cellulosic components into fermentable sugars is necessary. A variety of microorganisms including bacteria and fungi may have the ability to degrade the cellulosic biomass to glucose monomers. Bacterial cellulases exist as discrete multi-enzyme complexes, called cellulosomes that consist of multiple subunits. Cellulolytic enzyme systems from the filamentous fungi, especially *Trichoderma reesei*, contain two exoglucanases or cellobiohydrolases (CBH1 and CBH2), at least four endoglucanases (EG1, EG2, EG3, EG5), and one β-glucosidase. These enzymes act synergistically to catalyse the hydrolysis of cellulose. Different physical parameters such as pH, temperature, adsorption, chemical factors like nitrogen, phosphorus, presence of

phenolic compounds and other inhibitors can critically influence the bioconversion of lignocellulose. The production of cellulases by microbial cells is governed by genetic and biochemical controls including induction, catabolite repression, or end product inhibition. Several efforts have been made to increase the production of cellulases through strain improvement by mutagenesis. Various physical and chemical methods have been used to develop bacterial and fungal strains producing higher amounts of cellulase, all with limited success. Cellulosic bioconversion is a complex process and requires the synergistic action of the three enzymatic components consisting of endoglucanases, exoglucanases and β-glucosidases. The co-cultivation of microbes in fermentation can increase the quantity of the desirable components of the cellulase complex. An understanding of the molecular mechanism leading to biodegradation of lignocelluloses and the development of the bioprocessing potential of cellulolytic microorganisms might effectively be accomplished with recombinant DNA technology. For instance, cloning and sequencing of the various cellulolytic genes could economize the cellulase production process. Apart from that, metabolic engineering and genomics approaches have great potential for enhancing our understanding of the molecular mechanism of bioconversion of lignocelluloses to value added economically significant products in the future.

Keywords: Lignocelluloses - Bioconversion - Cellulases - β-Glucosidase - Metabolic engineering

Wang, J. [1], Li, R. [1], Zhang, Z. [2], Sun W. [1], Wang, X. [1], Xu R. [1], Z. Xing[1] and Zhang X. [1]. ([1]Department of Chemistry, Liaoning University, Huanggu district, Chongshan Middle Road No 66, Shenyang, 110036, People's Republic of China, [2]Department of Environmental Science, Liaoning University, Huanggu district, Chongshan Middle Road No 66, Shenyang, 110036, People's Republic of China). **Degradation of Hazardous Dyes in Wastewater using Nanometer Mixed Crystal TiO_2 Powders under Visible Light Irradiation. Water, Air, & Soil Pollution, Vol 189(4) (2008): 225-237**

The partial phase transformation of nanometer TiO_2 powder from anatase phase to rutile phase was realized by heat-treatment and a new TiO_2 photocatalyst which could be excited by visible light was obtained. The heat-treated TiO_2 powder at different stage of transition crystal was characterized and monitored by XRD, TEM, FT-IR and UV–vis DRS methods. The test of photocatalytic activity of the heat-treated TiO_2 powder was carried out by the photocatalytic degradation of rhodamine B and acid orange II dyes, respectively, in aqueous solution under visible light irradiation. The results indicate that the nanometer TiO_2 photocatalyst heat-treated at 500°C for 60 min shows the highest photocatalytic activity, that is, it can effectively degrade the rhodamine B and acid orange II under visible light irradiation. The remarkable improvement of photocatalytic activity of heat-treated TiO_2 powder at 500°C for 60 min was mainly illustrated by the formation of special interphase between rutile and anatase phases, which not only restrains the recombination of photogenerated electrons and holes, but also reduces the adsorbability of nanometer anatase TiO_2 powder properly for various dyes. Additionally, the effects of dye-assisting chemicals such as Na_2CO_3 and NaCl on the photocatalytic degradation were also studied.

Keywords: Heat-treatment - Nanometer mixed crystal TiO_2 - Photocatalytic degradation - Rhodamine B - Acid orange II - Visible light

Herrera Y. [1, 2], Okoh A. I. [3], Alvarez L. [2], Robledo N. [4] and Trejo-Hernández M. R. [1]. ([1]Centro de Investigación en Biotecnología, Universidad Autónoma del Estado de Morelos, Av. Universidad 1001, Chamilpa, Cuernavaca, Morelos, 62209, Mexico, [2]Centro de Investigación en Ciencias Químicas, Universidad Autónoma del Estado de Morelos, Av. Universidad 1001, Chamilpa, Cuernavaca, Morelos, 62209, Mexico, [3] Department of Biochemistry and Microbiology, University of Fort Hare, Private Bag X1314, Alice, 5700, South Africa, [4] Centro de Recursos Bióticos, Instituto Politécnico Nacional, C.P. 62731, Yautepec, Morelos, Mexico). **Biodegradation of 2,4-dichlorophenol by a *Bacillus* consortium, World Journal of Microbiology and Biotechnology, Vol 24(1) (2008): 55-60**

As part of our effort at establishing microbial consortia of relevance for the bioremediation of xenobiotics polluted environments in Mexico, we assessed the aerobic biodegradation of 2,4-dichlorophenol (2,4-DCP) by a consortium of four Bacillus species that were isolated from a polluted soil by enrichment using a mixture of chlorophenols. The bacterial consortium effectively biodegraded 2-chlorophenol, 3-chlorophenol and 2,4-dichlorophenol at degradation rates of between 1.7 and 6.7 µmoles l^{-1} h^{-1}. In the presence of NH_4Cl or KNO_2 as nitrogen sources, 2,4-DCP was variously degraded. Under both conditions, cell biomass attained highest values of 350 and 450 mg l^{-1} respectively, while the amounts of 2,4-DCP metabolized in 21 days reached peak values of 2.1 and 2.5 mM representing between 70 and 85% degradation respectively. Chloride releases during the same period were highest at 4.7 mM and 5.3 mM in the presence of the two nitrogen sources. The presence of free-chloride in the culture medium had a significant impact on the catabolism of 2,4-dichlorophenol.

Keywords: 2,4-Dichlorophenol - *Bacillus* consortium - Nitrogen source - Biodegradation

Adebusoye S. A. [1, 2], Ilori M. O. [1], Picardal F. W. [2] and Amund O. O. [1]. ([1]Department of Botany and Microbiology, Faculty of Science, University of Lagos, Akoka, Yaba, Lagos, Nigeria, [2]Environmental Science Research Center, School of Public and Environmental Affairs, Indiana University, Bloomington, IN 47405, USA). **Cometabolic degradation of polychlorinated biphenyls (PCBs) by axenic cultures of *Ralstonia* sp. strain SA-5 and *Pseudomonas* sp. strain SA-6 obtained from Nigerian contaminated soils. World Journal of Microbiology and Biotechnology, Vol 24(1) (2008): 61-68**

Substantial metabolism of 2,3,4,5-tetrachlorobiphenyl (2,3,4,5-tetraCB) and 2,3′,4′,5-tetraCB by axenic cultures of *Ralstonia* sp. SA-5 and *Pseudomonas* sp. SA-6 was observed in the presence of biphenyl supplementation, although, the strains were unable to utilize tetrachlorobiphenyls as growth substrate. The former was more amenable to aerobic degradation (70% degradation) than the latter (22–45% degradation). Recovery of 2,5-chlorobenzoic acid and chloride from 2,3′,4′,5-tetraCB assay is an indication of initial dioxygenase attack on the 3,4-dichlorophenyl ring. The PCB-degradative ability of both strains was also investigated by GC analysis of individual congeners in Aroclor 1242 (100 ppm) following 12-day incubation with washed benzoate-grown cells. Results revealed two different catabolic properties. Whereas strain SA-6 required biphenyl as inducer of the degradation activity, such induction was not required by strain SA-5. Nearly all the detectable congeners in the mixture were extensively degraded (% reduction in ECD area counts for individual congeners ranged from 50.0 to 100% and 14.2 to 100%, respectively, for SA-5 and SA-6). The two strains exhibited no noticeable specificity for congeners with varying numbers of chlorine substitution and positions. The degradative competence of these isolates

most especially SA-5 makes them among the most versatile PCB-metabolizing organisms yet reported.

Keywords: Aroclor 1242 - Bacteria - Chlorobenzoic acid - Cometabolism - Degradation - Polychlorinated biphenyl

Deb Mandal M.[1], Mandal S. [1], Pal N. K. [1] and Aich A. [2]. ([1]Department of Bacteriology and Serology, Calcutta School of Tropical Medicine, C. R. Avenue, Kolkata, 700 073, India, [2] Department of Chemistry, Bose Institute, APC Road, Kolkata, 700 009, India). **Potential metabolites of dimethoate produced by bacterial degradation. World Journal of Microbiology and Biotechnology, Vol 24(1) (2008): 69-72**

Microbial degradation of pesticide has been recognized as a potential solution for the disposal of pesticide. Two bacterial strains namely *Bacillus licheniformis* and *Pseudomonas aeruginosa*, which were isolated from water and fish intestine, respectively, were allowed to grow in mineral salt solution. The acetonitrile extracts of the bacterial cultures were subjected to thin layer chromatography using two different solvent systems: hexane–chloroform–methanol and cyclohexane–acetone–chloroform. The chromatogram revealed the presence of four metabolites of dimethoate with different R_f values, in the original *P. aeruginosa* strain using both hexane–chloroform–methanol and cyclohexane–acetone–chloroform solvent systems. Total disappearance of dimethoate spot occurred in the culture of *B. licheniformis* strain at day 3. Thus, the present study establishes the bacterial degradation of dimethoate and also suggests the role of bacteria in the bioremediation of pesticides.

Keywords: Bacteria - Dimethoate degradation - TLC - UV-spectra

Prathibha K. [1] and Sumathi S. [2]. ([1] School of Biosciences and Bioengineering, Indian Institute of Technology-Bombay, Powai, Mumbai, 400 076, Maharashtra, India [2] Centre for Environmental Science and Engineering, Indian Institute of Technology-Bombay, Powai, Mumbai, 400 076, Maharashtra, India). **Biodegradation of mixture containing monohydroxybenzoate isomers by *Acinetobacter calcoaceticus*. World Journal of Microbiology and Biotechnology, Vol 24 (6) (2008): 813-823**

A bacterial strain capable of utilizing a mixture containing 2-hydroxybenzoic acid (2-HBA), 3-hydroxybenzoic acid (3-HBA) and 4-hydroxybenzoic (4-HBA) acid was isolated through enrichment from a soil sample. Based on 16SrDNA sequencing, the microorganism was identified as *Acinetobacter calcoaceticus*. The sequence of biodegradation of the three isomers when provided as a mixture (0.025%, w/v each) was elucidated. The dihydroxylated metabolites formed from the degradation of 2-HBA, 3-HBA and 4-HBA were identified as catechol, gentisate and protocatechuate, respectively, using the cell-free supernatant and cell-free crude extracts. Monooxygenases and dioxygenases that were induced in the cells of *Acinetobacter calcoaceticus* in response to growth on mixture containing 2-HBA, 3-HBA and 4-HBA could be detected in cell-free extracts. These data revealed the pathways operating in *Acinetobacter calcoaceticus* for the sequential metabolism of monohydroxybenzoate isomers when presented as a mixture.

Keywords: *Acinetobacter calcoaceticus* - 2-hydroxybenzoic acid - 3-hydroxybenzoic acid - 4-hydroxybenzoic acid - Oxygenases

Cuadrado V. [1], Merini L. J. [1], Flocco C. G. [1] and Giulietti A. M. [1]. (Microbiología Industrial y Biotecnología, Facultad de Farmacia y Bioquímica, Universidad de Buenos Aires, Junín 956 (1113), Buenos Aires, Argentina). **Degradation of 2,4-DB in Argentinean agricultural soils with high humic matter content. Applied Microbiology and Biotechnology, Vol 77(6) (2008): 1371-1378**

The dissipation of 4-(2,4-dichlorophenoxy) butyric acid (2,4-DB) in high-humic-matter-containing soils from agricultural fields of the Argentinean Humid Pampa region was studied, employing soil microcosms under different experimental conditions. The added herbicide was dissipated almost completely by soils with and without history of herbicide use by day 28. At 500 ppm, both soils showed the same degradation rates; but at 5-ppm concentration, the chronically exposed soil demonstrated a faster degradation of the herbicide. 2,4-DB addition produced increases in herbicide-degrading bacteria of three and 1.5 orders of magnitude in soils with and without history of herbicide use, respectively, in microcosms with 5 ppm. At 500-ppm concentration, the increase in 2,4-DB degraders was five orders of magnitude after 14 days, independent of the history of herbicide use. No differences were observed in either 2,4-DB degradation rates or in degrader bacteria numbers in the presence and absence of alfalfa plants, in spite of some differential characteristics in patterns of 2,4-DB metabolite accumulation. The main factor affecting 2,4-DB degradation rate would be the history of herbicide use, as a consequence of the adaptation of the indigenous microflora to the presence of herbicides in the field.

Keywords: Argentinean Humid Pampa region - Humic acids - Microcosms - 2,4-DB - Biodegradation - Soil microflora - Alfalfa rhizosphere

Zhang L. L. [1], Chen J. M. [1] and Fang F. [1]. (School of Biological and Environmental Engineering, Zhejiang University of Technology, no. 6 District, Zhaohui, Hangzhou, 310032, China). **Biodegradation of methyl *t* -butyl ether by aerobic granules under a cosubstrate condition. Applied Microbiology and Biotechnology, Vol 78 (3)(2008): 543-550**

Aerobic granules efficient at degrading methyl *tert*-butyl ether (MTBE) with ethanol as a cosubstrate were successfully developed in a well-mixed sequencing batch reactor (SBR). Aerobic granules were first observed about 100 days after reactor startup. Treatment efficiency of MTBE in the reactor during stable operation exceeded 99.9%, and effluent MTBE was in the range of 15–50 μg/L. The specific MTBE degradation rate was observed to increase with increasing MTBE initial concentration from 25 to 500 mg/L, which peaked at 22.7 mg MTBE/g (volatile suspended solids)·h and declined with further increases in MTBE concentration as substrate inhibition effects became significant. Microbial-community deoxyribonucleic acid profiling was carried out using denaturing gradient gel electrophoresis of polymerase chain reaction-amplified 16S ribosomal ribonucleic acid. The reactor was found to be inhabited by several diverse bacterial species, most notably microorganisms related to the genera *Sphingomonas*, *Methylobacterium*, and *Hyphomicrobium vulgare*. These organisms were previously reported to be associated with MTBE biodegradation. A majority of the bands in the reactor represented a group of organisms belonging to the *Flavobacteria–Proteobacteria–Actinobacteridae* class of bacteria. This study demonstrates that MTBE can be effectively degraded by aerobic granules under a cosubstrate condition and gives insight into the microorganisms potentially involved in the process.

Keywords: Aerobic granule - MTBE - DGGE - Microbial community

Ferreira M. I. M. [1], Marchesi J. R. [2] and Janssen D. B. [1]. ([1]Department of Biochemistry, Groningen Biomolecular Sciences and Biotechnology Institute, University of Groningen, NL-9747, AG, Groningen, The Netherlands, [2] Department of Microbiology/Alimentary Pharmabiotic Centre, University College Cork, College Road, Cork, Ireland). **Degradation of 4-fluorophenol by *Arthrobacter* sp. strain IF1. Applied Microbiology and Biotechnology, Vol 78 (4) (2008): 709-717**

A Gram-positive bacterial strain capable of aerobic biodegradation of 4-fluorophenol (4-FP) as the sole source of carbon and energy was isolated by selective enrichment from soil samples collected near an industrial site. The organism, designated strain IF1, was identified as a member of the genus *Arthrobacter* on the basis of 16S ribosomal RNA gene sequence analysis. *Arthrobacter* strain IF1 was able to mineralize 4-FP up to concentrations of 5 mM in batch culture. Stoichiometric release of fluoride ions was observed, suggesting that there is no formation of halogenated dead-end products during 4-FP metabolism. The degradative pathway of 4-FP was investigated using enzyme assays and identification of intermediates by gas chromatography (GC), GC–mass spectrometry (MS), high-performance liquid chromatography, and liquid chromatography–MS. Cell-free extracts of 4-FP-grown cells contained no activity for catechol 1,2-dioxygenase or catechol 2,3-dioxygenase, which indicates that the pathway does not proceed through a catechol intermediate. Cells grown on 4-FP oxidized 4-FP, hydroquinone, and hydroxyquinol but not 4-fluorocatechol. During 4-FP metabolism, hydroquinone accumulated as a product. Hydroquinone could be converted to hydroxyquinol, which was further transformed into maleylacetic acid and β-ketoadipic acid. These results indicate that the biodegradation of 4-FP starts with a 4-FP monooxygenase reaction that yields benzoquinone, which is reduced to hydroquinone and further metabolized via the β-ketoadipic acid pathway.

Keywords: Biodegradation - 4-Fluorophenol - Hydroquinone - Monooxygenase - Fluoride

X. Li[a] , Li P. [a,b], Lin X.[b], Zhang C.[a], Qi Li[a] and Gong Z. [a]. ([a]Institute of Applied Ecology, Chinese Academy of Sciences, P.O. Box 417, Wenhua Road 72, Shenyang 110016, PR China, [b]Key Lab. of Environmental Engineering, Shenyang 110044, PR China). **Biodegradation of aged polycyclic aromatic hydrocarbons (PAHs) by microbial consortia in soil and slurry phases. Journal of Hazardous Materials, Vol 150(1) (2008): 21-26**

Microbial consortia isolated from aged oil-contaminated soil were used to degrade 16 polycyclic aromatic hydrocarbons (15.72 mg kg^{-1}) in soil and slurry phases. The three microbial consortia (bacteria, fungi and bacteria–fungi complex) could degrade polycyclic aromatic hydrocarbons (PAHs), and the highest PAH removals were found in soil and slurry inoculated with fungi (50.1% and 55.4%, respectively). PAHs biodegradation in slurry was lower than in soil for bacteria and bacteria–fungi complex inoculation treatments. Degradation of three- to five-ring PAHs treated by consortia was observed in soil and slurry, and the highest degradation of individual PAHs (anthracene, fluoranthene, and benz(a)anthracene) appeared in soil (45.9–75.5%, 62–83.7% and 64.5–84.5%, respectively) and slurry (46.0–75.8%, 50.2–86.1% and 54.3–85.7%, respectively). Therefore, inoculation of microbial consortia (bacteria, fungi and bacteria–fungi complex) isolated from in situ contaminated soil to degrade PAHs could be considered as a successful method.

Keywords: PAHs; Microbial consortia; Soil; Slurry; Degradation

Wang S.[a], Ma J.[a], Liu B.[b], Jiang Y. [b] and Zhang H. [c]. ([a]School of Municipal and Environmental Engineering, Harbin Institute of Technology, Harbin 150090, China, [b]College of Biological and Environmental Engineering, Zhejiang University of Technology, Hangzhou 310032, China, [c]Wenchang Wastewater Treatment Plant of Harbin, Harbin 150059, China). Degradation characteristics of secondary effluent of domestic wastewater by combined process of ozonation and biofiltration. Journal of Hazardous Material, Vol 150(1) (2008): 109-114

The performance of the combined process of ozonation and biofiltration was studied for treating the secondary effluent from sewage treatment plant. It was found that COD, NH_3–N, and TOC were removed from 40–52, 10–19, and 9–13 mg/L in the raw water to 18–23, 0.5–1.5, and 7–8.5 mg/L in the effluent water (removal efficiency were 58, 89, and 25%, respectively), respectively, with an ozone dose of 10 mg/L (0.7–1.1 mg O_3/(mg TOC) and 0.2–0.25 mg O_3/(mg COD)), and contacting time of 4 min. Under the operation conditions, ozonation enhanced the biodegradability of the organics in the secondary effluent, as illustrated by increasing biodegradable dissolved organic carbon (BDOC) value from 0.8–1.1 mg/L in the raw water to the 2.0–2.7 mg/L in the effluent water. Meanwhile, the percentage of the organics with molecular size less than 1 k Da in the secondary effluent increased from 52.9 to 72.6%. The experimental results supported the expectation that the combined process of O_3/Biofiltration might enhance the overall treatment efficiency of secondary effluent treatment.

Keywords: Ozonation; Biofilter; Advanced treatment; Secondary effluent of domestic wastewater

Momani F. A [a]., Smith D. W [a]. and El-Din M. G. [b] ([a]Department of Chemical Engineering, Mutah University, Jordan, [b]Department of Civil and Environmental Engineering, University of Alberta, Edmonton, Alberta, Canada T6G 2M8). Degradation of cyanobacteria toxin by advanced oxidation processes. Journal of Hazardous Materials, Vol 150(2) (2008): 238-249

Advanced oxidation processes (AOPs) using O_3, H_2O_2, O_3/H_2O_2, O_3/Fe(II), and Fenton treatment were investigated for the degradation of aqueous solutions of cyanobacteria. The effects of concentration of reactants, temperature, and pH on toxins degradation were monitored and the reaction kinetics was assessed. O_3 alone or combined with either H_2O_2 or Fe(II) were efficient treatment for toxins elimination. A higher toxin oxidation tendency was observed with Fenton reaction; total toxins degradation (MC-LR and MC-RR) was achieved in only 60 s.

The ozonation treatment was successfully described by second-order kinetics model, with a first-order with respect to the concentration of either ozone or toxin. At 20 °C, with initial concentration of MC-LR of 1 mg/L, the overall second-order reaction rate constant ranged from 6.79×10^4 to 3.49×10^3 M^{-1} s^{-1} as the solution pH increased from 2 to 11. The reaction kinetics of the other AOPs (O_3/H_2O_2, O_3/Fe(II), and Fenton), were fitted to pseudo first-order kinetics. A rapid reaction was observed to took place at higher initial concentrations of O_3, H_2O_2 and Fe(II), and higher temperatures. At pH 3, initial concentration of toxin of 1 mg/L, the pseudo first-order rate constant, achieved by Fenton process, was in order of 8.76 ± 0.7 s^{-1}.

Keywords: Cyanobacteria; Fenton; Hydroxyl radical (**.**OH); Reaction rate constant

Blánquez P. [a, b] and Guieysse B. [a ,c] . ([a]Biotechnology Department, Lund University, PO Box 124, S-221 00 Lund, Sweden, [b]Departament d'Enginyeria Química, Escola Tècnica Superior d'Enginyeria, Universitat autònoma de Barcelona, Bellaterra 08193, Spain, [c]School of Civil and Environmental Engineering, Nanyang Technological University, Block N1, Nanyang Avenue 639798, Singapore). Continuous biodegradation of 17β-estradiol and 17α-ethynylestradiol by *Trametes versicolor* . Journal of Hazardous Materials ,Vol 150(2) (2008): 459-462

The feasibility of 17β-estradiol (E2) and 17α-ethynylestradiol (EE2) removal by *Trametes versicolor* was demonstrated in batch and continuous cultures. In batch, E2 and EE2 initially supplied at 10 mg l^{-1} were removed by more than 97% in 24 h, which corresponded to volumetric removal rates of 0.43 and 0.44 mg l^{-1} h^{-1}, respectively. A bioreactor inoculated with *T. versicolor* pellets was then continuously operated during 26 days at a hydraulic retention time of 120 h. E2 and EE2 were completely removed at volumetric removal rates of 0.16 and 0.09 mg l^{-1} h^{-1}, respectively, when fed at 18.8 and 7.3 mg l^{-1}, respectively. Evidence was found that removal was caused by laccase. This study demonstrates the technical feasibility of fungal treatment of estrogens using continuous bioreactor with suspended fungal biomass.

Keywords: Bioreactor; Emerging contaminant; Estrogens; Endocrine disrupter; White-rot fungi

H. Jung[b], K.D. Sohn[b], Neppolian B. [a] and Choi H. [b]. ([a]Department of Environmental Science and Engineering, Gwangju Institute of Science and Technology (GIST), 1 Oryong-dong, Buk-gu, Gwangju 500712, South Korea, [b]Environmental Management Corporation, Environmental Research Complex, Kyungseo-Dong, Seo-gu, Incheon 404708, South Korea). Effect of soil organic matter (SOM) and soil texture on the fatality of indigenous microorganisms in intergrated ozonation and biodegradation. Journal of Hazardous Materials, Vol 150 (3) (2008), 809-817

In situ ozonation has been proposed as a method to remediate soils contaminated with organic pollutants. Soil column experiments were performed on eight different soils in order to investigate the effects of soil properties, such as soil organic matter (SOM) and soil texture on the survival and regrowth of indigenous microorganisms after *in situ* ozonation. Indigenous microorganisms were found to be very sensitive to ozone in the soil column experiments. The microbial fatality revealed a linear relationship with the SOM content in the range of 1.72–2.42% of SOM content, whereas water content was poorly correlated. Four weeks of incubation of ozone-treated soil samples allowed for the regrowth of indigenous microorganisms with inverse relation to ozonation time. The regrowth was also significantly influenced by the SOM content in the same soil texture. Oxidation and removal rate of hexadecane was affected by particle size distribution. Especially, sand exhibited the highest oxidation rate of hexadecane, which resulted from having the lowest SOM content, water content, and surface area with respect to the other samples. The soil samples ozonated for 90–180 min were determined to exhibit the lowest concentration of hexadecane, with the exception of sand, after 4 weeks of incubation. This study provided insight into the influence of SOM and soil texture on indigenous microbial potential to degrade hexadecane in integrated ozonation and biodegradation.

Keywords: *In situ* ozonation; Indigenous microorganisms; SOM; Soil texture; Hexadecane

Pokhrel D. and Viraraghavan T. . ([a]Faculty of Engineering, University of Regina, 3737 Wascana Parkway, Regina, SK, S4S 0A2, Canada). Arsenic removal from an aqueous

solution by modified *A. niger* biomass: Batch kinetic and isotherm studies. Journal of Hazardous Materials, Vol 150 (3) (2008): 818-825

Batch studies were conducted to examine the adsorption kinetics and adsorption capacity of iron oxide-coated biomass (IOCB) for As(III) and As(V). The optimum pH for As(V) and As(III) removal was found to be 6. The equilibrium time for removal of arsenic was found to be approximately 7 h. The adsorption of As(V) on IOCB was rapid compared to that of As(III) adsorption. An increase in temperature (from 5 to 30 °C) was found to increase As(III) removal, whereas in the case of As(V), the removal increased with temperature from 5 to 10 °C, but remained relatively constant thereafter up to 30 °C. The pseudo-second order rate equation was found to describe better the kinetics of arsenic adsorption than other equations. The isotherm data for As(V) removal fitted better with the Langmuir equation compared with other tested models and the isotherm data for As(III) removal fitted better with Redlich–Peterson equation than other tested models. Iron oxide-coated fungal biomass (*A. niger*) was found to be efficient in removing arsenic from an aqueous solution.

Keywords: Arsenic removal; Iron oxide-coated biomass; *Aspergillus niger*; Kinetics;

Ozlem Tepe and Arzu Y. Dursun. ([a]Department of Environmental Engineering, Firat University, 23100 Elazig, Turkey). Combined effects of external mass transfer and biodegradation rates on removal of phenol by immobilized *Ralstonia eutropha* in a packed bed reactor. Journal of Hazardous Materials, Vol 151(1) (2008):9-16

Biodegradation of phenol by calcium-alginate immobilized *Ralstonia eutropha* was carried out in a batch stirred and a packed bed reactor. In the batch system studies, the effect of initial phenol concentration on biodegradation was investigated at 30 °C and pH 7 while in the continuous system studies, the effects of flow rate and inlet phenol concentration on biodegradation were tested at the same temperature and pH. The observed biodegradation rate constant was calculated at different flow rates with the assumption of first-order biodegradation kinetics. Various external mass transfer correlations were evaluated and a new correlation of the type $J_D = K(N_{Re})^{-(n-1)}$ was developed with the values of $K = 1.34$ and $n = 0.65$. The intrinsic first-order biodegradation rate constants and the external mass transfer coefficients were calculated then the combined effects of these rates on the observed first-order biodegradation rate constants were also investigated.

Keywords: Phenol; Ca-alginate gel-immobilized *Ralstonia eutropha*; Biodegradation; Packed bed reactor; External mass transfer coefficient

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This study employed direct photolysis to treat mixed polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) solutions. The solutions included a synthetic standard 17 2, 3, 7, 8-substituted congeners solution and a practical liquid extracted from the bag filter ash of an electric arc furnace. Additionally, this work utilized a coupled

catalyst (ZnO/SnO_2) under UV irradiation for photocatalytic degradation of 1, 2, 3, 6, 7, 8-HxCDD and OCDD. The direct photolysis rate of PCDFs was faster than that of PCDDs. The degradation rate of international toxicity equivalency quantity (I-TEQ) for PCDDs and PCDFs in the synthetic standard solution was 1.369 and 1.472 h^{-1}, respectively, and that in the ash-extracted solution was 0.061 and 0.117 h^{-1}, respectively. The rate of photocatalytic degradation declined as the number of chlorine atoms increased. No 2, 3, 7, 8-substituted congeners were identified during photocatalytic degradation; additionally, the photolytic rate of the UV/coupled catalyst was higher than that of UV/single catalyst system. Experimental results suggested that the primary degradation pathway for direct photolysis and photocatalysis of PCDD/Fs was the C—Cl cleavage and C—O cleavage, respectively.

Keywords: PCDD/Fs; Direct photolysis; Photocatalysis; Coupled catalyst

Bandala E. R. [a], Peláez M. A. [a], Salgado M. J. [a] and Torres L. [a]. ([a]Instituto Mexicano de Tecnología del Agua, Paseo Cuauhnáhuac 8532, Progreso Jiutepec, Morelos 62550, Mexico and [b]Instituto de Ingeniería, Universidad Nacional Autónoma de México (UNAM), Mexico). **Degradation of sodium dodecyl sulphate in water using solar driven Fenton-like advanced oxidation processes. Journal of Hazardous Materials, Vol 151(2-3) (2008): 578-584**

Synthetic wastewater samples containing a model surfactant were treated using two different Fenton-like advanced oxidation processes promoted by solar radiation; the photo-Fenton reaction and Co/PMS/UV processes. Comparison between the different experimental conditions was performed by means of the overall surfactant degradation achieved and by obtaining the initial rate in the first 15 min of reaction (IR_{15}). It was found that, for dark Fenton reaction, the maximum surfactant degradation achieved was 14% under low iron and oxidant concentration. Increasing Fenton reagents by one magnitude order, surfactant degradation achieved 63% in 60 min. The use of solar radiation improved the reaction rate by 17% under same conditions and an additional increase of 12.5% was obtained by adjusting initial pH to 2. IR_{15} values for dark and irradiated Fenton reactions were 0.143 and 0.154 mmol/min, respectively, for similar reaction conditions and this value increased to 0.189 mmol/min when initial pH was adjusted. The use of the Co/PMS system allow us to determine an increase in the degradation rate, for low reaction conditions (1 mM of transition metal; 4 mM oxidant) similar to those used in dark Fenton reaction. Surfactant degradation increased from 3%, for Fenton reaction, to 44.5% in the case of Co/PMS. When solar irradiation was included in the experiments, under same reaction conditions described earlier, surfactant degradation up to 64% was achieved. By increasing Co/PMS reagent concentration by almost 9 times under irradiated conditions, almost complete (>99%) surfactant degradation was reached in 5 min. Comparing IR_{15} values for Co/PMS and Co/PMS/UV, it allow us to observe that the use of solar radiation increased the degradation rate in one magnitude order when compared with dark experiments and further increase of reagent concentration increased reaction rate twice.

Keywords: Co/PMS; AOPs; Fenton reagent; Degradation; Wastewater treatment; Soil restoration; SDS

Dash R. R. [a], Balomajumder C. [b] and Kumar A. [b]. ([a]Department of Civil Engineering, Indian Institute of Technology Roorkee, Roorkee 247667, Uttaranchal, India and [b]Department of Chemical Engineering, Indian Institute of Technology Roorkee, Roorkee 247667, Uttaranchal, India). **Treatment of metal cyanide bearing wastewater by**

simultaneous adsorption and biodegradation (SAB). Journal of Hazardous Materials, Vol 152(1) (2008) : 387-396

This paper presents process review and comparative study of biodegradation and adsorption alone with simultaneous adsorption and biodegradation (SAB) process using *Pseudomonas fluorescens*. Ferrocyanide solution was used for all studies with initial CN^- concentrations of 50, 100, 200 and 300 mg/L, and initial pH of 6. *Pseudomonas fluorescens* used ferrocyanide as sole source of nitrogen and biodegradation efficiency was observed as 96.4, 94.1, 86.2 and 69.3%, respectively after 60 h of agitation. Whereas in adsorption process with granular activated carbon (GAC) as adsorbent, CN^- removal efficiency was found to be 85.6, 80.1, 70.2 and 50.2%, respectively. But in SAB process the removal efficiency could be more than 70% for all concentrations only at 36 h of agitation and achieved removal efficiency of 99.9% for 50 and 100 mg CN^-/L. It was found that SAB process is more effective than biodegradation and adsorption alone.

Keywords: Adsorption; Biodegradation; Ferrocyanide; *Pseudomonas fluorescens*; SAB

Li Q.[a], Wang H.[a], He N.[a], Wang Y.[b], Sun D.[a] and Lu Y.[a] ([a]Department of Chemical and Biochemical Engineering, College of Chemistry and Chemical Engineering, Key Lab for Chemical Biology of Fujian Province, Xiamen University, Xiamen 361005, China). **High efficiency of batch operated biofilm hydrolytic–aerobic recycling process in degradation of 2,4-dichlorophenol. Journal of Hazardous Materials, Vol.152(2) (2008):536-544**

The degradation of a model molecule, 2,4-dichlorophenol (2,4-DCP), was studied using four biofilm processes: stand-alone hydrolytic process, stand-alone aerobic process, hydrolytic–aerobic in-series process (in-series process) and hydrolytic–aerobic recycling process (recycling process). The overall removal efficiency of 2,4-DCP was far higher in the recycling process than in the stand-alone hydrolytic process, the stand-alone aerobic process and the in-series process. 2,4-DCP removal efficiency in the recycling process was 99% with the recycling rate being 10 mL/min in 12 h, while those in the stand-alone hydrolytic, stand-alone aerobic and the in-series process were 96%, 82% and 89%, respectively. COD removal efficiency could reach 91% in the recycling process in 4 h whereas those were only 23%, 69% and 25% in the stand-alone hydrolytic, stand-alone aerobic and the in-series process, respectively. In the recycling process, the concentrations of volatile fatty acid (VFA) gradually increased to 3.5 mmol/L in first 5 h and then declined to below 3 mmol/L, and the pH values were all around 7.5 during the whole process. The alkalinity of the solution in the recycling process was apparently higher than that in both the stand-alone processes and in-series process within 12 h. Moreover, the ratios of VFA/alkalinity were all less than 0.8 in the recycling process, which indicated the activity of hydrolytic microorganisms was not inhibited and the process maintained a stable condition. Therefore, the recycling process could successfully solve the problem of over-acidification and effectively enhanced the removal efficiencies of 2,4-DCP and COD.

Keywords: Biodegradation; 2,4-DCP; Recycling; Hydrolytic; Aerobic

Jou C.J. (Department of Safety, Health and Environmental Engineering, National Kaohsiung First University of Science and Technology, Kaohsiung, Taiwan). ROC, **Degradation of pentachlorophenol with zero-valence iron coupled with microwave energy. Journal of Hazardous Materials, Vol 152 (2) (2008):699-702**

The objective of this research is to study the degradation of pentachlorophenol with zero-valence iron (Fe^0) coupled with the use of microwave energy. The sample containing 1000 mg/L PCP solution was dosed with 0.5 g Fe^0 and then subject to 700 W microwave energy for 10 s; 85% pentachlorophenol was noted to be removed. If the microwave treatment time was increased to 30 s, the pentachlorophenol removal efficiency exceeded 99% with end products including H_2O, CO_2, HCl, etc. Using Fe^0 as a medium, the microwave treatment is made an efficient method for degrading pentachlorophenol. The time needed to achieve a satisfactory treatment is also reduced leading to significant savings of energy consumption to make this method cost-effective. Since this technology applies Fe^0, which is amenable to natural environment, to speed up the decomposition of an industrial solvent, it is not only cost-effective but also environmental friendly for the industry to pursuit sustainable development.

Keywords: Microwave; Induced; Zero-valence iron; Pentachlorophenol

Zhou H. W. [a, b] Luan T. G. [c], Zou F. [b] and Tam N. F. Y.[a.] ([a]Department of Biology and Chemistry, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong SAR, China, [b]Department of Environmental Health, School of Public Health and Tropical Medicine, Southern Medical University, Guangzhou, Guangdong 510515, China and [c]School of Life Science/State Key Laboratory for Biocontrol, Sun Yat-sen (Zhongshan) University, Guangzhou 510275, China). Different bacterial groups for biodegradation of three- and four-ring PAHs isolated from a Hong Kong mangrove sediment. Journal of Hazardous Materials, Vol.152 (3) (2008) : 1179-1185

Mangrove sediments have been found to degrade three- to four-ring PAHs extensively. In the present study, 11 strains from 4 genera *Mycobacterium* (3 strains), *Sphingomonas* (5), *Terrabacter* (2) and *Rhodococcus* (1) were isolated from a single surface sediment sample of a Hong Kong mangrove swamp, among which the *Terrabacter* strains were isolated to grow with fluoranthene for the first time. Although all four genera could degrade three- and four-ring PAHs, their *in situ* activities in natural sediment slurry were found to be different. A cultivable method showed that *Sphingomonas* strains grew rapidly under the induction of three-ring, but not four-ring PAHs, while only *Mycobacterium* degrading strains dominated in the four-ring PAHs spiked slurry. Culture-independent method using a reverse transcriptional PCR showed expressions of *nahAc*-like (mainly found in Gram-negative bacteria) and *nidA*-like (in Gram-positive bacteria) dioxygenase genes parallel with the degradation of three- and four-ring PAHs, respectively. The present study suggested that surface mangrove sediments harbored diverse PAH-degrading bacteria, which showed different importance for biodegradation of three- and four-ring PAHs in the sediment.

Keywords: Polycyclic aromatic hydrocarbons; Mangrove; Biodegradation; *Mycobacterium*; *Sphingomonas*; *Terrabacter*

Sohrabi M.R. and Ghavami M. ([a]Department of Chemistry, Islamic Azad University North Tehran Branch, P.O. Box 1913674711, Tehran, Iran). Photocatalytic degradation of Direct Red 23 dye using UV/TiO_2: Effect of operational parameters. Journal of Hazardous Materials, Vol. 153(3) (2008):1235-1239

In this study, the photocatalytic degradation of Direct Red 23 (Scarlet F-4BS) was investigated in UV/TiO_2 system. The effect of catalyst loading and pH on the reaction rate was ascertained and optimum conditions for maximum degradation were determined. The results obtained

showed that acidic pH is proper for the photocatalytic removal of Direct Red 23. In addition, the effects of several cations (Cu^{2+}, Al^{3+}, Cr^{3+}, and Sn^{4+}) and anions (BiO_3^-, SO_4^{2-}, and CN^-) and C_2H_5OH were examined in this photocatalytic process. On the order hand, three types of catalysts (Fe_2O_3, SnO_2, and ZnO) were compared with TiO_2. After 90 min reaction, the relative decomposition order established was UV/TiO_2 > UV/SnO_2 > UV/Fe_2O_3 > UV/ZnO.

Keywords: Direct Red 23 dye; UV/TiO_2; Photocatalysis; Wastewater treatment

Zhuo Q., Wang B. M. and Fan F. ([a]Key Laboratory of Applied Surface and Colloid Chemistry, Ministry of Education, Institute of Energy Chemistry, School of Chemistry and Materials Science, Shaanxi Normal University, Xi'An 710062, China). Degradation of methylene blue: Optimization of operating condition through a statistical technique and environmental estimate of the treated wastewater. Journal of Hazardous Materials, Vol. 153(1-2) (2008): 44-51

FeO_x-MoO_3-P_2O_5 (x = 1 or 1.5) composite catalyst was prepared by solid reaction method and characterized by X-ray diffraction (XRD) and X-ray Photoelectron Spectroscopy (XPS). Its catalytic activities on degradation of a heteropolyaromatic dye, methylene blue (MB), were also investigated under mild condition. In order to determine the optimum operating condition, the orthogonal experiments were devised. And the results revealed that initial concentration of MB was the key factor that affected the decoloration, while the catalysts dose has an insignificant effect. Environmental estimation was also done and the results showed that the treated wastewater have little influence on plant growth and could totally be applied to irrigation.

Keywords: Methylene blue; Catalyst; Degradation; Orthogonal experiments

Andrade L. S.[a], Rocha-Filho R. C. [a], Bocchi N. [a], Biaggio S. R. [a]. Iniesta J.[b], García-Garcia V [b]. and Montiel V. [b]. ([a]Departamento de Química, Universidade Federal de São Carlos, C.P. 676, 13560-970 São Carlos, SP, Brazil, [b]Departamento de Química Física, Instituto Universitario de Electroquímica, Facultad de Ciencias, Universidad de Alicante, Apartado de Correos 99, E-03080 Alicante, Spain). Degradation of phenol using Co- and Co,F-doped PbO_2 anodes in electrochemical filter-press cells. Journal of Hazardous Materials, Vol. 153(1-2) (2008):252-260

A comparative study on the electrooxidation of phenol in H_2SO_4 medium using pure PbO_2 or F-, Co- and Co,F-doped PbO_2 electrodes in filter-press cells was carried out. The oxide films were obtained by galvanostatic electrodeposition using an electrolytic bath containing sodium lauryl sulfate as additive and Pb^{2+}, F^-, Co^{2+} or Co^{2+} + F^-, under magnetic stirring (to obtain 4-cm^2 electrodes) or ultrasound waves (to obtain 63-cm^2 electrodes). The best results were attained with PbO_2 electrodes doped with a low-Co content (1 mM Co^{2+} in the electrolytic bath) along with F^-: the chemical oxygen demand (COD) and the total organic carbon content (TOC) of the simulated wastewaters were removed by about 75% and 50%, respectively. When pure PbO_2 electrodes were used, the COD and TOC removals were about 60% and 45%, respectively. For the smaller electrodes, an average current efficiency (ACE) and an energy consumption (EC) of about 16% and 70 kWh kg_{COD}^{-1}, respectively, were obtained. For the larger electrodes, the ACE and EC values were about 18% and 105 kWh kg_{COD}^{-1}, respectively. Stability tests of the electrodes showed that they are suitable for use in the electrochemical treatment of phenol wastewaters.

Keywords: Phenol degradation; Co-doped lead dioxide; F-doped lead dioxide; Electrochemical wastewater treatment; Filter-press cell

Zhou M.[a, b,] and He J. [a] ([a]Department of Environmental Science, Zhejiang University, Hangzhou 310028, China, [b]Department of Chemical and Biomolecular Engineering, Sydney University, NSW 2006, Australia). **Degradation of cationic red X-GRL by electrochemical oxidation on modified PbO_2 electrode. Journal of Hazardous Materials, Vol. 153(1-2) (2008):357-363**

This work investigated the degradation of an azo dye, cationic red X-GRL, by electrochemical oxidation on a novel PbO_2 anode modified by fluorine resin. The influences of treatment time, electrolyte concentration, current density, temperature and initial dye concentration on the color and COD removal were critically examined. This process showed a high current efficiency and competitive energy consumption for effective treatment of dye wastewater containing a certain salt content. In the investigated electrolyte concentrations, high salt content exhibited insignificant promotion on the color and COD removal but favored the decrease of energy consumption. During treatment, the current efficiency decreased but the energy consumption increased with treatment time; thus, this method was more suitable for the pretreatment of high-concentrated azo dye wastewater. Based on the degradation intermediates identification, a simplified degradation pathway for cationic red X-GRL was proposed.

Keywords: Electrochemical oxidation; Cationic red X-GRL; Azo dye; PbO_2 electrode; Degradation mechanism

Cheng H. F., Kumar M. and Lin J.G. ([a]Institute of Environmental Engineering, National Chiao Tung University, 75 Po-Ai Street, Hsinchu 300, Taiwan). **Degradation kinetics of di-(2-ethylhexyl) phthalate (DEHP) and organic matter of sewage sludge during composting. Journal of Hazardous Materials, Vol. 154(1-3) (2008):55-62**

The potential degradation of di-(2-ethylhexyl) phthalate (DEHP) and organic matter of sewage sludge by composting was investigated using laboratory reactor at different operating conditions (E-1, E-2 and E-3). In all conditions, single stage thermophilic phase was observed within 2 days and almost, 60% of DEHP was degraded under this phase. At the end of composting, total DEHP degradation of more than 85% was observed in all conditions and total carbon reduction was 11.8% in E-1, 7.6% in E-2 and 10.8% in E-3. Similar trend was observed in the degradation of total nitrogen. The reduction of volatile solids (VS) in the composting reactors was 5.4% in E-1 (18 days), 5.5% in E-2 (12 days) and 4.3% in E-3 (18 days). The degradation kinetics of DEHP in thermophilic phase (including initial mesophilic phase) and the phase there after were determined by first order and fractional power kinetics, respectively. The significance of experimental parameters in DEHP degradation was assessed by Pearson correlation approach. Elevated temperature produced during composting was effective for the rapid degradation of DEHP from sewage sludge compared to mesophilic treatment.

Keywords: Di-(2-ethylhexyl) phthalate; Composting; Kinetics; Reactor study

Nievas M.L.[a], Commendatore M.G.[a], Esteves J.L.[a] and Bucalá V. [b]. ([a]Centro Nacional Patagónico, Unidad de Investigación de Oceanografía y Meteorología, Laboratorio de Oceanografía Química y Contaminación de Aguas, CONICET, Bv. Brown 2825, U9120ACF, Puerto Madryn, Argentina and [b]Departamento de Ingeniería Química,

PLAPIQUI, Universidad Nacional del Sur, CONICET, Camino La Carrindanga Km 7, 8000, Bahía Blanca, Argentina). Biodegradation pattern of hydrocarbons from a fuel oil-type complex residue by an emulsifier-producing microbial consortium. Journal of Hazardous Materials, Vol. 154 (1-3) (2008):96-104

The biodegradation of a hazardous waste (bilge waste), a fuel oil-type complex residue from normal ship operations, was studied in a batch bioreactor using a microbial consortium in seawater medium. Experiments with initial concentrations of 0.18 and 0.53% (v/v) of bilge waste were carried out. In order to study the biodegradation kinetics, the mass of *n*-alkanes, resolved hydrocarbons and unresolved complex mixture (UCM) hydrocarbons were assessed by gas chromatography (GC). Emulsification was detected in both experiments, possibly linked to the *n*-alkanes depletion, with differences in emulsification start times and extents according to the initial hydrocarbon concentration. Both facts influenced the hydrocarbon biodegradation kinetics. A sequential biodegradation of *n*-alkanes and UMC was found for the higher hydrocarbon content. Being the former growth associated, while UCM biodegradation was a non-growing process showing enzymatic-type biodegradation kinetics. For the lower hydrocarbon concentration, simultaneous biodegradation of *n*-alkanes and UMC were found before emulsification. Nevertheless, certain UCM biodegradation was observed after the medium emulsification. According to the observed kinetics, three main types of hydrocarbons (*n*-alkanes, biodegradable UCM and recalcitrant UCM) were found adequate to represent the multicomponent substrate (bilge waste) for future modelling of the biodegradation process.

Keywords: Biodegradation; Bilge waste; Fuel oil residue; UCM; Emulsification

Lohi A., Cuenca M. A., Anania G., Upreti S.R. and Wan L. (Laboratory of Water and Wastewater Treatment Technologies, Department of Chemical Engineering, Ryerson University, 350 Victoria Street, Toronto, Ontario M5B 2K3, Canada). Biodegradation of diesel fuel-contaminated wastewater using a three-phase fluidized bed reactor. Journal of Hazardous Materials, Volume 154, Issues 1-3, 15 June 2008, Pages 105-111

Aerobic biodegradation of diesel fuel (DF)-contaminated wastewater is carried out in a three-phase fluidized bed reactor under unsteady and steady state conditions. The solid phase lava rock particles, which act as the support for the biomass, are fluidized by the upward flows of influent wastewater, and air. The results show that the reactor under unsteady state operation achieved 100% DF removal from synthetic wastewater loaded with 0.43–1.03 kg/m^3 day of DF. An average of over 97% of the influent chemical oxygen demand (COD) was also removed from the wastewater with COD concentrations in the range, 547–4025 mg/L. For influent COD concentrations up to 1345 mg/L, the removal is greater than 90%. Under steady state operation, the reactor was able to remove 100% of the DF, and an average of 96% of the COD from the wastewater. It had approximately 200 mg/L of DF, and 1237 mg/L of COD at a low hydraulic residence time of 4 h. In general, the results demonstrate that the reactor is very efficient, and requires short residence times to remove both DF and COD from heavily contaminated wastewater.

Keywords: Diesel fuel removal; Wastewater biodegradation; Aerobic fluidized bed reactor

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[c]Department of Chemical Engineering, Universiti Technologi PETRONAS, Malaysia). Degradation mechanism and kinetic model for photocatalytic oxidation of PVC–ZnO composite film in presence of a sensitizing dye and UV radiation. Journal of Hazardous Materials, Vol. 154(1-3) (2008): 230-236

White or plastic pollution has become a serious concern to the environmentalists for the last few years. Degradation of waste plastics in conventional incinerators leads to emission of carcinogenic dioxins to the atmosphere. In this work, an attempt has been made for the photocatalytic degradation of polyvinyl chloride (PVC) using ZnO as semi-conductor catalyst in the form of PVC–ZnO composite film. The surface morphology as well as the FTIR spectroscopy of the irradiated film has been critically examined. The degradation was measured by weight loss data and was found to follow a pseudo-first order rate equation. The various parameters studied were loading of the semi-conductor, intensity of UV radiation and presence of Eosin Y as a sensitizing dye. It was observed that dye-sensitization enhanced degradation of PVC to a large extent. A possible mechanism has been suggested and the corresponding rate equation has been modeled for the dye-sensitized rate of degradation. The model has been validated by the experimental data.

Keywords: PVC degradation; ZnO-photo-catalyst; Dye-sensitizer; UV radiation; Kinetic model

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Biodegradability of aqueous solutions of the herbicide alachlor and the fungicide pyrimethanil, partly treated by photo-Fenton, and the effect of photoreaction intermediates on growth and DOC removal kinetics of the bacteria *Pseudomonas putida* CECT 324 are demonstrated. Toxicity of 30–120 mg L^{-1} alachlor and pyrimethanil has been assayed in *P. putida*. The biodegradability of photocatalytic intermediates found at different photo-treatment times was evaluated for each pesticide. At a selected time during batch-mode phototreatment, larger-scale biodegradation kinetics were analysed in a 12 L bubble column bioreactor. Both alachlor and pyrimethanil are non-toxic for *P. putida* CECT 324 at the test concentrations, but they are not biodegradable. A ~100 min photo-Fenton pre-treatment was enough to enhance biodegradability, the biological oxidation response being dependent on the pesticide tested. The different alachlor and pyrimethanil respiration and carbon uptake rates in pre-treated solutions are related to change in the growth kinetics of *P. putida*. Reproducible results have shown that *P. putida* could be a suitable microorganism for determining photo-Fenton pre-treatment time.

Keywords: Alachlor; Pyrimethanil; Photo-Fenton; Biodegradability; *Pseudomonas putida*

Rentz J. A.[a], Alvarez P. J. J.[b] and J. L. Schnoor[a]. ([a]Civil and Environmental Engineering, University of Iowa, Iowa City, IA 52242, USA, [b]Civil and Environmental Engineering, Rice University, Houston, TX 77251, USA). Benzo[*a*]pyrene degradation by *Sphingomonas yanoikuyae* JAR02. Environmental Pollution, Vol. 151(3) (2008): 669-677.

Batch experiments were conducted to characterize the degradation of benzo[*a*]pyrene, a representative high molecular weight (HMW) polycyclic aromatic hydrocarbon (PAH), by *Sphingomonas yanoikuyae* JAR02. Concentrations up to the solubility limit (1.2 μg l^{-1}) of benzo[*a*]pyrene were completely removed from solution within 20 h when the bacterium was grown on salicylate. Additional experiments with [^{14}C]7-benzo[*a*]pyrene demonstrated 3.8% mineralization over 7 days when salicylate was present is solution, and one major radio-labeled metabolite was observed that accounted for ~10% of the initial radio-label. Further characterization of the radio-labeled metabolite using HPLC/MS and HPLC/MS/MS identified radio-labeled pyrene-8-hydroxy-7-carboxylic acid and unlabeled pyrene-7-hydroxy-8-carboxylic acid as novel ring-cleavage metabolites, and a benzo[*a*]pyrene degradation pathway was proposed. Results indicate that biostimulation of HMW PAH degradation by salicylate, a water-soluble, non-toxic substrate, has significant potential for in situ bioremediation.

Benzo[a]pyrene degradation and mineralization by Sphingomonas yanoikuyae JAR02 was stimulated with salicylate, and novel ring-cleavage metabolites were identified.

Keywords: Salicylate; Biostimulation; Biodegradation; Mineralization

Kim D.S. [1], Um H. J. [1], Lim E.S. [2], Min J. [2] and Kim Y.H. [1]. ([1] School of Life Science, Chungbuk National University, 12 Gaeshin-Dong, Heungduk-Gu, Cheongju, 361-763, South Korea, [2] Graduate School of Semiconductor and Chemical Engineering, Chonbuk National University, 664-14, 1-Ga, Duckjin-Dong, Duckjin-Gu, Jeonju, 561-156, South Korea, jihomin@chonbuk.ac.kr). **Degradation of diphenyl phthalate by *Sphingomonas chungbukensis.* Biotechnology Letters, Vol. 30 (1) (2008): 93 – 96.**

More than 80% of diphenyl phthalate (DPP) at 100 mg l^{-1} was degraded by *Sphingomonas chungbukensis* KCTC 2955 in a mineral salts medium at pH 7.0 and 30°C within 48 h. The maximum specific degradation rate was 5 mg DPP l^{-1} h^{-1}. It was rapidly converted to monophenyl phthalate and phthalic acid which were further degraded.

Keywords: Diphenyl phthalate - Microbial degradation - *Sphingomonas chungbukensis*

Thomas Nilsson and Charlotte Björdal. (Faculty of Forest Sciences, Swedish University of Agricultural Sciences, Uppsala, Sweden). **Culturing wood-degrading erosion bacteria. International Biodeterioration & Biodegradation, Vol. 61(1) (2008):3-10**

Wood-degrading erosion bacteria have been successfully cultured from archaeological wood and wood samples of foundation piles. Mixed cultures of bacteria with erosion bacteria present were obtained from a large number of wood samples. The liquid medium used and the conditions for culturing are described. Erosion bacterial activity occurred only in cultures where access to air was limited. Microscopy was used to confirm bacterial degradation of pine wood and kapok fibres.

Keywords: Archaeological wood; Culturing; Decay; Erosion bacteria; Foundation piles; Kapok fibres; Wood

Harbottle M. J. and Tabbaa A. A.. ([a]Department of Engineering, Cambridge University, Trumpington Street, Cambridge CB2 1PZ, UK). **Degradation of 2-chlorobenzoic acid in**

stabilised/solidified soil systems. International Biodeterioration & Biodegradation, Vol. 61 (2) (2008): 173-181

The possibility of facilitating organic contaminant biodegradation within eight different stabilised/solidified soil systems was investigated. Two soils, a silty sand and clayey silt contaminated with 2-chlorobenzoic acid, were mixed with two different grouts; Portland cement grout and a magnesium phosphate cement grout. The effect of a soil amendment (green waste compost) was examined. Biological activity was monitored using plate counts and dehydrogenase activity. After 106 days, contamination within the silty sand soil/Portland cement mix was reduced by approximately 60% on average, and by over 95% on average with compost addition. Cement grout addition gave substantial changes in the microbial communities present, with Portland cement leading to initial decreases in microbial numbers (by up to a factor of 10^4) but with a corresponding increase in dehydrogenase activity (by 250% with added compost). Subsequently, microbial numbers increased and the dehydrogenase activity reduced to negligible levels. Magnesium phosphate cement addition led to a decrease in the presence of bacteria and an increase in fungi, whilst with added compost high levels of dehydrogenase activity were maintained for 106 days. It is concluded that contaminant degradation can occur in stabilised/solidified soil systems, but the role of microbes in this removal is not certain.

Scientific relevance

This paper investigates the possibility of combining biodegradation of organic contaminants with in situ stabilisation/solidification techniques, providing both short-term and long-term contaminant control for contaminated land. The latter technique is in use around the world and is becoming more commonplace in the UK; however, there are concerns about its long-term performance in retaining contamination, which the proposed amendment seeks to address.

Keywords: Contaminated land; Stabilisation/solidification; Bioremediation; Sustainability

Mohanty G. and Mukherji S. (Centre for Environmental Science and Engineering (CESE), Indian Institute of Technology (IIT) Bombay, Powai, Mumbai 400076, India). Biodegradation rate of diesel range *n*-alkanes by bacterial cultures *Exiguobacterium aurantiacum* and *Burkholderia cepacia*. International Biodeterioration & Biodegradation, Vol. 61(3) (2008): 240-250

The biodegradation rate of hydrocarbons is an important consideration determining the time scale for bioremediation in oil-contaminated environments. Two naturally occurring bacterial cultures, *Exiguobacterium aurantiacum* and *Burkholderia cepacia*, were capable of utilizing diesel oil as the sole source of carbon and energy by induction of hydrophobic cell surfaces with water contact angle greater than 70°. The cultures demonstrated good degradation characteristics for diesel range *n*-alkanes (C9–C26) and were also capable of degrading pristane. A significant correlation was observed between maximum decay rate (MTR) of individual *n*-alkane peak area and initial abundance of *n*-alkanes in diesel (r^2=0.79 and 0.97 for *E. aurantiacum* and *B. cepacia*, respectively). Thus, MTR (day^{-1}) was essentially constant, in the range of 0.07–0.20, for *n*-alkanes with a wide range of carbon numbers from C12 to C26. Biodegradation altered the relative abundance of *n*-alkanes in diesel and resulted in a loss of symmetry in *n*-alkane distribution. C9, C17–C19, and C26 were completely degraded by both the cultures. In *B. cepacia*, the residual diesel was enriched in the higher carbon number *n*-alkanes C20–C25. The

MTR of *n*-C16 present as a component of diesel was comparable to that for *n*-C16 when present as sole substrate for *B. cepacia* but not for *E. aurantiacum*.

Scientific relevance

Two cultures *E. aurantiacum* and *B. cepacia* were capable of utilizing diesel oil as sole substrate and exhibited uniform decay rates for a wide range of *n*-alkanes from C12 to C26. In contrast, most researchers have reported decreasing degradation rate with increasing carbon number.

Keywords: Oil; NAPL; Biodegradation; Bacteria; Hydrophobicity

S. Ndlovu. (School of Chemical and Metallurgical Engineering, University of the Witwatersrand, Private Bag X3, Wits 2050, Johannesburg, South Africa). Biohydrometallurgy for sustainable development in the African minerals industry. Hydrometallurgy, Vol. 91(1-4)(2008):20-27

Biohydrometallurgy is no longer a promising technology but is now an established economical alternative for treating specific mineral ores. It occupies an increasingly important place among the available mining technologies. A significant number of the current large-scale bioprocessing operations are located in developing countries. The popularity of this technology in most developing countries is largely due to low capital cost requirements and its simplicity in operation. The African continent, with South Africa in particular, pioneered and currently houses institutes that count among the top researchers in further development of the biohydrometallurgical technology. However, despite its abundant mineral reserves and deposits, Africa is still much behind in the commercialization process. This paper looks at possible reasons behind the lag in adoption of this technology in the African continent. It further considers the influencing factors for the adoption and effective application of biohydrometallurgy for the sustainable development of the African minerals industry.

Keywords: Sustainability; African minerals industry; Biohydrometallurgy

Biosensor

Sangchul Rho[a], Deokjin Jahng[a], Jae Hoon Lim[b], Jinsub Choi[b], Jeong Ho Chang[b], Sang Cheon Lee[b] and Kyung Ja Kim[b]. ([a]Department of Environmental Engineering and Biotechnology, Myongji University, Yongin, Gyunggi-do 449-728, South Korea, [b]Nanomaterials Application Division, Korea Institute of Ceramic Engineering and Technology (KICET), Seoul 153-801, South Korea). Electrochemical DNA biosensors based on thin gold films sputtered on capacitive nanoporous niobium oxide. Biosensors and Bioelectronics, Vol. 23(6) (2008): 852-856

Electrochemical DNA biosensors based on a thin gold film sputtered on anodic porous niobium oxide ($Au@Nb_2O_5$) are studied in detail here. We found that the novel DNA biosensor based on $Au@Nb_2O_5$ is superior to those based on the bulk gold electrode or niobium oxide electrode. For example, the novel method does not require any time-consuming cleaning step in order to obtain reproducible results. The adhesion of gold films on the substrate is very stable during electrochemical biosensing, when the thin gold films are deposited on anodically prepared

nanoporous niobium oxide. In particular, the novel biosensor shows enhanced biosensing performance with a 2.4 times higher resolution and a three times higher sensitivity. The signal enhancement is in part attributed to capacitive interface between gold films and nanoporous niobium oxide, where charges are accumulated during the anodic and cathodic scanning, and is in part ascribed to the structural stability of DNA immobilized at the sputtered gold films. The method allows for the detection of single-base mismatch DNA as well as for the discrimination of mismatch positions.

Keywords: Anodization; Niobium oxide; Porous oxide; Electrochemical biosensor; Capacitance

Yongjin Zou[a, b], Cuili Xiang[a, b], Li-Xian Sun[a] and Fen Xu[a]. ([a]Dalian Institute of Chemical Physics, Chinese Academy of Sciences, Dalian 116023, China, [b]Graduate School of the Chinese Academy of Sciences, Beijing 100049, China). **Glucose biosensor based on electrodeposition of platinum nanoparticles onto carbon nanotubes and immobilizing enzyme with chitosan-SiO_2 sol–gel. Biosensors and Bioelectronics, Vol. 23(7) (2008): 1010-1016**

A novel amperometric biosensor, based on electrodeposition of platinum nanoparticles onto multi-walled carbon nanotube (MWNTs) and immobilizing enzyme with chitosan-SiO_2 sol–gel, is presented in this article. MWNTs were cast on the glass carbon (GC) substrate directly. An extra Nafion coating was used to eliminate common interferents such as acetaminophen and ascorbic acids. The morphologies and electrochemical performance of the modified electrodes have been investigated by scanning electron microscopy (SEM) and amperometric methods, respectively. The synergistic action of Pt and MWNTs and the biocompatibility of chitosan-SiO_2 sol–gel made the biosensor have excellent electrocatalytic activity and high stability. The resulting biosensor exhibits good response performance to glucose with a wide linear range from 1 μM to 23 mM and a low detection limit 1 μM. The biosensor also shows a short response time (within 5 s), and a high sensitivity (58.9 $\mu Am\ M^{-1}\ cm^{-2}$). In addition, effects of pH value, applied potential, rotating rate, electrode construction and electroactive interferents on the amperometric response of the sensor were investigated and discussed in detail.

Keywords: Pt nanoparticles; Chitosan-SiO_2 sol–gel; Glucose biosensor; Multi-walled carbon nanotubes

E. Mazzotta[a], R.A. Picca[a], C. Malitesta[a], S.A. Piletsky[b] and E.V. Piletska[b]. ([a]Laboratorio di Chimica Analitica, Dipartimento di Scienza dei Materiali, Università del Salento, Via Arnesano, 73100 Lecce, Italy, [b]Cranfield Health, Cranfield University, Silsoe, Bedfordshire, MK45 4DT, UK). **Development of a sensor prepared by entrapment of MIP particles in electrosynthesised polymer films for electrochemical detection of ephedrine ☆ Biosensors and Bioelectronics, Vol. 23(7) (2008): 1152-1156**

A voltammetric sensor for (−)-ephedrine has been prepared by a novel approach based on immobilisation of an imprinted polymer for ephedrine (MIPE) in an electrosynthesised polypyrrole (PPY) film. Composite films were grown potentiostatically at 1.0 V vs. Pt (QRE) on a glassy carbon electrode using an unconventional “upside-down” (UD) geometry for the three-electrode cell. As a consequence, a high MIP loading was obtained, as revealed by SEM. The sensor response was evaluated, after overoxidation of PPY matrix, by cyclic voltammetry after pre-concentration in a buffered solution of analyte in 0.5–3 mM concentration range. An ephedrine peak at ≈0.9 V increasing with concentration and saturating at high concentrations was

evident. PPY-modified electrode showed a response, which was distinctly lower than the MIP response for the same concentration of the template. The effect of potential interferences including compounds usually found in human fluids (ascorbic acid, uric acid, urea, glucose, sorbitol, glycine, dopamine) was examined.

Keywords: Molecular imprinting; Electrochemical sensor; Polypyrrole; Ephedrine

Alisa Rudnitskaya[1] and Andrey Legin[1]. ([1]Chemistry Department, St *Petersburg State University, Universitetskaya nab. 7/9, 199034 St Petersburg, Russia)*. **Sensor systems, electronic tongues and electronic noses, for the monitoring of biotechnological processes. Journal of Industrial Microbiology and Biotechnology, Vol. 35(5) (2008): 443-451**

Production of biofuel is based on the conversion by microorganisms of complex organic substrates into the methane or ethanol, which are consequently used as energy sources. Real time monitoring of the fermented media composition is of paramount for the effectiveness of the whole process. However, despite the fact that products worth billions of dollars are produced through fermentation processes annually, analytical instruments used for these processes' monitoring remain relatively primitive. Established laboratory techniques produce exhaustive information about media composition but analysis is often quite time-consuming, expensive, requires skilled personnel and hardly can be automated. Lack of on-line sensors for the fermentation monitoring is commonly stressed in the literature. One of the techniques particularly suitable for this purpose is chemical sensors. Such features as low prices, relatively simple instrumentation, minimal sample preparation and easy automation of measurements make chemical sensors an attractive tool for industrial process control. However, practical use of chemical sensors in complex media is often hindered by their insufficient selectivity. For example, only pH and oxygen probes are routinely used in bio-reactors. One of the emerging approaches permitting to overcome the selectivity problems is the use of systems instead of discrete sensors. Such systems for liquid and gas analysis were named electronic tongues and electronic noses correspondingly. They are capable to perform both quantitative analysis (components' concentrations) and classification or recognition of multicomponent media. This review presents recent achievements in the R&D and applications of electronic tongues and noses to the monitoring of biotechnological processes.

Keywords: Multisensor systems - Biofuel production - Biomimetic sensors - Electronic tongue - Electronic nose - Fermentation monitoring

Sabato D'Auria[*] and Joseph R Lakowicz[†]. ([*] Institute of Protein, Biochemistry and Enzymology, CNR, Via Marconi 10, 80125 Naples, Italy, [†] Center for Fluorescence Spectroscopy, University of Maryland, School of Medicine, 725 West Lombard Street, Baltimore, MD 21201, USA). **Enzyme fluorescence as a sensing tool: new perspectives in biotechnology. Current Opinion in Biotechnology, Vol. 12(1) (2008): 99-104**

The technology for fluorescence protein-sensing is advancing rapidly owing to the continued introduction of new concepts, new fluorophores, and proteins engineered for sensing-specific analytes. Concerns about the reversibility and selectivity of engineered proteins are being addressed by developing biosensors that are based on the utilisation of coenzyme-depleted enzymes. Such biomolecules do not consume the substrate and can exhibit conformational changes upon the binding of the analyte, which can be easily detected as fluorescence change. In addition, concerns about the stability of biosensors can be overcome by using thermostable

enzymes isolated from thermophilic microorganisms. Finally, the development of new techniques such as polarization-based sensing, anisotropy-based sensing and lifetime-based sensing, all of which can be accomplished with light-emitting diodes as the light source, is prompting the design of a new class of specific and stable biosensors, as has occurred with blood glucose measurement. These biosensors represent a valid alternative to the conventional clinical chemistry diagnostics.

Keywords: blood glucose measurement; non-consuming; fluorophores; apo-enzymes; coenzyme-depleted enzymes; biosensors

Maria del Busto-Ramos[1], Michael Budzik[1], Carlos Corvalan[1], Mark Morgan[1], Ronald Turco[2], David Nivens[1] and Bruce Applegate[1]. ([1]*Department of Food Science, Purdue University, 745 Agriculture Mall Dr., West Lafayette, IN 47907–2009, USA.* [2]*Department of Agronomy, Purdue University, West Lafayette, IN 47907–2009, USA*).
Development of an online biosensor for in situ monitoring of chlorine dioxide gas disinfection efficacy. Applied Microbiology and Biotechnology, Vol. 78(4) (2008): 573-580

A prototype bioluminescence-based biosensor was designed and constructed to evaluate the antimicrobial efficacy of chlorine dioxide (ClO_2) gas under various treatment conditions. The biosensor consisted of a bioluminescent bioreporter (*Pseudomonas fluorescens* 5RL), an optical transducer (photomultiplier tube), and a light-tight chamber housing, the bioreporter and the transducer. The bioluminescent recombinant *P. fluorescens* 5RL in the biosensor allowed for online monitoring of bioluminescence during ClO_2 gas disinfection. Experiments were performed to evaluate the effects of the two key physical parameters associated with ClO_2 disinfection: relative humidity (40, 60, 80%) and ClO_2 gas concentration (0.5, 1.0, 1.6, 2.1 mg/l) on the bioreporter. Results showed that increasing concentrations of ClO_2 gas corresponded to a faster decrease in luminescence. The rates of luminescence decrease from *P. fluorescens* 5RL, and the log reduction time (LRT, time required to obtain 1-log reduction in luminescence) were calculated for each treatment tested. The LRT values of luminescence were 103, 78, 53, and 35 s for 0.5, 1.0, 1.6, and 2.1 mg/l of ClO_2 gas treatment, respectively, at 78% relative humidity. The gas concentration which caused a tenfold change in LRT (*z* value) for luminescence of *P. fluorescen*s 5RL was 3.4 mg/l of ClO_2. The prototype biosensor showed potential for many applications, such as monitoring real-time microbial inactivation and understanding parameters that influence the efficacy of gaseous decontamination procedures.

Keywords: Chlorine dioxide gas - Disinfection efficacy - Online sensor

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Earthworms as bioindicator of metals (Zn, Fe, Mn, Cu, Pb and Cd) in soils: Is metal bioaccumulation affected by their ecological category? Ecological Engineering, Vol. 32(2) (2008): 99-107

The importance of earthworms in metal pollution monitoring is widely recognized in terrestrial ecosystems. Metal bioaccumulation by soil-dwelling earthworms can be used as an ecological indicator of metal availability in soils. In this study, we quantify the level of DTPA extractable metals in casts and tissues of earthworms (endogeic: *Metaphire posthuma* (Vaillant) and anecic: *Lampito mauritii* Kinberg) and ingesting soils, collected form cultivated land, urban garden and sewage soils. Soil and worm casts collected from sewage and cultivated land showed the greater

metal concentrations. The concentration of Zn, Fe, Pb and Mn in earthworm casts was in the order: sewage soil > cultivated land > urban garden, while for Cu and Cd the order was cultivated land > sewage soil > urban garden. Data suggested that the level of DTPA extractable metals was higher than that of surrounding soils. We got close relationships between metal concentration in worm tissues and surrounding soils: Zn (r^2 = 0.94 and 0.89, $P < 0.01$ for both), Fe (r^2 = 0.95 and 0.97, $P < 0.01$ for both), Cu (r^2 = 0.93 and 0.96, $P < 0.01$), Pb (0.63, $P < 0.01$ and 0.57, $P > 0.05$), and Cd (r^2 = 0.15, $P > 0.01$ and 0.75, $P < 0.01$), respectively, for *M. posthuma* and *L. mauritii.* The study clearly indicates that earthworms have efficient potentials for bioaccumulation of metals in their tissues which can be used as an ecological indicator of soil contaminations. A species-specific metal accumulation pattern was observed in studied earthworms. Comparatively, endogeic showed the higher metal contents in their tissues than anecic (*t*-test: $P < 0.05$); collected form different habitats studied. Data suggested that species-specific feeding behaviour, earthworm niche structure, ecological category of inhabiting earthworm and even horizontal distribution of contaminants in soil layers are some major determinant for metal accumulation patterns in soil dwelling earthworms. The difference in burrowing patterns can influence the patterns of metal bioaccumulations between endogeic and anecic, although other factors are also contributory. Further more detailed study is still required to elaborate the proposed hypothesis.

Keywords: Agro-ecosystem; Anecic; Earthworm; Epigeic; *Lampito mauritii*; *Metaphire posthuma*; Metal-bioavailability; Soil pollution; Worm casts

Bioengineering

S.M. Mousavi[a, b], S. Yaghmaei[a], M. Vossoughi[a], R. Roostaazad[a], A. Jafari[c], M. Ebrahimi[d], O. Habibollahnia Chabok[d] and I. Turunen[b]. ([a]Department of Chemical and Petroleum Engineering, Sharif University of Technology, Tehran, Iran, [b]Department of Chemical Engineering, Lappeenranta University of Technology, Lappeenranta, Finland, [c]Department of Energy and Environmental Engineering, Lappeenranta University of Technology, Lappeenranta, Finland, [d]Faculty of Engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran). **The effects of Fe(II) and Fe(III) concentration and initial pH on microbial leaching of low-grade sphalerite ore in a column reactor. Bioresource Technology, Vol. 99(8) (2008): 2840-2845**

In this study the effects of initial concentration of Fe(II) and Fe(III) ions as well as initial pH on the bioleaching of a low-grade sphalerite ore in a leaching column over a period of 120 days with and without bacteria were investigated. Four different modifications of medium were used as column feed solutions to investigate the effects of initial concentration of Fe(II) and Fe(III) ions on zinc extraction. The experiments were carried out using a bench-scale, column leaching reactor, which was inoculated with mesophilic iron oxidizing bacteria, *Acidithiobacillus ferrooxidans*, initially isolated from the Sarcheshmeh chalcopyrite concentrate (Kerman, Iran). The effluent solutions were periodically analyzed for Zn, total Fe, Fe(II) and Fe(III) concentrations as well as pH values. Bacterial population was measured in the solution (free cells). Maximum zinc recovery in the column was achieved about 76% using medium free of initial ferrous ion and 11.4 g/L of ferric ion (medium 2) at pH 1.5. The extent of leaching of sphalerite ore with bacteria was significantly higher than that without bacteria (control) in the

presence of ferrous ions. Fe(III) had a strong influence in zinc extraction, and did not adversely affect the growth of the bacteria population.

Keywords: Bioleaching; Low-grade sphalerite; Ferrous and ferric ions; Zinc extraction; Column reactor

K. Vijayaraghavan[a], Juan Mao[a] and Yeoung-Sang Yun[a]. ([a]Division of Environmental and Chemical Engineering, Research Institute of Industrial Technology, Chonbuk National University, Chonbuk 561-756, South Korea). **Biosorption of methylene blue from aqueous solution using free and polysulfone-immobilized *Corynebacterium glutamicum*: Batch and column studies. Bioresource Technology, Vol. 99(8) (2008): 2864-2871**

The amino acid fermentation industry waste, *Corynebacterium glutamicum*, has been found to possess excellent biosorption capacity towards methylene blue (MB). Due to practical difficulties in solid–liquid separation and biomass regeneration, *C. glutamicum* was immobilized in a polysulfone matrix. The pH edge experiments revealed that neutral or alkaline pH values favored MB biosorption. Isotherm experiments indicated that *C. glutamicum*, when in immobilized state, exhibited slightly inferior dye uptake compared to free biomass. Also considering the two forms, immobilized biomass took a long time to attain equilibrium. An attempt to identify the diffusion limitations in immobilized beads was successful, with the Weber–Morris model clearly indicating intraparticle as the rate controlling step. Regeneration of the free biomass was not possible as it tended to become damaged under strong acidic conditions. On the other hand, immobilized biomass performed well with 99% desorption of MB from the biosorbent with the aid of 0.1 mol/l HCl. The immobilized biomass was also successfully regenerated and reused for three cycles without significant loss in sorption capacity. An up-flow packed column loaded with immobilized biomass was employed for the removal of MB. The column performed well in the biosorption of MB, exhibiting a delayed and favorable breakthrough curve with MB uptake and % removal of 124 mg/g biomass and 70.1%, respectively.

Keywords: Wastewater treatment; Immobilization; Polysulfone; Packed column; Modeling

Wu-Chung Chan[a], and Kang-Hong Peng[a]. ([a]Civil Engineering Department, Chung-Hua University, Hsinchu 30067, Taiwan, ROC). **Biofiltration of ketone compounds by a composite bead biofilter. Bioresource Technology, Vol. 99(8) (2008): 3029-3035**

In this study, the biochemical kinetic behaviors of ketone compounds in a composite bead biofilter were investigated. Both microbial growth rate k_g and biochemical reaction rate k_d would be inhibited at higher average inlet concentration. For the microbial growth process, the inhibitive effect was the least pronounced for acetone and the order of k_g value was MEK > MIPK > acetone in the average inlet concentration range of 100–150 ppm. The degree of inhibitive effect was almost the same for three ketone compounds and the order of k_g value was acetone > MEK > MIPK in the average inlet concentration range of 200–300 ppm. The values of half-saturation constant K_s for acetone, MEK and MIPK were 26.80, 21.56 and 22.96 ppm, respectively. The values of maximum reaction rate V_m for acetone, MEK and MIPK were 8.55, 9.06 and 7.55 g-C/h-kg packed material, respectively. The zero-order kinetic with the diffusion rate limitation could be regarded as the most adequate biochemical reaction model. For the biochemical reaction process, the inhibitive effect was the most pronounced for MEK and the order of k_d value was MEK > acetone > MIPK in the average inlet concentration range of 100–

150 ppm. The degree of inhibitive effect was MIPK > MEK > acetone and the order of k_d value was acetone > MEK > MIPK in the average inlet concentration range of 200–300 ppm. The maximum elimination capacity of acetone, MEK and MIPK were 0.157, 0.127 and 0.101 g-C/h-kg packed material.

Keywords: Ketone compound; Microbial growth process; Biofilter; Biochemical reaction process; Composite bead

Lavanya Meesala [1], Chandrajeet Balomajumder [1 *], Shamba Chatterjee [2], Partha Roy [2]. ([1]Department of Chemical Engineering, Indian Institute of Technology, Roorkee 247667, Uttarakhand, India, [2]Department of Biotechnology, Indian Institute of Technology, Roorkee 247667, Uttarakhand, India. email: Chandrajeet Balomajumder (cbmajumder@yahoo.com. [*]Correspondence to Chandrajeet Balomajumder, Department of Chemical Engineering, Indian Institute of Technology, Roorkee 247667, Uttarakhand, India). **Biodesulfurization of dibenzothiophene using recombinant *Pseudomonas* strain.** **Journal of Chemical Technology & Biotechnology, Vol. 83(3) (2008): 294 – 298**

BACKGROUND: The sulfur content in crude oil available from various sources ranges from 0.03 to values as high as 8.0 wt%. These high quantities of sulfur must be removed before the crude oil is processed because combustion of this oil would result in severe environmental pollution, such as acid rain. Due to high utility and operating costs, the conventional hydrodesulfurization process (HDS) is considered to be uneconomic. The biotechnological option, biodesulfurization (BDS) seems an attractive low cost, environmentally benign technology.

RESULTS: This paper reports the development of a recombinant strain of bacteria designed by introducing desulfurizing, *dsz* genes containing plasmid pSAD 225-32, which was isolated from *Rhodococcus erythropolis* IGTS8 into a gram negative solvent-tolerant bacterium, *Pseudomonas putida* (MTCC 1194). This recombinant bacterium can desulfurize the dibenzothiophene (DBT) in the sulfur selective 4S-pathway. It has been observed that for the same concentration of DBT, the recombinant strain's growth rate is greater than that of the parent strain. Increasing the concentration of DBT resulted in an increase of lag phase as well as decreased growth rate, which shows that the bacteria is following substrate inhibition type kinetics. This genetically modified bacterium can desulfurize 73.1% of 1.2 mmol L^{-1} DBT (dissolved in ethanol) in 67 h of cultivation time using growing cells.

CONCLUSIONS: It is concluded that further research in this area of biodesulfurization using genetically modified organisms may remove the bottlenecks presently in the way of commercialization of the BDS process.

Keywords: biodesulfurization • dibenzothiophene • gram-negative bacteria • recombinant bacteria

F Javier Álvarez-Hornos, Carmen Gabaldón [*], Vicente Martínez-Soria, Paula Marzal, Josep-Manuel Penya-roja. (Department of Chemical Engineering, University of Valencia. Dr. Moliner, 50, 46100 Burjassot, Spain, email: Carmen Gabaldón (carmen.gabaldon@uv.es). [*]Correspondence to Carmen Gabaldón, Department of Chemical Engineering, University of Valencia. Dr. Moliner, 50, 46100 Burjassot, Spain). **Biofiltration of toluene in the absence and the presence of ethyl acetate under continuous**

and intermittent loading. Journal of Chemical Technology & Biotechnology, Vol. 83(5) (2008): 643 – 653

BACKGROUND: Two peat biofilters were used for the removal of toluene from air for one year. One biofilter was fed with pure toluene and the other received 1:1 (by weight) ethyl acetate:toluene mixture.

RESULTS: The biofilters were operated under continuous loading: the toluene inlet load (IL) at which 80% removal occurred was 116 g m^{-3} h^{-1} at 57 s gas residence time. Maximum elimination capacity of 360 g m^{-3} h^{-1} was obtained at an IL of 745 g m^{-3} h^{-1}. The elimination of toluene was inhibited by the presence of ethyl acetate. Intermittent loading, with pollutants supplied for 16 h/day, 5 days/week, did not significantly affect the removal efficiency (RE). Biomass was fully activated in 2 h after night closures, but 6 h were required to recover RE after weekend closures. Live cell density remained relatively constant over the operational period, while the dead cell fraction increased. Finally, a 15 day starvation period was applied and operation then re-started. Performance was restored with similar re-acclimatization period to that after weekend closures, and a reduction in dead cell fraction was observed.

CONCLUSION: This study demonstrates the capacity of the system to handle intermittent loading conditions that are common in industrial practices, including long-term starvation

Keywords: biofiltration • toluene • carbon dioxide production • living and dead cells • transient loads • starvation

Pollen Biotechnology

Jean-Pierre Y. Scheerlinck[a], Kenneth J. Snibson[a], Vernon M. Bowles[a] and Philip Sutton[a]. ([a]Centre for Animal Biotechnology, School of Veterinary Science, University of Melbourne, Victoria 3010, Australia). **Biomedical applications of sheep models: from asthma to vaccines. Trends in Biotechnology, Vol. 26(5) (2008): 259-266**

Although rodent models are very popular for scientific studies, it is becoming more evident that large animal models can provide unique opportunities for biomedical research. Sheep are docile in nature and large in size, which facilitates surgical manipulation, and their physiology is similar to humans. As a result, for decades they have been chosen for several models and continue to be used to study an ever-increasing array of applications. Despite this, their full potential has not been exploited. Here, we review the use of sheep as an animal model for human vaccine development, asthma pathogenesis and treatment, the study of neonatal development, and the optimization of drug delivery and surgical techniques.

Prem L. Bhalla[a,] and Mohan B. Singh[a]. ([a]Plant Molecular Biology and Biotechnology Laboratory, Australian Research Council Centre of Excellence for Integrative Legume Research, Faculty of Land and Food Resources, The University of Melbourne, Parkville, Victoria 3010, Australia). **Biotechnology-based allergy diagnosis and vaccination. Trends in Biotechnology, Vol. 26(3) (2008): 153-161**

The diagnosis and immunotherapy currently applied to allergic diseases involve the use of crude extracts of the allergen source without defining the allergy-eliciting molecule(s). Advances in

recombinant DNA technology have made identification, cloning, expression and epitope mapping of clinically significant allergens possible. Recombinant allergens that retain the immunological features of natural allergens form the basis of accurate protein-chip-based methods for diagnosing allergic conditions. The ability to produce rationally designed hypoallergenic forms of allergens is leading to the development of novel and safe forms of allergy vaccines with improved efficacy. The initial clinical tests on recombinant-allergen-based vaccine preparations have provided positive results, and ongoing developments in areas such as alternative routes of vaccine delivery will enhance patient compliance.

Biotechnology Policy Issue

Thompson PB, Hannah W. (Department of Philosophy, Michigan State University, 48824-1320, East Lansing, MI, USA, thomp649@msu.edu.). Food and Agricultural Biotechnology: A Summary and Analysis of Ethical Concerns. Adv Biochem Eng Biotechnol., Vol 4 (1), (2008): 245-251

The range of social and ethical concerns that have been raised in connection with food and agricultural biotechnology is exceedingly broad. Many of these deal with risks and possible outcomes that are not unique to crops or animals developed using recombinant DNA. Food safety, animal welfare, socio-economic and environmental impacts, as well as shifts in power relations or access to technology raise concerns that might be generalized to many technologies. These aspects of the controversy over biotechnology are analyzed below as elements of general technological ethics, and key norms or values pertinent to each of these categories are specified in some detail. However, a number of special concerns unique to the use of rDNA in manipulating plant and animal genomes have been raised, and these are reviewed as well. The chapter concludes by reviewing two broad policy strategies for responding to the issues, one involving labels and consumer consent, the other applying the precautionary principle.

Carlson R.J. (University of Washington, Seattle, WA, USA). Preemptive public policy for genomics. J Health Polit Policy Law, Vol 33(1) (2008) :39-51

To many, genomics is merely exploitable technology for the leviathan of biotechnology. This is both shallow and short sighted. Genomics is applied knowledge based on profound and evolving science about how living things develop, how healthy or sick we are, and what our future will be like. In health care, genomics technologies are disruptive yet potentially cost-effective because they enable primary prevention, the antidote to runaway costs and declining productivity. The challenges to integration are great, however, and many bioethical and social-policy implications are alarming. Because it is poorly understood today, we must debate genomics vigorously if we are to act wisely. Public policy must lead.

Johnston M, Holloway T. (Center for Sustainability and the Global Environment, University of Wisconsin, Madison 53726, USA. mjohnston@wisc.edu). A global comparison of national biodiesel production potentials. Environ Sci Technol.Vol 41(23), (2007):7967-73.

This study presents a consistent, national-level evaluation of potential biodiesel volumes and prices, replicated across 226 countries, territories, and protectorates. Utilizing all commercially

exported lipid feedstocks from existing agricultural lands, we compare the upper-limit potential for expanded biodiesel production in terms of absolute biodiesel volumes, profitable potential from biodiesel exports, and potential from expanded vegetable oil production through agricultural yield increases. Country findings are compared across a variety of economic, energy, and environmental metrics. Our results show an upper-limit worldwide volume potential of 51 billion liters from 119 countries; 47 billion of which could be produced profitably at today's import prices. Also significant production gains are possible through increasing agricultural yields: a 12-fold increase over existing potential, primarily hinging on better management of tropical oilseed varietals.

Agricultural Biotechnology

Macek T, Kotrba P, Svatos A, Novakova M, Demnerova K, Mackova M. (Institute of Organic Chemistry and Biochemistry, Academy of Sciences of the Czech Republic, Flemingovo n. 2, 166 10 Prague, Czech Republic. tom.macek@uochb.cas.cz). Novel roles for genetically modified plants in environmental protection. Trends Biotechnol., Vol. 26(3) (2008):146-52

Transgenic plants of environmental benefit typically consist of plants that either reduce the input of agrochemicals into the environment or make the biological remediation of contaminated areas more efficient. Examples include the construction of species that result in reduced pesticide use and of species that contain genes for either the degradation of organics or the increased accumulation of inorganics. Cutting-edge approaches, illustrated by our own work, focus on the applicability of genetically modified (GM) plants that produce insect pheromones or that are specifically tailored to the phytoremediation of cadmium or PCBs. This paper discusses the role that the next generation of GM plants might play in preventing and reducing chemical contamination and in converting contaminated sites into safe agricultural or recreational land.

Romeis J, Bartsch D, Bigler F, Candolfi MP, Gielkens MM, Hartley SE, Hellmich RL, Huesing JE, Jepson PC, Layton R, Quemada H, Raybould A, Rose RI, Schiemann J, Sears MK, Shelton AM, Sweet J, Vaituzis Z, Wolt JD. (Agroscope Reckenholz-Tänikon Research Station ART, Reckenholzstr. 191, 8046 Zurich, Switzerland. joerg.romeis@art.admin.ch). Assessment of risk of insect-resistant transgenic crops to nontarget arthropods. Nat Biotechnol., Vol. 26(2) (2008):203-8.

An international initiative is developing a scientifically rigorous approach to evaluate the potential risks to nontarget arthropods (NTAs) posed by insect-resistant, genetically modified (IRGM) crops. It adapts the tiered approach to risk assessment that is used internationally within regulatory toxicology and environmental sciences. The approach focuses on the formulation and testing of clearly stated risk hypotheses, making maximum use of available data and using formal decision guidelines to progress between testing stages (or tiers). It is intended to provide guidance to regulatory agencies that are currently developing their own NTA risk assessment guidelines for IRGM crops and to help harmonize regulatory requirements between different countries and different regions of the world.

Chen, Hao; Zhang, Guoan; Zhang, Qifa; Lin, Yongjun. Effect of Transgenic *Bacillus thuringiensis* Rice Lines on Mortality and Feeding Behavior of Rice Stem Borers (Lepidoptera: Crambidae) J Econ Entomol.,Vol. 101(1) (2008):182-9.

Ten transgenic *Bacillus thuringiensis* Bt rice, *Oryza sativa* L., lines with different *Bt* genes (two Cry1Ac lines, three Cry2A lines, and five Cry9C lines) derived from the same variety Minghui 63 were evaluated in both the laboratory and the field. Bioassays were conducted by using the first instars of two main rice lepidopteran insect species: yellow stem borer, *Scirpophaga incertula*s (Walker) and Asiatic rice borer, *Chilo suppressalis* (Walker). All transgenic lines exhibited high toxicity to these two rice borers. Field evaluation results also showed that all transgenic lines were highly insect resistant with both natural infestation and manual infestation of the neonate larvae of *S. incertula*s compared with the nontransformed Minghui63. Bt protein concentrations in leaves of 10 transgenic rice lines were estimated by the sandwich enzyme-linked immunosorbent assay. The *cry9C* gene had the highest expression level, next was *cry2A* gene, and the *cry1Ac* gene expressed at the lowest level. The feeding behavior of 7-d-old Asiatic rice borer to three classes of Bt transgenic rice lines also was detected by using rice culm cuttings. The results showed that 7-d-old larvae of Asiatic rice borer have the capacity to distinguish Bt and non-Bt culm cuttings and preferentially fed on non-Bt cuttings. When only Bt culm cuttings with three classes of different Bt proteins (Cry1Ac, Cry2A, and Cry9C) were fed, significant distribution difference of 7-d-old Asiatic rice borer in culm cuttings of different Bt proteins also was found. In the current study, we evaluate different *Bt* genes in the same rice variety in both the laboratory and the field, and also tested feeding behavior of rice insect to these Bt rice. These data are valuable for the further development of two-toxin Bt rice and establishment of appropriate insect resistance management in the future.

Keywords: Bacillus thuringiensis; cry1Ac; cry2A; cry9C; feeding behavior

Guo JY, **Wan FH**, **Dong L**, **Lövei GL**, **Han ZJ**. **(State Key Laboratory for Biology of Plant Diseases and Insect Pests, Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China. guojy@cjac.org.cn).** **Tri-trophic interactions between Bt cotton, the herbivore Aphis gossypii Glover (Homoptera: Aphididae), and the predator Chrysopa pallens (Rambur) (Neuroptera: Chrysopidae). Environ Entomol., Vol. 37(1)(2008):263-70.**

Tri-trophic impacts of transgenic Bacillus thuringiensis (Bt) cotton GK12 and NuCOTN 99B were studied using a predator, the great lacewing Chrysopa pallens (Rambur), and its prey, the cotton aphid Aphis gossypii Glover, in laboratory feeding experiments. The parental nontransgenic cotton cultivar of GK12 was used as control. The predator was fed with uniform (aphids from a single cultivar) or mixed prey (aphids from the three cotton cultivars provided on alternate days). Mortality and development of the immature stages, pupal body mass, adult sex ratio, fecundity, and egg viability of C. pallens were measured. When fed GK12-originated aphid prey, pupal body mass of C. pallens was significantly higher than that of the control, more females emerged, and these females laid significantly more eggs. Other parameters were not impacted. Females emerging from larvae maintained on NuCOTN 99B-originated prey laid fewer eggs than those maintained on GK12. Other measurements did not differ significantly between the two Bt cotton cultivars. Compared with the control, mixed feeding significantly prolonged pupal development time and increased pupal body mass and percentage of females but did not affect other parameters. These results indicate that C. pallens is sensitive to aphid prey from different cotton cultivars. Transgenic Bt cotton GK12-originated aphid prey has no adverse impact on survival, development, and fecundity of C. pallens. Between the two Bt cotton cultivars, NuCOTN 99B-originated aphid prey provided to C. pallens in the larval stage may

lower female fecundity. Mixed feeding of C. pallens with the two Bt cotton-originated prey and non-Bt prey may have some adverse impacts on pupal development.

F.X. Naramabuye[a], R.J. Haynes[c,] and A.T. Modi[b]. ([a]School of Environmental Sciences, University of KwaZulu-Natal, Pietermaritzburg, Private Bag X01, Scottsville 3209, South Africa, [b]School of Agricultural Sciences and Agribusiness, University of KwaZulu-Natal, Pietermaritzburg, Private Bag X01, Scottsville 3209, South Africa, [c]Faculty of Natural Resources, Agriculture and Veterinary Science/CRC CARE, The University of Queensland, Gatton Campus, Gatton, Qld 4343, Australia). **Cattle manure and grass residues as liming materials in a semi-subsistence farming system. Agriculture, Ecosystems & Environment, Vol.124(1-2) (2008): 136-141**

A field experiment was conducted on an acid soil in a semi-subsistence farming area of KwaZulu-Natal, South Africa to investigate the possibility of using organic amendments as liming materials within a minimum tillage (strip cultivation) system to produce maize. Amendments (cattle manure, grass residues and dolomitic lime) were incorporated to a depth of 20 cm in bands 15 cm wide down plant rows at rates of 10 and 20 t ha^{-1} (in the amended area) for organic materials and 2.5 and 5.0 t ha^{-1} for lime. The remainder of the field remained untilled. Additions of cattle manure rapidly increased soil pH, and concentrations of exchangeable K, Ca and Mg and extractable P were also greatly elevated. Grass residue additions increased pH progressively and increased exchangeable K and Mg and those of dolomitic lime increased pH, exchangeable Ca and Mg. Addition of each of the amendments decreased concentrations of exchangeable Al; the effect was greatest for animal manure after 6 weeks and for lime and grass residues at harvest. At harvest, addition of all three amendments had significantly reduced concentrations of both phytotoxic monomeric and total Al in soil solution. The system not only resulted in an increase in pH and extractable nutrients in row soil compared to that in the inter-row but also an increase in the size and activity of the soil microbial community. Maize yields were increased by additions of amendments under both unfertilised and fertilised conditions and yields were generally greatest at the higher rate of addition. Under unfertilised conditions, cattle manure treatments gave the greatest yields. Fertiliser additions increased yields greatly particularly in the control, grass residue and lime treatments. It was concluded that the strip tillage system used is a practicable way of applying high rates of organic materials to soils, that cattle manure has a rapid liming effect as well as being a nutrient source and that grass residues from rangeland decompose slowly and, therefore, have a slow liming effect.

Keywords: Lime; Organic amendments; Soil acidity; Strip tillage

Angela Di Pinto[a,], Flora Alfano[b], Angela Giordano[b], Federico Capuano[b], Terio Valentina[a, b] and Giuseppina Tantillo[a]. ([a]Dipartimento di Sanità e Benessere degli Animali – Sezione di Ispezione degli Alimenti, Facoltà di Medicina Veterinaria, Università degli Studi di Bari, Strada Prov.le per Casamassima, km 3, 70010 Valenzano, Bari, Italy, [b]Istituto Zooprofilattico Sperimentale del Mezzogiorno, via Salute, 2 80055 Portici, Napoli, Italy). **Quantitative real-time polymerase chain reaction for the presence of genetically-modified maize in breaded "*ready-to-cook*" food products. Food Control, Vol. 19(10) (2008):1002-1005**

The aim of this study was to screen genetically-modified maize and to detect BT 11, BT 176 and MON 810 maize in 10 samples of breaded "*ready-to-cook*" food products obtained from local

markets. Screening for GM maize and quantification were performed with both qualitative and quantitative DNA-based assays. The positive samples contained at least one of the above GM maizes in quantities greater than the 0.9% threshold required for labeling, although the label showed no such information. These results pose an important sanitary problem, which requires the enforcement of legislative guidelines on labeling rules and appropriate traceability systems in order to guarantee public health and consumer choice.

Jörg Romeis[1], Detlef Bartsch[2], Franz Bigler[1], Marco P Candolfi[3,19], Marco M C Gielkens[4], Susan E Hartley[5], Richard L Hellmich[6], Joseph E Huesing[7], Paul C Jepson[8], Raymond Layton[9], Hector Quemada[10], Alan Raybould[11], Robyn I Rose[12], Joachim Schiemann[13], Mark K Sears[14], Anthony M Shelton[15], Jeremy Sweet[16], Zigfridas Vaituzis[17] & Jeffrey D Wolt[18.] Assessment of risk of insect-resistant transgenic crops to nontarget arthropods. *Nature Biotechnology*, Vol. 26(2008): **203 – 208**

An international initiative is developing a scientifically rigorous approach to evaluate the potential risks to nontarget arthropods (NTAs) posed by insect-resistant, genetically modified (IRGM) crops. It adapts the tiered approach to risk assessment that is used internationally within regulatory toxicology and environmental sciences. The approach focuses on the formulation and testing of clearly stated risk hypotheses, making maximum use of available data and using formal decision guidelines to progress between testing stages (or tiers). It is intended to provide guidance to regulatory agencies that are currently developing their own NTA risk assessment guidelines for IRGM crops and to help harmonize regulatory requirements between different countries and different regions of the world.

Katrina M. Dlugosch and Jeannette Whitton. (Department of Botany, University of British Columbia, Vancouver, BC, Canada V6T 2K8). Can we stop transgenes from taking a walk on the wild side? Molecular Ecology, Vol. 17(5) (2008): 1167-1169,

Whether the potential costs associated with broad-scale use of genetically modified organisms (GMOs) outweigh possible benefits is highly contentious, including within the scientific community. Even among those generally in favour of commercialization of GM crops, there is nonetheless broad recognition that transgene escape into the wild should be minimized. But is it possible to achieve containment of engineered genetic elements in the context of large scale agricultural production? In a previous study, Warwick *et al.* (2003) documented transgene escape via gene flow from herbicide resistant (HR) canola (*Brassica napus*) into neighbouring weedy *B. rapa* populations (Fig. 1) in two agricultural fields in Quebec, Canada. In a follow-up study in this issue of Molecular Ecology, Warwick *et al.* (2008) show that the transgene has persisted and spread within the weedy population in the absence of selection for herbicide resistance. Certainly a trait like herbicide resistance is expected to spread when selected through the use of the herbicide, despite potentially negative epistatic effects on fitness. However, Warwick *et al.*'s findings suggest that direct selection favouring the transgene is not required for its persistence. So is there any hope of preventing transgene escape into the wild?

Bioenergy

W. James Catallo[a], Todd F. Shupe[b], and Thomas L. Eberhardt[c]. ([a]Laboratory for Ecological Chemistry, Comparative Biomedical Sciences Department, Louisiana State University, Baton Rouge, LA 70803, USA, [b]School of Renewable Natural Resources, Louisiana State University Agricultural Center, Baton Rouge, LA 70803, USA, [c]USDA Forest Service, Southern Research Station, Pineville, LA 71360, USA). Hydrothermal processing of biomass from invasive aquatic plants. Biomass and Bioenergy, Vol 32(2) (2008): 140-145

The purpose of this study was to examine the hydrothermal (HT) treatment of three invasive aquatic plants (i.e., *Lemna* sp., *Hydrilla* sp., and *Eichhornia* sp.) with respect to the generation of semi-volatile hydrocarbon product mixtures and biomass volume reduction. Identical HT treatments yielded similar semi-volatile product mixtures for *Hydrilla* sp. and *Eichhornia* sp. versus a significantly different mixture for *Lemna* sp. Pre-treatment (i.e., control) extracts of the plant substrates showed no semi-volatile hydrocarbons. Post-HT treatment product mixtures were comprised of complex mixtures of compounds including branched and unbranched alkanes and alkenes as well as light aromatics including substituted benzenes and phenols. All three plant HT product mixtures were dominated by phenol, C_1 alkyl phenols, and oxygenated cycloalkenes. *Lemna* sp. products showed much more diverse distributions of C_2–C_5 alkyl benzenes, alkyl indanes, and alkyl naphthalenes at higher relative levels. Other products from the *Lemna* sp. HT treatment included C_2–C_4 phenols, and alkyl indole and indanol compounds. Results of wet chemical analyses showed that a major difference between *Lemna* sp. and the other two plants was significantly higher extractives levels in the former. It was found that this fraction accounted for much of the complexity in HT product mixture of the *Lemna* sp. biomass. For all HT treatments the substrate mass was reduced by 95% or more.

Keywords: Aquatic weeds; Biomass; *Eichhornia* sp.; Hydrothermal reaction systems; *Lemna* sp.; *Hydrilla* sp.

Nasib Qureshi[a], Badal C. Saha[a], Ronald E. Hector[a], Stephen R. Hughes[b] and Michael A. Cotta[a]. ([a]United States Department of Agriculture (USDA),[1] Agricultural Research Service (ARS), National Center for Agricultural Utilization Research (NCAUR), Fermentation Biotechnology Research Unit, 1815 N. University Street, Peoria, IL 61604, USA, [b]USDA, ARS, NCAUR, Bioproducts & Biocatalysis Research Unit, 1815 N. University Street, Peoria, IL 61604, USA). Butanol production from wheat straw by simultaneous saccharification and fermentation using *Clostridium beijerinckii*: Part I—Batch fermentation. Biomass and Bioenergy, Vol 32(2) (2008): 168-175

Five different processes were investigated to produce acetone–butanol–ethanol (ABE) from wheat straw (WS) by *Clostridium beijerinckii* P260. The five processes were fermentation of pretreated WS (Process I), separate hydrolysis and fermentation of WS to ABE without removing sediments (Process II), simultaneous hydrolysis and fermentation of WS without agitation (Process III), simultaneous hydrolysis and fermentation with additional sugar supplementation (Process IV), and simultaneous hydrolysis and fermentation with agitation by gas stripping (Process V). During the five processes, 9.36, 13.12, 11.93, 17.92, and 21.42 g L^{-1}

ABE was produced, respectively. Processes I–V resulted in productivities of 0.19, 0.14, 0.27, 0.19, and 0.31 g L^{-1} h^{-1}, respectively. It should be noted that Process V resulted in the highest productivity (0.31 g L^{-1} h^{-1}). In the control experiment (using glucose), an ABE productivity of 0.30 g L^{-1} h^{-1} was achieved. These results suggest that simultaneous hydrolysis of WS to sugars and fermentation to butanol/ABE is an attractive option as compared with more expensive glucose to ABE fermentation. Further development of enzymes for WS hydrolysis with optimum characteristics similar to fermentation would make conversion of WS to butanol/ABE even more attractive.

Keywords: Butanol; Acetone–butanol–ethanol (ABE); Wheat straw; *Clostridium beijerinckii* P260; Saccharification; Fermentation

Fatemeh Ebrahimi[a], Morteza Khanahmadi[b], Shapoor Roodpeyma[a] and Mohammad J. Taherzadeh[c]. ([a]Chemical Engineering Department, Isfahan University of Technology, Isfahan, Iran, [b]Agricultural Engineering Research Department, Isfahan Center for the Research of Agricultural Science & Natural Resources, Isfahan, Iran, [c]School of Engineering, University of Borås, SE-50190 Borås, Sweden). **Ethanol production from bread residues. Biomass and Bioenergy, Vol 32(4) (2008): 333-337**

Bread residues were converted into a suitable fermentation feed via a two-step starch hydrolysis using amylolytic enzymes. Wheat flour hydrolysis was also carried out at the same conditions for comparison. For the first stage, namely liquefaction, effects of temperature (50–85 °C) and substrate concentration (20% and 35%) were investigated. The 3-h liquefaction of the 20% bread suspension made 70% of initial dry matter soluble regardless of the temperature. The liquefaction of the 35% bread suspension had to be carried out by a fed-batch method due to the pasty behavior of the suspension. It resulted in a 65% dissolution of the suspended bread at 85 °C. Saccharification of the latter product led to a fermentation feedstock having a dextrose equivalent (DE) of more than 95 and almost 80% dissolution of the initial dry matter. The prepared feedstock was then cultivated using *Saccharomyces cerevisiae*, which resulted in an overall yield of 350 g ethanol per kg of initial bread dry matter. Staling of the bread for a week had no effect on liquefaction, saccharification and ethanol yield.

Keywords: Bread residues; Ethanol; Hydrolysis; -Amylase; Starch; Amyloglucosidase

N. Sunil[a], K.S. Varaprasad[a], N. Sivaraj[a], T. Suresh Kumar[b], Babu Abraham[a] and R.B.N. Prasad[c]. ([a]National Bureau of Plant Genetic Resources, Regional Station, Hyderabad 500 030, India, [b]Fruit Research Station, Acharya N.G. Ranga Agricultural University, Sangareddy, Andhra Pradesh, India, [c]Indian Institute of Chemical Technology, Hyderabad, Andhra Pradesh, India). **Assessing *Jatropha curcas* L. germplasm *in-situ*—A case study. Biomass and Bioenergy, Vol 32(3) (2008): 198-202**

A systematic collection of *Jatropha curcas* germplasm has been carried out from four distinct ecogeographic zones of peninsular India in 2005. This involved recording of passport data, documentation of important plant traits *in-situ*, ecogeographic parameters and assessment of variability. By using the Soxhlet method, the oil content of 162 collected accessions was estimated, which ranged from 22% to 42%. A method has been developed for identification of superior lines by assessing the phenotypic traits of plants recorded *in-situ*. This method facilitates selection of promising accessions for multi-location evaluation and hastens the process of utilization of germplasm. The traits for the plus trees of Jatropha have been discussed.

Keywords: *Jatropha curcas*; Germplasm; Traits; Ecogeographic; Variability; Biofuel; Sampling

B. Demirel[a] and P. Scherer [a]. ([a]Lifetec Process Engineering, Faculty of Life Sciences, Hamburg University of Applied Sciences, Lohbrügger Kirchstrasse 65, 21033 Hamburg, Germany). **Production of methane from sugar beet silage without manure addition by a single-stage anaerobic digestion process. Biomass and Bioenergy, Vol 32(3) (2008): 203-209**

Single-stage continuous anaerobic conversion of sugar beet silage without manure to methane was investigated in this experimental work, using a laboratory-scale mesophilic anaerobic biogas digester. The sugar beet silage had an extreme low pH of 3.3. The reactor was operated in a hydraulic retention time (HRT) range of between 95 and 15 days, and an organic loading rate (OLR) range of between 0.937 and 6.33 g^{-1} VS l^{-1} d^{-1}. The highest specific gas production rate (spec. GPR) of 0.72 l g VS^{-1} d^{-1} could be obtained at 25 days of HRT, with an average methane content of about 63%, at a pH of around 6.8. Since sugar beet silage without the leaves is a poor substrate, in terms of the availability of the nutrients and the buffering capacity, external supplementation of nitrogen and buffering agents has to be regularly performed, in order to achieve a stable and an efficient process. Sodium or potassium hydrogen carbonate addition seemed to function best in our case, among the other agents used, to provide adequate buffering capacity and to keep the digester pH stable during the operation. Use of a new harvest (a new charge of substrate) also affected the spec. GPR values significantly.

Keywords: Anaerobic digestion; Biogas; Biomass; Methane; Renewable energy; Sugar beet

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The present-day energy crisis brings forth to attention biogas as an alternative energy source, i.e. economically feasible and unlimited in potential. Moreover, the economy of biogas plants can be improved by using high biogas potential substrates in combination with cattle dung. One such substrate was identified, having high nitrogen and phosphate content, to amend in cattle dung biogas plants. This amendment was mustard oil cake (MOC) (*Brassica compestries*) added at different ratios to cattle dung digesters. Results indicated a tremendous increase in volatile solids destruction, with a 12.2–13.08% increase in the case of 30% mustard cake addition with a corresponding gas production of 0.329 m^3 kg^{-1} VSa with 4591 ml day^{-1}. This is almost a 63.44% increase in biogas production compared with only cattle dung, which resulted in 2809 ml day^{-1}. But based on the mustard cake availability, an optimum of 20% addition is also very suitable. In general, a biogas increase of 13.38%, 25.27%, 39.16%, 52.26% and 63.44% was observed at 10%, 15%, 20%, 25% and 30% mustard meal/cake addition. Capillary suction time (CST) remained in the range of 320–394 s, indicating good waterability of the digested sludge. Manurial value of the digested sludge was very good.

Keywords: Mustard oil cake; Cattle dung digester; Biogas enhancement; Manurial value

Abbreviations: CD, cow dung; CST, capillary suction time; HRT, hydraulic retention time; kgVSa, kilogram volatile solids; MOC, mustard oil cake; VS, volatile solids; VSa, volatile solids added

Habibollah Younesi[a], Ghasem Najafpour[b], Ku Syahidah Ku Ismail[c], Abdul Rahman Mohamed[d] and Azlina Harun Kamaruddin[d]. ([a]Department of Environmental Science, Faculty of Natural Resources and Marine Sciences, Tarbiat Modarres University, P.O. Box 46414-356 I. R. IRAN, Noor, Iran, [b]Faculty of Chemical Engineering, Noshirvani Institute of Technology, University of Mazandaran, Babol, Iran, [c]School of Bioprocess Engineering, University Malaysia Perlis, Jejawi Complex 3, 02600 Arau, Perlis, Malaysia, [d]School of Chemical Engineering, Engineering Campus, University Sains Malaysia, Penang, 14300 Nibong Tebal, Seri Ampangan, Penang, Malaysia). **Biohydrogen production in a continuous stirred tank bioreactor from synthesis gas by anaerobic photosynthetic bacterium: *Rhodopirillum rubrum*. Bioresource Technology, Vol 99(7) (2008): 2612-2619**

Hydrogen may be considered a potential fuel for the future since it is carbon-free and oxidized to water as a combustion product. Bioconversion of synthesis gas (syngas) to hydrogen was demonstrated in continuous stirred tank bioreactor (CSTBR) utilizing acetate as a carbon source. An anaerobic photosynthetic bacterium, *Rhodospirillum rubrum* catalyzed water-gas shift reaction which was applied for the bioconversion of syngas to hydrogen. The continuous fermentation of syngas in the bioreactor was continuously operated at various gas flow rates and agitation speeds, for the period of two months. The gas flow rates were varied from 5 to 14 ml/min. The agitation speeds were increasingly altered in the range of 150–500 rpm. The pH and temperature of the bioreactor was set at 6.5 and 30 °C. The liquid flow rate was kept constant at 0.65 ml/min for the duration of 60 days. The inlet acetate concentration was fed at 4 g/l into the bioreactor. The hydrogen production rate and yield were 16 ± 1.1 mmol g^{-1} cell h^{-1} and 87 ± 2.4% at fixed agitation speed of 500 rpm and syngas flow rate of 14 ml/min, respectively. The mass transfer coefficient (K_La) at this condition was approximately 72.8 h^{-1}. This new approach, using a biocatalyst was considered as an alternative method of conventional Fischer-Tropsch synthetic reactions, which were able to convert syngas into hydrogen.

Keywords: Hydrogen; Syngas; *Rhodospirillum rubrum*; Mass transfer; Agitation rate and dilution rate

Akinori Matsushika[a], Seiya Watanabe[b, c, d], Tsutomu Kodaki[b, c], Keisuke Makino[b, c, e] and Shigeki Sawayama[a]. ([a]Biomass Technology Research Center (BTRC), National Institute of Advanced Industrial Science and Technology (AIST), 2-2-2 Hirosuehiro, Kure, Hiroshima 737-0197, Japan, [b]Institute of Advanced Energy, Kyoto University, Gokasho, Uji, Kyoto 611-0011, Japan, [c]CREST, Japan Science and Technology Agency (JST), Gokasho, Uji, Kyoto 611-0011, Japan, [d]New Energy and Industrial Technology Development Organization (NEDO), 1310 Omiya-cho, Saiwai-ku, Kawasaki, Kanagawa 212-8554, Japan, [e]Innovative Collaboration Center, Kyoto University, Yoshidahonmachi, Sakyo-ku, Kyoto 606-8501, Japan). **Bioethanol production from xylose by recombinant *Saccharomyces cerevisiae* expressing xylose reductase, $NADP^+$-dependent xylitol dehydrogenase, and xylulokinase. Journal of Bioscience and Bioengineering, Vol 105(3) (2008): 296-299**

We constructed a set of recombinant *Saccharomyces cerevisiae* strains with xylose-fermenting ability. A recombinant *S. cerevisiae* strain D-XR/ARSdR/XK, in which protein engineered $NADP^+$-dependent XDH was expressed, showed 40% increased ethanol production and 23% decrease in xylitol excretion as compared with the reference strain D-XR/XDH/XK expressing the wild-type XDH.

Keywords: lignocellulosic biomass; fermentation; ethanol; xylose; yeast; xylitol dehydrogenase; xylulokinase

Vipin Chandra Kalia[1] and Hemant J. Purohit[2]. ([1]*Microbial Biotechnology and Genomics, Institute of Genomics and Integrative Biology (IGIB), CSIR, Delhi University Campus, Mall Road, Delhi, 110007, India, [2]Environmental Genomics Unit, National Environmental Engineering Research Institute (NEERI), CSIR, Nehru Marg, Nagpur, 440020, India).* **Microbial diversity and genomics in aid of bioenergy. Journal of Industrial Microbiology and Biotechnology, Volume 35(5) (2008): 403-419**

In view of the realization that fossil fuels reserves are limited, various options of generating energy are being explored. Biological methods for producing fuels such as ethanol, diesel, hydrogen (H_2), methane, etc. have the potential to provide a sustainable energy system for the society. Biological H_2 production appears to be the most promising as it is non-polluting and can be produced from water and biological wastes. The major limiting factors are low yields, lack of industrially robust organisms, and high cost of feed. Actually, H_2 yields are lower than theoretically possible yields of 4 mol/mol of glucose because of the associated fermentation products such as lactic acid, propionic acid and ethanol. The efficiency of energy production can be improved by screening microbial diversity and easily fermentable feed materials. Biowastes can serve as feed for H_2 production through a set of microbial consortia: (1) hydrolytic bacteria, (2) H_2 producers (dark fermentative and photosynthetic). The efficiency of the bioconversion process may be enhanced further by the production of value added chemicals such as polydroxyalkanoate and anaerobic digestion. Discovery of enormous microbial diversity and sequencing of a wide range of organisms may enable us to realize genetic variability, identify organisms with natural ability to acquire and transmit genes. Such organisms can be exploited through genome shuffling for transgenic expression and efficient generation of clean fuel and other diverse biotechnological applications.

Keywords: Bacillus - Biodiversity - Biowastes - Biological hydrogen - Genomics

Mette Hedegaard Thomsen[1] and Henrik Haugaard-Nielsen[1]. ([1]Biosystems Department, Risø National Laboratory for Sustainable Energy Technical University of Denmark-DTU, Building 330, P.O. Box 49, DK-4000 Roskilde, Denmark). **Sustainable bioethanol production combining biorefinery principles using combined raw materials from wheat undersown with clover-grass. Journal of Industrial Microbiology and Biotechnology, Vol 35(5) (2008): 303-311**

To obtain the best possible net energy balance of the bioethanol production the biomass raw materials used need to be produced with limited use of non-renewable fossil fuels. Intercropping strategies are known to maximize growth and productivity by including more than one species in the crop stand, very often with legumes as one of the components. In the present study clover-grass is undersown in a traditional wheat crop. Thereby, it is possible to increase input of symbiotic fixation of atmospheric nitrogen into the cropping systems and reduce the need for fertilizer applications. Furthermore, when using such wheat and clover-grass mixtures as raw material, addition of urea and other fermentation nutrients produced from fossil fuels can be reduced in the whole ethanol manufacturing chain. Using second generation ethanol technology mixtures of relative proportions of wheat straw and clover-grass (15:85, 50:50, and 85:15) were pretreated by wet oxidation. The results showed that supplementing wheat straw with clover-grass had a positive effect on the ethanol yield in simultaneous saccharification and fermentation

experiments, and the effect was more pronounced in inhibitory substrates. The highest ethanol yield (80% of theoretical) was obtained in the experiment with high fraction (85%) of clover-grass. In order to improve the sugar recovery of clover-grass, it should be separated into a green juice (containing free sugars, fructan, amino acids, vitamins and soluble minerals) for direct fermentation and a fibre pulp for pretreatment together with wheat straw. Based on the obtained results a decentralized biorefinery concept for production of biofuel is suggested emphasizing sustainability, localness, and recycling principles.

Keywords: Biomass - Intercropping - Bioethanol - Wetoxidation - Biorefinery

Georgia Antonopoulou[a, b], Hariklia N. Gavala[a, b], Ioannis V. Skiadas[a, b], K. Angelopoulos[c] and Gerasimos Lyberatos[a, b]. ([a]Department of Chemical Engineering, University of Patras, Karatheodori 1 st., 26500 Patras, Greece, [b]Institute of Chemical Engineering and High Temperature Chemical Processes, 26504 Patras, Greece, [c]Department of Biology, University of Patras, 26500 Patras, Greece). **Biofuels generation from sweet sorghum: Fermentative hydrogen production and anaerobic digestion of the remaining biomass. Bioresource Technology, Vol 99(1) (2008): 110-119**

The present study focuses on the exploitation of sweet sorghum biomass as a source for hydrogen and methane. Fermentative hydrogen production from the sugars of sweet sorghum extract was investigated at different hydraulic retention times (HRT). The subsequent methane production from the effluent of the hydrogenogenic process and the methane potential of the remaining solids after the extraction process were assessed as well. The highest hydrogen production rate (2550 ml H_2/d) was obtained at the HRT of 6 h while the highest yield of hydrogen produced per kg of sorghum biomass was achieved at the HRT of 12 h (10.4 l H_2/kg sweet sorghum). It has been proved that the effluent from the hydrogenogenic reactor is an ideal substrate for methane production with approximately 29 l CH_4/kg of sweet sorghum. Anaerobic digestion of the solid residues after the extraction process yielded 78 l CH_4/kg of sweet sorghum. This work demonstrated that biohydrogen production can be very efficiently coupled with a subsequent step of methane production and that sweet sorghum could be an ideal substrate for a combined gaseous biofuels production.

Keywords: Biofuels; Fermentation; Hydrogen; Methane; Sweet sorghum

Pål Börjesson[1] and Bo Mattiasson[2]. ([1]Environmental and Energy Systems Studies, Department of Technology and Society, Lund University, Box 118, SE-221 00 Lund, Sweden, [2]Department of Biotechnology, Centre for Chemistry and Chemical Engineering, Lund University, Box 124, SE-221 00 Lund, Sweden). **Biogas as a resource-efficient vehicle fuel. Trends in Biotechnology, Vol 26(1) (2008): 7-13**

There are currently strong incentives for increased use of renewable fuels in the transport sector worldwide. However, some bioethanol and biodiesel production routes have limitations with regard to resource efficiency and reduction of greenhouse gases. More efficient biofuel systems are those based on lignocelluloses and novel conversion technologies. A complementary strategy to these is to increase the production of biogas from the digestion of organic residues and energy crops, or from byproducts of ethanol and biodiesel production. Compared with other biomass-based vehicle fuels available so far, biogas often has several advantages from an environmental and resource-efficiency perspective. This provides the motivation for further technological

development aiming to reduce costs and thereby increased economic competitiveness of biogas as a vehicle fuel.

Yusuf Chisti[a]. ([a]School of Engineering, Massey University, Private Bag 11 222, Palmerston North, New Zealand). Biodiesel from microalgae beats bioethanol. Trends in Biotechnology, Vol 26(3) (2008): 126-131

Renewable biofuels are needed to displace petroleum-derived transport fuels, which contribute to global warming and are of limited availability. Biodiesel and bioethanol are the two potential renewable fuels that have attracted the most attention. As demonstrated here, biodiesel and bioethanol produced from agricultural crops using existing methods cannot sustainably replace fossil-based transport fuels, but there is an alternative. Biodiesel from microalgae seems to be the only renewable biofuel that has the potential to completely displace petroleum-derived transport fuels without adversely affecting supply of food and other crop products. Most productive oil crops, such as oil palm, do not come close to microalgae in being able to sustainably provide the necessary amounts of biodiesel. Similarly, bioethanol from sugarcane is no match for microalgal biodiesel.

Palligarnai T. Vasudevan[1] and Michael Briggs[2]. ([1]Department of Chemical Engineering, University of New Hampshire, Durham, NH, USA, [2]Department of Physics, University of New Hampshire, Durham, NH, USA). Biodiesel production—current state of the art and challenges. Journal of Industrial Microbiology and Biotechnology, Vol 35(5) (2008): 421-430

Biodiesel is a clean-burning fuel produced from grease, vegetable oils, or animal fats. Biodiesel is produced by transesterification of oils with short-chain alcohols or by the esterification of fatty acids. The transesterification reaction consists of transforming triglycerides into fatty acid alkyl esters, in the presence of an alcohol, such as methanol or ethanol, and a catalyst, such as an alkali or acid, with glycerol as a byproduct. Because of diminishing petroleum reserves and the deleterious environmental consequences of exhaust gases from petroleum diesel, biodiesel has attracted attention during the past few years as a renewable and environmentally friendly fuel. Since biodiesel is made entirely from vegetable oil or animal fats, it is renewable and biodegradable. The majority of biodiesel today is produced by alkali-catalyzed transesterification with methanol, which results in a relatively short reaction time. However, the vegetable oil and alcohol must be substantially anhydrous and have a low free fatty acid content, because the presence of water or free fatty acid or both promotes soap formation. In this article, we examine different biodiesel sources (edible and nonedible), virgin oil versus waste oil, algae-based biodiesel that is gaining increasing importance, role of different catalysts including enzyme catalysts, and the current state-of-the-art in biodiesel production.

Keywords: Biodiesel - Edible and nonedible - Algae-based - Waste oil - Enzymes - Catalysis - Lipase - Photosynthesis

M. Canakci[1, 2] and H. Sanli[3]. ([1]Department of Mechanical Education, Kocaeli University, 41380 Izmit, Kocaeli, Turkey, [2]Alternative Fuels R&D Center, Kocaeli University, 41040 Izmit, Kocaeli, Turkey, [3]Golcuk Vocational High School, Kocaeli University, 41660 Izmit, Kocaeli, Turkey). Biodiesel production from various feedstocks and their effects on the fuel properties. Journal of Industrial Microbiology and Biotechnology, Vol 35(5) (2008): 431-441

Biodiesel, which is a new, renewable and biological origin alternative diesel fuel, has been receiving more attention all over the world due to the energy needs and environmental consciousness. Biodiesel is usually produced from food-grade vegetable oils using transesterification process. Using food-grade vegetable oils is not economically feasible since they are more expensive than diesel fuel. Therefore, it is said that the main obstacle for commercialization of biodiesel is its high cost. Waste cooking oils, restaurant greases, soapstocks and animal fats are potential feedstocks for biodiesel production to lower the cost of biodiesel. However, to produce fuel-grade biodiesel, the characteristics of feedstock are very important during the initial research and production stage since the fuel properties mainly depend on the feedstock properties. This review paper presents both biodiesel productions from various feedstocks and their effects on the fuel properties.

Keywords: Biodiesel - Feedstocks - Transesterification - Fuel properties

Mei-Yun Wang[1], Betty H. Olson[2] and Jo-Shu Chang[1]. ([1]Department of Chemical Engineering, National Cheng Kung University, No. 1 University Road, Tainan, 701, Taiwan, [2]Department of Civil and Environmental Engineering, University of California at Irvine, 1368 Social Ecology II, Irvine, CA 92697, USA). **Relationship among growth parameters for *Clostridium butyricum, hyd* A gene expression, and biohydrogen production in a sucrose-supplemented batch reactor. Applied Microbiology and Biotechnology, Vol 78(3) (2008): 525-532**

This study was undertaken to identify the relationship between the performance of dark H_2 fermentation and expression of the key functional gene (i.e., hydrogenase gene) involved in the bioH_2 production process. *Clostridium butyricum* CGS5 isolated from anaerobic sewage sludge was used as the model strain for this study. Copy number of the hydrogenase gene (*hyd*A) and mRNA transcripts (cDNA *hyd*A) (after amplification) and the total DNA and RNA (before amplification) were measured over the course of the growth of strain CGS5. Cell concentration was also determined by optical density and converted to dry weight. After amplification, the *hyd*A gene increased 1,500-fold during late exponential growth phase after normalization to the copy number at time 0, and cDNA from mRNA transcripts of *hyd*A also increased 500-fold after normalization. mRNA transcripts of *hyd*A lagged behind the increase of total DNA and RNA, and increases in *hyd*A more closely mimicked those of total DNA. Increases in both of these parameters corresponded with hydrogen production. Transcripts of 16s ribosomal RNA reached a maximum value earlier (38 h) than did those of *hyd*A (47 h). All molecular characteristics matched those for sucrose utilization, growth, and hydrogen production. These experiments indicated that transcription as measured by cDNA can be related to hydrogen production and possesses the potential to be used as tool for process control.

Keywords: Biohydrogen - C*lostridium butyricum* - Expression of *hyd*A gene - Hydrogenase - RT-PCR - qPCR

Liam Jed Thompson[1], Vincent Myles Gray[1], Bukasa Kalala[1], Denise Lindsay[1], Kelley Reynolds[1] and Alex von Holy[1]. ([1]School of Molecular and Cell Biology, University of the Witwatersrand, Private Bag 3, Wits, 2050, South Africa). **Biohydrogen production by *Enterobacter cloacae* and *Citrobacter freundii* in carrier induced granules. Biotechnology Letters, Vol 30(2) (2008); 271-274**

Carrier induced granular particles comprising *Enterobacter cloacae* and *Citrobacter freundii* were used to generate H_2 from sucrose in an anaerobic fluidized bed bioreactor. At a hydraulic retention time of 4.5 h, 95.8% of the sucrose was consumed and the rate of H_2 production reached 180 mmol H_2 l h^{-1}. Biogas composition for H_2 and CO_2 was 42 and 55%, respectively.

Keywords: Biohydrogen - Bioreactor - Fluidized - Granules

Name of Journals

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2. Aerobiologia
3. Annual Review-Plant Pathology
4. Annual Review- Ecology and Systematics
5. Annual Review-Biochemistry
6. Annual Review-Biomedical Engineering
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10. Annual Review-Phytopathology
11. Annual Review-Physiology
12. Annual Review-Plant Physiology
13. Annual Review-Public Health
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106. Shaspa
107. The Indian Forester
108. Trends in Biotechnology
109. Water, Air and Soil Pollution
110. World Journal of Biotechnology
111. World Journal of Microbiology and Biotechnology
112. Bio-metallurgy and Hydro-metallurgy

Authors Index